

M.Sc. ZOOLOGY

LOCF SYLLABUS 2026

(w.e.f. June 2026)



Department of Zoology

School of Life Sciences

St. Xavier's College (Autonomous), Palayamkottai

Affiliated to Manonmaniam Sundaranar University, Tirunelveli
(Recognized as "College with Potential for Excellence" by UGC)
(Accredited with "A⁺⁺" Grade with a CGPA of 3.66/4 in IV cycle)

Tirunelveli – 627 002, Tamil Nadu, India

VISION

To mould young men and women as leaders in all walks of life so that they may serve the people especially the poor and the oppressed of our nation in truth, justice and love.

MISSION

To achieve a synthesis of academic excellence and the formation of character.

To ensure social justice through equity and access.

To include the excluded for empowerment.

To equip students with global competencies.

To engage in relevant research activities.

To promote Lab to Land through the Outreach Programme – Student Training and Action for Neighbourhood Development (STAND).

SCHOOLS OF EXCELLENCE WITH CHOICE-BASED CREDIT SYSTEM (CBCS)

ESSENTIAL FEATURES OF CBCS

Standardisation of degree courses to internationally accepted levels.

Focus on skill-based curriculum.

Emphasis on value education.

Institution - Industry collaboration.

Provision for earning more credits.

Development of communication skills.

POST GRADUATE COURSES

The existing PG curriculum was thoroughly upgraded based on the expectations of the academicians and the aspirations of the student community. The PG syllabus has two parts : Core and Elective. The minimum number of credits to be earned by a student is 100. The aim of the project work at the PG level is to develop the skill of solving problems and to promote research motivation. All the I-year PG students are offered one Value - Added Course and during their II year they are supposed to do one Extra Credit course outside their class hours to enhance their employability skills. However, during every semester, they are free to learn one ECC paper, offered by the respective departments.

CREDIT SYSTEM

The credit system at St. Xavier's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines. The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work. For postgraduate (PG) courses, students are required to accumulate a minimum of 100 credits, as stipulated in the programme pattern table. The total number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

Outcome-Based Education (OBE) is a student-centric teaching and learning methodology that focuses on measuring student performance through clearly defined outcomes. For St. Xavier's College, with its commitment to excellence and NAAC/NBA accreditation requirements, OBE is not just a regulatory expectation but a pathway to academic quality, global competitiveness, and improved employability of graduates.

We prepare students to meet future industry requirements and reinforce St. Xavier's College, Palayamkottai, as a leader in quality higher education. St. Xavier's College introduced OBE in 2018, and for the Attainment Calculation, we developed our own method in 2018. From the academic year 2025-26 onwards, in examinations, for each question we mark Course Outcome (CO), Competency and Performance Indicator, Programme Outcome / Programme Specific Outcome, Bloom's Revised Cognitive Level and we follow the OBE procedure for the calculation of the Attainment of Outcome for each student, course, semester, programme.

EVALUATION PATTERN (PG)

CONTINUOUS INTERNAL ASSESSMENT

There is no internal minimum for any paper. However, Continuous Internal Assessment (CIA) is a mandatory requirement for all students. A student must take at least one CIA test out of two tests and must fulfil at least one mode of assessment among assignments, quiz, seminars, etc., otherwise he/she will not be permitted to write the semester examination.

ALLOTMENT OF MARKS

S.No	Component	Marks Allotted
1	I CIA Test	70
2	II CIA Test	70
	Total	140

3. Average marks of CIA -1 and 2 will be converted to 70 marks
4. Assignment – 15 marks + *Viva voce* – 15 marks
5. Aggregate marks = 100

The total CIA marks of 140 will be converted to 70 marks. An additional 30 marks will be awarded through other internal assessment components.

The Continuous Internal Assessment (CIA) consists of two component tests, each carrying 15 marks (15 + 15).

The final internal assessment marks will be calculated out of 100 (70 + 30). The obtained marks will be converted to 50 marks.

QUESTION PATTERN FOR CIA AND SEMESTER EXAMINATIONS

PG Semester Examinations (3 Hours)

PART	TYPE	Mark Distribution	Total Marks
A	MCQ	10X1	10
B	ALL	5X3	15
C	Either/or	5X6	30
D	3 out of 5	3X15	45
		Total	100

SEMESTER (EXTERNAL) EXAMINATION

- The External Semester Examination will be conducted for **100 marks**.
- The obtained marks will be **converted to 50 marks**.

PG INTERNAL EXAMINATIONS (2 Hours)

PART	TYPE	Mark Distribution	Total Marks
A	MCQ	10X1	10
B	ALL	3X3	09
C	Either/or	3x7	21
D	3 out of 5	3X10	30
		Total	70

QUESTION PATTERN AND MARKS FOR PRACTICAL EXAMINATION

Type of questions	Marks
Major Practical Procedure-5 Marks Performance of the experiment, observation, calculation and table or graph-7 Marks Discussion -3 Marks	15
Minor Practical / Instrumentation Performance of the experiment/observation, calculation and table or graph-7 Marks Discussion -3 Marks	10
Identification of animals / instruments / spotters (5 or 10 with 1 mark or 0.5 mark each) / Mini project / Insect Box	5
Spotters (5 x 3) -Identification – ½ mark, Diagram – ½ mark, Labelling – ½ mark (Unlabelled diagram carries no mark) and explanation - 1½ mark	15
Record notebook	5
Total	50

GRADING SYSTEM

Range of Marks	Letter Grade	Grade Point	Description
90-100	A+	9.0-10.0	Outstanding
80-89	A	8.0-8.9	Excellent
70-79	B+	7.0-7.9	Very Good
60-69	B	6.0-6.9	Good
50-59	U	5.0-5.9	Average
00-49	U	0	Reappear

Programme Name: M.Sc. ZOOLOGY

Programme Code: PZO

PROGRAMME OUTCOMES (PO) FOR PG PROGRAMMES

Students of all Undergraduate Degree Programmes at the time of graduation will be able to attain the following:

PO1. Critical Thinking: Acquire the knowledge in the respective field and take informed actions.

PO2. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3. Social Interaction: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional practice.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Ethics: Recognize different value systems and apply ethical principles and commit to professional ethics and responsibilities and norms of different value systems.

PO6. Environment and Sustainability: Demonstrate the issues of environmental contexts and sustainable development.

PO7. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modeling to complex activities with an understanding of the limitations.

PO8. Self-directed and Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PROGRAMME SPECIFIC OBJECTIVES

1. M.Sc. in Zoology is a two-year Post-Graduate academic degree programme which focuses on the studies relating to animals. The teaching programme in the department is interdisciplinary and the course covers the emerging areas in life sciences.
2. These include courses like Structure and Function of Invertebrates, Comparative Anatomy of Chordates, Biochemistry, Ecology, Research Methodology, Biostatistics, Immunology and Microbiology, Genetics, Developmental Biology, Bioinstrumentation, Bioinformatics, Biotechnology, Evolution, Cell and Molecular Biology, Comparative Animal Physiology, Animal Husbandry, Apiculture, Entomology, Aquaculture, Poultry Farming, and Sericulture in M.Sc. teaching programme.
3. Hands-on practical training to the students is one of the outstanding features of the M.Sc. Zoology programme.
4. The teaching and research laboratories in the department are very well equipped with all the required instruments / equipments and students are always encouraged to use them.
5. The department houses a library catering to the needs of the students. Special efforts are made to add latest text books and scientific journals to the collection. M.Sc. students of the department have access to the internet facilities for academic purposes.
6. In order to expose the students to research environment, every student is also required to complete a small research project during the second year of the programme.

7. Every year study tour is arranged to various places in India, as part of the M.Sc. curriculum.
8. The research activities of the department are also recognised nationally and internationally and cover areas such as aquaculture and entomology with sharp focus on molecular biology, genetics, cell and developmental biology, animal physiology etc. The faculty members of this department have received several research grants from various national and international agencies.

PROGRAMME SPECIFIC OUTCOMES

On completion of the M.Sc. program in Zoology the students will be able to:

1. Describe the biochemistry of bio-molecules, its metabolism and functions.
2. Understand ultra-structure and functions of various cellular organelles including cancerous cells and cell signaling.
3. Demonstrate parametric and non-parametric statistics and their biological applications.
4. Outline taxonomy, diversity of animals and their comparative functional anatomy.
5. Summarize ecosystem, bio-resources and their management, role of GMOs in biodegradation of xenobiotic compounds.
6. Summarize classical and modern genetics, genetic disorders, genetic counseling, tools and applications of genetic engineering and biotechnology.
7. Describe structure and functions of various organ systems and the physiology of animals and human beings.
8. Comprehend the concepts of ecosystem and to understand the impact of environment and their management strategies.
9. Describe fundamentals of the developmental process of various organisms.
10. Trace the origin of life and evolution, evolutionary processes, major trends of evolution and future of man.

EMPLOYMENT AND HIGHER STUDIES OPPORTUNITIES FOR M.SC. ZOOLOGY STUDENTS

1. The higher studies options after M.Sc. Zoology are: Doctor of Philosophy (Ph.D) in Zoology, -/Biotechnology / Life Sciences.
2. A Master degree holder is eligible to –appear competitive exams like NET, SET, placement as Project Assistant, employability in Fishery Board of India and Department of Sericulture and Department of Forests, Government of Tamil Nadu, Central Silk Board, etc.
3. P.G students are eligible to pursue B.Ed., and appear for TNPSC, IAS, IPS, IFS (Group 1 exams).Job opportunity including Biological Laboratory Technician, Conservationist, Environmental Consultant, Herpetologist, Veterinary Technologist, Wildlife Educator, Wildlife Rehabilitator, Zoologist, etc.

COURSE STRUCTURE FOR M. Sc. ZOOLOGY

Semester	Part	Status	Subject Code	Title	Hours	Credits
I	A	Core - 1	26PZOC11	Biochemistry	6	5
		Core -2	26PZOC12	Structure and Function of Invertebrates	6	5
		Core-3	26PZOC13	Biochemistry & Biostatistics- Practical	4	2
		Core-4	26PZOC14	Structure and Function of Invertebrates & Comparative Anatomy of Chordates-Practical	4	2
	B	EC-1	26PZOE11	Comparative Anatomy of Chordates	5	3
		EC-2	26PZOE12	Biostatistics	5	3
				Sub Total	30	20
II	A	Core – 5	26PZOC21	Cell and Molecular Biology	5	5
		Core – 6	26PZOC22	Developmental Biology	5	5
		Core-7	26PZOC23	Cell and Molecular Biology & Developmental Biology- Practical	4	2
		Core-8	26PZOC24	Immunology and Microbiology - Practical	4	2
	B	EC-3	26PZOE21	Immunology and Microbiology	4	3
		EC-4	26PZOE22	Research Methodology	4	3
		SEC-1	26PZOS21	Stem cell Biology	4	2
	C	Extension activities		STAND		1
				Sub Total	30	23
III	A	Core-9	26PZOC31	Evolution	5	5
		Core-10	26PZOC32	Animal Physiology	5	5
		Core-11	26PZOC33	Evolution and Genetics - Practical	4	2
		Core -12	26PZOC34	Animal Physiology - Practical	4	2
	B	EC-5	26PZOE31	Genetics	4	4
		SEC-2	26PZOS31	Animal Husbandry	4	3
		SEC-3	26PZOS32	Animal Biotechnology	4	3
		Internship	26PZOI35	Carried out in summer vacation at the end of Semester II		2
				Sub Total	30	26
IV	A	Core-13	26PZOC41	Ecology	4	4
		Core-14	26PZOC42	Aquaculture	4	4
		Core-15	26PZOC43	Entomology-Practical	4	2
		Project	26PZOC44	Project with viva voce	10	7
	B	EC-6	23PZOE41	Aquaculture and Ecology- Practical	4	2
		SEC-4	23PZOS41	Entomology	4	3
				Sub Total	30	22
				GRAND TOTAL	120	91

Additional Compulsory Course

Additional Compulsory Courses					
I PG	Value Added course(Anyone)	26PZOVA11/ 26PZOVA12/ 26PZOVA13	Dairy Farming/ Zoology for Competitive Exams /Industrial Zoology		3
II PG	Extra credit course-(Anyone)	26PZOEC1/26PZOE C2/26PZOEC3/26PZ OEC4	Biodiversity / Medical Entomology/ Animal Behaviour/ Biopesticides		3
Field visit/ Industrial visit					1
MOOC					2
Total				120	100

EC- Elective course; FC- Foundation course;VE- Value education; SEC-Skill Enhancement Course

BIOCHEMISTRY

(Subject code: 26PZOC11)

Semester: I

Core: 1

Credits: 5

Hours: 6

Course objective: To provide a fundamental understanding of the structure of biomolecules and their metabolic pathways; the biochemical roles of vitamins and hormones, and to learn the biochemical basis of nutrition, health, and diseases.

Course outcomes: At the end of the course the students will be able to

CO1	Demonstrate the basic structure of atoms, molecules and their interactions and recall the classification, structure, properties, and functions of biomolecules	K1
CO2	Analyze the structure and organization of nucleic acids and to explain the classification, structure, and properties of enzymes	K2
CO3	Illustrate and interpret the metabolic pathways of carbohydrates, proteins, and lipids, emphasizing their regulation and physiological significance	K3
CO4	Classify vitamins and hormones and explain their sources, properties, biochemical roles.	K4
CO5	Integrate the biochemical roles and interactions of carbohydrates, proteins, lipids, nucleic acids, hormones, and vitamins.	K5
CO6	Create models to demonstrate and interpret the regulatory functions in metabolism and homeostasis.	K6

(K1-Remember;K2-Understand;K3-Apply;K4-Analyze;K5-Evaluate;K6–Create)

Unit I : Interactions in Biomolecules

(18Hours)

Structure of biomolecules – Structure of atoms and molecules, Molecular interactions – covalent and non-covalent interactions, Stabilizing interactions (Vander Waals, electrostatic and hydrophobic interaction). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics and colligative properties)

Unit II : Carbohydrates, Proteins and Lipids

(18 Hours)

Carbohydrates - Monosaccharides - general structure and properties; oligosaccharides; Polysaccharides. Proteins - Amino acids – Peptides, Protein configuration, classification and properties, General structure - Primary, secondary, tertiary and quaternary structure, Ramachandran plot. Lipids - classification, properties of fats and fatty acids.

Unit III : Nucleic Acids and Enzymes

(18 Hours)

Nucleic Acids – Chemistry, nucleosides, nucleotides, variants of DNA, single-stranded DNA; RNA-types and chemistry. Enzymes–nomenclature, classification, three-dimensional structure, mechanism of action, enzyme kinetics and enzyme regulation and Isoenzymes.

Unit IV: Metabolism

(18 Hours)

Glycolysis, alcoholic fermentation, pyruvate oxidation, citric acid cycle, HMP pathway, glyoxylate cycle, electron transport, oxidative phosphorylation; oxidation of even-chain fatty acids (oxidation), unsaturated fatty acids and odd-chain fatty acids; Amino acid metabolism, Metabolism of nucleotides.

Unit V: Vitamins and Hormones

(18Hours)

Fat-soluble vitamins–characteristic features, structure, deficiency; water-soluble vitamins–characteristic features, structure, deficiency; coenzyme Q, metabolism of vitamin A and C
General function and outline classification -steroid hormones, peptide hormones, amino acid derivatives, para-hormones, vasoactive peptides, pheromones, mechanism of hormone action.

Textbooks:

1. Peter J. Kennelly, Kathleen M. Botham, Owen McGuinness, Victor W. Rodwell, P. Anthony Weil. 2022. Harper's Illustrated Biochemistry, 32nd edition, McGraw-Hill Education. 816 pages.
2. U.Satyanarayana, U.Chakrapani.2020.Biochemistry,5thedition,Elsevier.777pages.
3. J. L.Jain, Sunjay Jain, Nitin Jain. 2016. Fundamentals of biochemistry, S.Chand &Co. Ltd., New Delhi. 1264 pages.

Reference books:

1. K. Ramadevi. 2016. Ambika Shanmugam's Fundamentals of Biochemistry for Medical Students. 8th edition. Wolters Kluwer (India) Pvt. Ltd. 590 pages.
2. D. M. Vasudevan. 2023. Textbook of Biochemistry for Medical Students. 10th edition. Jaypee Brothers Medical Publishers. 922 pages.
3. Denise R. Ferrier. 2020. Lippincott's Illustrated Reviews - Biochemistry South Asian Edition. Wolters Kluwer (India) Pvt. Ltd. 950 pages.
4. David L. Nelson and Michael M. Cox. 2017. Lehninger - Principles of Biochemistry. 7th edition. W. H. Freeman. 1172 pages.
5. A. Hofmann and S. Clokie. 2018. Wilson and Walker's - Principles and Techniques of Biochemistry and Molecular Biology. 8th edition. Cambridge University Press. 929pages.

E-resources

1. <http://jpkc.gmu.cn/swhx/book/Biochemistry.pdf>
2. <http://www.louisbolk.org/downloads/1282.pdf>
3. http://library.aceondo.net/ebooks/Chemistry/lehninger_principles_of_biochemistry_4th.ed.pdf
4. http://global.oup.com/us/companion.websites/fdscontent/uscompanion/us/static/companion.websites/9780199730841/McKee_Chapter8_Sample.pdf
5. http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/mini/Principles-of-Biochemistry-by-ALbert-Leningher.pdf

STRUCTURE AND FUNCTION OF INVERTEBRATES

(Subject code: 26PZOC12)

Semester: I

Core: 2

Credits: 5

Hours: 6

Course objective: To provide an in-depth understanding of taxonomic principles and the structural and functional organization of major invertebrate groups.

Course outcomes: At the end of the course the students will be able to

CO1	Apply principles of animal taxonomy, nomenclature, and coelomic organization to classify and differentiate major invertebrate groups.	K3
CO2	Apply concepts of locomotion, nutrition, and digestion to explain functional adaptations in protozoa and lower metazoans.	K3
CO3	Apply knowledge of respiratory and excretory systems to explain physiological regulation and osmoregulation in invertebrates.	K3
CO4	Analyze the organization and evolution of nervous systems across invertebrate phyla using comparative anatomical features.	K4
CO5	Evaluate the evolutionary and ecological significance of invertebrate larval forms and their adaptive strategies.	K5
CO6	Integrate structure, function, and evolution of invertebrate systems across phyla.	K6

(K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6- Create)

Unit I: Principles of animal taxonomy

18 Hours

Species concept; International Code of Zoological nomenclature - Taxonomic procedures. New trends in taxonomy - Organization of coelom - Acoelomates –Pseudocoelomates- Coelomates- Symmetry and Metamerism Protostomia and Deuterostomia. Evolutionary relationships among major invertebrate phyla.

Unit II: Locomotion

18 Hours

Pseudopodia-Flagella and ciliary movement in protozoa-Hydrostatic movement in Coelenterata, Annelida and Echinodermata - Nutrition and Digestion - Patterns of feeding and digestion in lower metazoan -Filter feeding in Polychaeta, Mollusca and Echinodermata.Energetics and efficiency of invertebrate movement.

Unit III: Respiration

18 Hours

Organs of respiration: cutaneous, gills, lungs and trachea-Respiratory pigments- Mechanism of respiration. Role of circulatory system in respiration. Excretion- Organs of excretion: coelom, coelomoducts, nephridia and Malpighian tubules - mechanisms of excretion-Excretion and osmoregulation

Unit IV: Nervous system

18 Hours

Primitive nervous system: Coelenterata and Echinodermata - Advanced nervous system: Annelida, Arthropoda (crustaceans and insects) and Mollusca (Cephalopoda) - Trends in neural

evolution. Sensory organs in invertebrates: photoreceptors, statocysts, mechanoreceptors.

Unit V: Larval forms and Minor Phyla

18 Hours

Larval forms of free living invertebrates (Porifera, Coelenterata, Annelida, Crustacea, Echinodermata) - Larval forms of parasites (Helminthes, Mollusca) - Strategies and evolutionary significance of larval forms - Minor Phyla (Structural features and affinity) - Concept and significance - Organization and general characters (Mesozoa, Rhynchocoela, Rotifera, Phoronida)

Textbooks:

1. Kotpal, R. L., Agarwal, S. K., & Ketarpal, R. P. R. (2019). Modern Textbook of Zoology: Invertebrates (12th ed.). Rastogi Publications.
2. Brusca, R. C., Moore, W., & Shuster, S. M. (2016). Invertebrates (3rd ed.). Sinauer Associates.
3. Ekambaranatha Ayyar, M., & Ananthakrishnan, T. N. (1992). A Manual of Zoology: Invertebrata (Vols. I–II). S. Viswanathan (Printers & Publishers).

Reference books:

1. Pechenik, J. A. (2014). Biology of the Invertebrates (7th ed.). McGraw-Hill.
2. Ruppert, E. E., & Barnes, R. D. (2006). Invertebrate Zoology (7th ed.). Saunders.
3. Barnes, R. S. K., Calow, P., Olive, P. J. W., Golding, D. W., & Spicer, J. I. (2002). The Invertebrates: A New Synthesis. Blackwell Science.
4. Anderson, D. T. (2001). Invertebrate Zoology (2nd ed.). Oxford University Press.
5. Barrington, E. J. W. (1979). Invertebrate Structure and Function (2nd ed.). ELBS / Nelson.

E-resources:

1. https://www.researchgate.net/profile/Seema-Saxena-2/publication/383398812_Text_Book_of_Animal_Taxonomy/links/66cadbe5c2eaa5002314da81/Text-Book-of-Animal-Taxonomy.pdf
2. <https://uou.ac.in/sites/default/files/slm/MSCZO-501.pdf>
3. https://deb.ugc.ac.in/Uploads/SelfLearning/HEI-P-U-0482/HEI-P-U-0482_SelfLearning_20230331142843.pdf
4. http://rcastilho.pt/DA/ewExternalFiles/Invertebrates_Cap_33_Cambell.pdf
5. https://www.bdu.ac.in/cde/REVISED_SLM/UG/B.Sc%20Zoology/Invertebrata_CRC.pdf

Mapping with programme outcomes								
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M
CO6	S	M	S	M	S	S	M	M

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

BIOCHEMISTRY&BIOSTATISTICS-PRACTICAL

(Subject code: 26PZOC13)

Semester: I

Core: 3

Credits: 2

Hours: 4

Course objective: To impart the basic principles of biochemistry and the concepts and applications of biostatistics; and to build practical skills in the isolation and estimation of biomolecules and enzyme assays and statistical software for data analysis, hypothesis testing.

COs	Course outcome: At the end of the course the students are expected to	K
CO1	Inculcate the knowledge on the basic principles of biochemistry and the fundamental concepts and applications of biostatistics	K1
CO2	Familiarize with the basic principles of biochemical analysis, including pH, buffer systems.	K2
CO3	Develop practical skills in isolation and estimation of biomolecules and enzyme assays.	K3
CO4	Gain practical experience in separation and analytical techniques, including paper chromatography and thin-layer chromatography.	K4
CO5	Gain hands on training in applications of biostatistical tools, enabling students to collect, organize, analyze, and interpret biological data using statistical methods.	K5
CO6	Develop competence in the use of statistical software and tools, including MS Excel and SPSS, for data analysis, hypothesis testing, and graphical representation.	K6

(K1-Remember;K2-Understand;K3-Apply;K4-Analyze;K5-Evaluate;K6–Create)

Experiments:

1. Concept of pH, measuring Ph of different solutions
2. Preparation of Phosphate buffer
3. Estimation of Carbohydrate in fish muscles/liver
4. Estimation of salivary amylase activity
5. Estimation of protein by Lowry's method
6. Estimation of protease activity
7. Estimation of nucleic acids (DNA) using blood sample
8. Estimation of iodine value in edible oils
9. Determination of acid value of fats and oils
10. Estimation of ascorbic acid by Titrimetric method
11. Separation of lipids by TLC
12. Separation of amino acids by ascending paper chromatography
13. Calculation of mean, standard deviation and standard error using marine shell
14. Correlation – Students height and weight.
15. Probability– tossing with two and three coins.
16. Regression analysis– neem leaflets
17. MSEXCEL Functions– *t*-test, F-test and Z-test.
18. SPSS– One way/Two way ANOVA calculation

Spotters: Biochemistry - Structure of glucose, Starch, Structure of protein, Myoglobin, Haemoglobin, α -lecithin, Cephalin, Stearic acid, Oleic acid, Cyclic AMP, Urea cycle, Krebs's cycle, Structure of DNA, Types of DNA, Structure & types of RNA, Enzyme action- lock and key model, Induced fit model; Fat soluble vitamins and water soluble vitamins, steroid and peptide hormonal action. Instruments -pH meter, colorimeter, Paper chromatography, gel electrophoresis, spectrophotometer and centrifuge. Biostatistics - Histogram, bar diagram, pictogram, pie chart, frequency polygon, venn diagram, types of correlation.

STRUCTURE AND FUNCTION OF INVERTEBRATES & COMPARATIVE ANATOMY OF CHORDATES - PRACTICAL

(Subject code: 26PZOC14)

Semester: I

Core: 4

Credits: 2

Hours: 4

Course objective. To train students in advanced dissection and mounting techniques. To correlate anatomical structures with physiological functions. To develop comparative skills between invertebrate and chordate systems.

Course outcomes:

CO1	Remember diagnostic anatomical features of specimens nomenclature, and coelomic organization to classify and differentiate major invertebrate and vertebrate groups.	K3
CO2	Understand concepts of locomotion, nutrition, and digestion to explain functional adaptations in protozoa and lower metazoans.	K3
CO3	Apply document observations using scientific standards.	K3
CO4	Analyze and compare nervous, digestive, and reproductive systems across taxa	K4
CO5	Evaluate the evolutionary and ecological significance of invertebrate larval forms and their adaptive strategies.	K5
CO6	Create and Interpret anatomical data in evolutionary context.	K6

Dissection

Cockroach	:	Nervous system, Reproductive System, Digestive System
Prawn	:	Nervous System
Crab	:	Nervous system
Fish	:	Reproductive System, Digestive System

Mounting

Earthworm	:	Body setae
Cockroach	:	Mouth parts
Prawn	:	Appendages
Shark	:	Scales
Fish	:	Scales
Fish	:	Weberian ossicles of fish
Birds	:	Feathers
Mammals	:	Hair

Study of the following slides/specimens with special reference to their salient features and their modes of life cycle

Amoeba, *Paramecium*, *Hydra* with bud., Liver fluke, Cercaria larva, Tape worm, *Ascaris*, Scorpion, *Penaeus indicus*, *Emerita* (Hippa), *Perna viridis*, Mysis of prawn, *Amphioxus* sp.

(Lancelet), *Ascidia* sp. (sea squirt), *Scoliodon laticaudatus* (Indian dog shark), *Trygon* sp. (Sting ray), *Torpedo* sp. (Electric ray), *Arius maculatus* (Cat fish), *Belonecancila* (Flute fish), *Exocoetus poecilopterus* (Flying fish), *Mugil cephalus* (Mullet), *Tilapia mossambicus* (Tilapia), *Rachycentron canadum* (Cobia), *Tetrodon punctatus* (Puffer fish), *Dendrophis* sp. (Tree snake)

Frog or Rabbit skeleton system (Representative samples)

Entire skeleton, Skull, Pectoral girdle and sternum, Pelvic girdle, Fore limb, Hind limb

COMPARATIVE ANATOMY OF CHORDATES

(Subject code: 26PZOE11)

Semester: I

EC: 1

Credits: 3

Hours: 5

Course objective: To provide an in-depth understanding of taxonomic principles and the structural and functional organization of major vertebrate groups.

Course outcomes: At the end of the course the students will be able to

CO1	Remember the salient features of chordates	K1
CO2	Understand the basic principles and definition of taxonomy.	K2
CO3	Analyse the structural organization and adaptive features of animals.	K2
CO4	Apply the concepts of the methodology of animal classifications	K4
CO5	Evaluate the comparative functional anatomy of vertebrates	K5
CO6	Create and Integrate the structure and function of animals	K6

(K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6- Create)

Unit I: Origin of chordata

(15 Hours)

Concept of protochordata - The nature of vertebrate morphology - Definition, scope and relation to other disciplines-Importance of the study of vertebrate morphology.

Unit II: Development, Structure and functions of integuments

(15 Hours)

Vertebrate integument and its derivatives -Development, general structure and functions of skin and its derivatives-Glands, scales, horns, claws, nail, hoofs, feathers and hairs.

Unit III: General plan of circulation and respiration

(15 Hours)

Structural and Functional modifications of heart, aortic arches and portal systems -Respiratory system -Characters of respiratory tissue - Internal and external respiration - Comparative account of respiratory organs.

Unit IV: Skeletal and Urino-genital system

(15 Hours)

Form, function, body size and skeletal elements of the body - Comparative account of jaw suspension, vertebral column-Limbs and girdles-Evolution of urino-genital system in vertebrate series.

Unit V: Sense organs and nervous system

(15 Hours)

Simple receptors, Organs of olfaction, taste and hearing; Lateral line system – Electoreception - Nervous system -Comparative anatomy of the brain in relation to its functions, Comparative anatomy of spinal cord, Nerves-Cranial, Peripheral and Autonomous nervous system.

Textbooks:

1. R. C. Gupta, Girish Chopra. (2020). Comparative Anatomy of Chordates. 8th edition. R. Chand & Co. 510 pages.

2. R. K. Saxena, Sumitra Saxena. (2020). Comparative Anatomy of Vertebrates. 2nd edition. Viva Books Private Limited. 676 pages.
3. Tripurari Mishra, Diwakar Mishra, Susmita Srivastav. (2021). Comparative Anatomy of Vertebrates with Practical. Mahaveer Publications. 350 pages.

Reference books:

1. Kenneth Kardong. (2008). Vertebrates. Comparative Anatomy, Function, Evolution. 5th edition. McGraw Hill Education. 800 pages.
2. G. C. Kent. (2018). Comparative Anatomy of the Vertebrates. 9th edition. McGraw Hill Education.
3. Karel F. Liem, William Bernis, Warren Walker, Lance Grande. (2001). Functional Anatomy of the Vertebrates: An Evolutionary Perspective. 3rd edition. S. Chand Company. 784 pages.
4. Theodore H. Eaton. (2015). Comparative Anatomy of the Vertebrates. Scientific Publishers.
5. J. S. Kingsley. (2016). Outlines of Comparative Anatomy of Vertebrates. Wentworth Press. 464 pages.

E-resources:

1. Wwww. Youtube.com (Search for)
2. WWW. Linkein.com (connect with experets)
- 3.. WWW.Redditit.com, ask questins to get good answer
4. www.edge.org. For better understanding
5. www.nature.com

Mapping with programme outcomes								
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	L	S	M	S	M	S
CO2	S	L	L	S	M	S	M	M
CO3	S	M	L	S	M	S	M	L
CO4	S	L	L	S	L	S	M	L
CO5	S	M	L	S	S	S	M	S
CO6	S	L	L	S	M	S	M	M

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

BIOSTATISTICS
(Subject code: 26PZOE12)

Semester: I

Elective: 2

Credits: 3

Hours: 5

Course objective: This course aims to introduce the fundamental concepts and methods of biostatistics and their applications in biological and health sciences

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

CO1	Describe the fundamental concepts, scope, and applications of biostatistics, including data types, sampling methods, and graphical representations.	K1
CO2	Explain and interpret measures of central tendency, dispersion, and probability distributions relevant to biological data.	K2
CO3	Apply appropriate statistical methods such as correlation, regression, and probability models to biological and population-based data.	K3
CO4	Analyze experimental and survey data using hypothesis testing techniques including parametric and non-parametric tests.	K4
CO5	Evaluate statistical results and identify merits and limitations of statistical tools in biological and health management studies.	K5
CO6	Design and implement suitable statistical analyses using MS Excel and SPSS for real-world biological data.	K6

Unit I: Introduction to Statistics

(15 Hours)

Definition, scope and applications; Primary and secondary data: Source and implications; Sampling methods; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.

Unit II: Measures of Central Tendency

(15 Hours)

Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error (one sample and two samples) and coefficient of variation; box plot and Venn diagram.

Unit III: Probability, Correlation and Regression

(15 Hours)

Probability - theories and rules; addition and multiplication theorem; probability distribution: Properties and application of Binomial, Poisson and Normal distributions; Correlation - Karl Pearson's and Spearman's, significance test for correlation coefficients. Regression - simple and multiple; regression coefficient, graphical representation and prediction.

Unit IV: Hypothesis testing

(15 Hours)

Hypothesis testing: Student 't' test (paired sample and mean difference); F-test; degrees of freedom; Variance: One-way and two-way classification; Parametric tests -ANOVA - one way,

two way; Non-parametric tests- Chi-square test, Wilcoxon signed rank test, Mann-Whitney test, Kolmogorov-Smirnow test.

Unit V: Statistical analyses with M.S. Excel and SPSS (15 Hours)

Standard tool bars and menus, statistical functions and applications (t , and F significance tests, correlations, ANOVA); chart and table creation, saving and printing. SPSS: Data file structure. AI tools for statistics (any 3)

Textbooks:

1. Arora, P. N. and P. K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp-447.
2. Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp-407.
3. Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp-363.

Reference books:

1. Jerrold H. Zar. (2014). Biostatistical Analysis. 5th edition. Pearson Education India. 760 pages.
2. Norman T. J. Bailey. (1995). Statistical Methods in Biology. 3rd edition. Cambridge University Press. 272 pages.
3. B. Antonisamy, Prasanna S. Premkumar, Solomon Christopher. (2017). Principles and Practice of Biostatistics. Elsevier. 390 pages.
4. Wayne W. Daniel, Chad L. Cross. (2014). Biostatistics: Basic Concepts and Methodology for the Health Sciences. 10th edition. Wiley. 954 pages.
5. Marcello Pagano, KimberleeGauvreau. (2018). Principles of Biostatistics. 2nd edition. Chapman & Hall. 584 pages.

E-resources

1. <https://uou.ac.in/sites/default/files/slm/MSCBOT-606.pdf>
2. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202003241550010566rajeev_pandey_parametric_test.pdf
3. <https://www.scribbr.com/frequently-asked-questions/one-way-vs-two-way-anova/>
4. <https://www.statology.org/hypothesis-testing-excel/>
5. <https://www.excel-easy.com/>

Mapping with programme outcomes								
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	M	L	M	S	S	M	S
CO2	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	S	S	S
CO4	M	M	S	L	M	M	M	S
CO5	M	M	S	L	M	S	M	L

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

CELL AND MOLECULAR BIOLOGY

(Subject Code: 26PZOC21)

Semester: II

Core: 5

Credits: 5

Hours: 5

Course objective: To provide an advanced understanding of cellular architecture, genome organization, and molecular mechanisms governing cell cycle, gene expression, and signal transduction.

Course outcomes: At the end of the course the students will be able to

CO1	Explain the ultrastructure, organization, and functions of major cell organelles and cytoskeletal components.	K2
CO2	Apply concepts of nuclear organization, chromosome structure, and cell cycle regulation to explain mitosis and meiosis.	K3
CO3	Apply principles of nucleic acid structure, replication, mutation, and DNA repair mechanisms in cellular systems.	K3
CO4	Analyze mechanisms of transcription, translation, and regulation of gene expression in prokaryotic and eukaryotic cells.	K4
CO5	Evaluate the molecular basis of cancer development, including oncogenes, tumour suppressor genes, and apoptosis.	K5
CO6	Integrate cell signalling pathways with gene activation and cellular responses.	K6

(K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create)

Unit I: Cell Organelles

(15 Hours)

Ultra structure, organisation and functions - Plasma membrane (transport of small molecule, endocytosis), Mitochondria, Endoplasmic reticulum, Golgibodies, Peroxisomes, Ribosome, Lysosome, Vacuoles, Plastids, Microtubules

Unit II: Nucleus, Chromosomes, Cell cycle and Division

(15 Hours)

Nucleus – nuclear envelope, nuclear transport mechanisms (nuclear pore complex, importins/exportins), internal organization, nucleolus and rRNA processing, Karyotypes, euchromatin, heterochromatin, transposons, polytene and lamp brush chromosomes; Cell cycle – regulators, check points, events of mitosis and meiosis.

Unit III: Nucleic Acids, Mutations and DNA repair

(15 Hours)

Nucleic acids- DNA and RNA as genetic materials; DNA replication – units of replication, enzymes involved, replication origin, fork, and fidelity; RNA interference (RNAi) – siRNA, miRNA, Reverse transcription and telomerase – structure and function. Genetic code – characteristics; DNA mutation- spontaneous, and frame-shift; DNA repair mechanism- photo reactivation, mismatch and SOS repair, excision, recombinational repair; RNA synthesis and processing.

Unit IV: Protein synthesis and cancer studies

(15 Hours)

Transcription, protein synthesis-initiation, elongation and termination process, post-translation modification of proteins; Regulation of gene expression in prokaryotes and eukaryotes; Role of

chromatin in gene expression and gene silencing; Cancer – development and causes, tumour viruses, oncogenes, tumor suppressor genes, cancerdiagnosis and treatment.

Unit V: Cell signalling

(15 Hours)

General principles, signalling molecules (hormones) and their receptors; cell surface receptors; Intracellular signal transduction; Activation and regulation of G-Protein coupled receptors. Adenylcyclase, Phospholipase, ion channels, activation of gene transcription.

Textbooks:

1. Gupta, P. K. (2025). Cell and molecular biology (5th rev. ed.). Rastogi Publications.
2. Paul, A. (2018). Textbook of cell and molecular biology (4th ed.). Books & Allied (P) Ltd.
3. Powar, C. B. (2016). Cell biology. Himalaya Publishing House.

Reference books:

1. Cooper, G. M., & Adams, K. (2023). The cell: A molecular approach (9th ed.). Oxford University Press.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2022). Molecular biology of the cell (7th ed.). W. W. Norton & Company.
3. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Matsudaira, P. (2016). Molecular cell biology (8th ed.). W. H. Freeman.
4. Karp, G. (2010). Cell and molecular biology: Concepts and experiments (6th ed.). John Wiley & Sons.
5. De Robertis, E. D. P., & De Robertis, E. M. F. (2001). Cell biology (8th ed.). Lippincott Williams & Wilkins.

E-resources:

1. <https://unacademy.com/content/wp-content/uploads/sites/2/2022/10/Cell-The-Unit-of-Life.pdf>
2. <https://microbenotes.com/dna-damage-and-repair/>
3. <https://egyankosh.ac.in/bitstream/123456789/81842/1/Unit-12.pdf>
4. https://samples.jblearning.com/0763740632/40632_ch08_rev151_188.pdf
5. https://application.wiley-vch.de/books/sample/3527313974_c01.pdf

Mapping with Programme Outcomes*								
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

DEVELOPMENTAL BIOLOGY

(Subject Code: 26PZOC22)

Semester: II

Core: 6

Credits: 5

Hours: 5

Course objective: To understand cellular and molecular basis of development. To study gametogenesis, fertilization, and cleavage patterns and to analyze gastrulation and organogenesis mechanisms. To examine genetic regulation of development.

Course outcomes:

CO1	Remember stages of embryonic development.	K2
CO2	Understand molecular and classical embryology.	K3
CO3	Apply principles of nucleic acid structure, replication, mutation, and DNA repair mechanisms in cellular systems.	K3
CO4	Analyze will analyze morphogenetic movements. Compare developmental strategies in animals.	K4
CO5	Evaluate evaluate regeneration and metamorphosis mechanisms.	K5
CO6	Create and Assess contemporary research findings	K6

(**K1**- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create)

Unit I: Gametogenesis, Fertilization and Cleavage

(15 Hours)

Spermatogenesis. Oogenesis. Egg: Polarity and gradient. Morphogenetic factors. Transcription factors. Maternal Gradient. Fertilization: Morphological, Biochemical and Physiological events. Cleavage: Types, patterns and rules. Role of yolk. Cell lineage.

Unit II: Gastrulation and Organogenesis

(15 Hours)

Gastrulation: Fate maps, Morphogenetic movements. Metabolic events. Neurulation and formation of primary germ layers. Induction and organizer. Potency, Commitment, specification, competence, determination and differentiation. Organogenesis: Brain, eye, heart and limb in frog.,

Unit III: Role of genes and cytoplasm in development

(15 Hours)

Caenorhabditis elegans: Life cycle, cell lineage, cell – cell interactions and polarity, *hox* genes, genetic control and microRNAs. Ascidian: Mosaic development, cytoplasmic factors, mesenchyme and notochord development.

Unit IV: Development of *Drosophila*

(15 Hours)

Early development upto hatching, Maternal genes and body axes, polarization of body axes during Oogenesis, Zygotic genes, Pattern formation: pattern of early embryo segmentation; the pair rule genes, segmentation polarity genes and Homeotic selector genes. Terminal genes.

Unit V: Metamorphosis and regeneration

(15 Hours)

Frog metamorphosis: Morphological, Physiological and Biochemical changes and causation of metamorphosis in frog. Regeneration: Types, (*Hydra*, salamander and mammalian liver) mechanism and factors, Polarity and gradient. Wolffian regeneration. Outline of insect metamorphosis

Textbooks:

1. Balinsky, B. I. (1981) Introduction to Embryology (5th Edition), CBS College Publishers, New York, pp-782.
2. Gilbert. S. F. (2006) Developmental Biology, 8th Edition, INC Publishers, USA, pp-785.
3. Berrill, N.J. (1974). Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.

Reference books:

1. Wilt, F.H. and N.K. Wessel. (1967) Methods in Developmental Biology, Thomas Y Crowell, New York.
2. Slack J.M.W. (2012) Essential Developmental Biology (3rd Edition), Wily-Blackwell Publications, USA, pp-496.
3. Mari-Beffa, M. and J. Knight. (2005) Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.
4. Michael Barresi and Scott , (2023) Developmental Biology ,Thirteenth Edition, pp-880.
5. Rashmi Sharma(2023)DevelopmentalBiology , Anvi Books & Publishers, pp-200.

E-resources

1. Wwww. Youtube.com (Search for)
2. WWW. Linkein.com (connect with experets)
- 3.. WWW.Redditit.com, ask questins to get good answer
4. www.edge.org. For better understanding
5. www.nature.com

Mapping with programme outcomes								
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	L	S	M
CO2	S	S	S	S	S	L	S	S
CO3	S	M	S	S	S	S	S	L
CO4	S	S	S	S	S	M	S	S
CO5	S	S	S	M	S	S	S	L

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

CELL AND MOLECULAR BIOLOGY & DEVELOPMENTAL BIOLOGY - PRACTICAL

(Subject code: 26PZOC23)

Semester: II

Core: 7

Credits: 2

Hours: 4

Course objective: To provide hands-on training in cytological and developmental techniques. To observe mitosis and meiosis using classical models.

Course outcomes

CO1	Remember stages of embryonic development, and Cell development.	K2
CO2	Understand molecular biology with classical embryology.	K3
CO3	Apply experimental observations scientifically	K3
CO4	Analyze will analyze morphogenetic movements. Compare developmental strategies in animals. Compare normal and abnormal developmental patterns.	K4
CO5	Evaluate regeneration and metamorphosis mechanisms.	K5
CO6	Create and Demonstrate professional laboratory competence	K6

CELLULAR AND MOLECULAR BIOLOGY

1. Observation of mitotic stages – in onion root tip
2. Observation of meiotic stages in grasshopper testis
3. Effect of colchicine on mitosis
4. Salivary gland chromosome of *Chironomus* / *Drosophila* larva.
5. Demonstration of Barr body in human buccal epithelial cells by supra vital staining method
6. Glycerine mount of different kinds of cells (Squamous epithelial cells and goblet cells)
7. Identification of cells in the haemolymph of the cockroach
8. Cellular constituents of human blood (RBC, WBC, and Platelets)

Spotters: Plasma membrane, Mitochondria, Ribosomes, Lysosomes, Endoplasmic reticulum, nucleus, Nucleolus, Golgi complex, Centrioles, Types of chromosomes, Ultrastructure of chromosomes, Cell secretion, DNA double helix, Variants of double helical DNA, Protein synthesis, DNA- Replication, Structure of Lac operon, DNA repair and Cancer.

DEVELOPMENTAL BIOLOGY

1. Mounting of eggs (fish / frog).
2. Observation of mammalian sperm motility.
3. Observation of developmental stages of *Drosophila*/ House fly and Mosquitoes.
4. Identification of mutant types in *Drosophila*

5. Chick embryo development - preparation of whole mounts; examination of live embryos - examination of foetal membranes.
6. Regeneration of tadpole tail
7. Effects of iodine on tadpole metamorphosis.
8. Observation of developmental stages in frog
9. Development of brain, eye, ear, limb, heart and urinogenital systems from slides.

Spotters: Frog -T.S. of Testis and Ovary, fertilized egg, first cleavage, 16 cell stage, blastula, gastrula, yolk plug stage, neurula, tadpole Sagittal section showing optic cup; Chick embryo - primitive streak, 26 hours of chick embryo, 36 hours, 48 hours, 72 hours, 96 hours; Types of placenta -Yolk sac, Yolk stalk, Discoidal, Diffuse, Cotyledonary; Teratology-Four legged chick, Double headed shark, Bifid Tail and Anencephalic foetus.

Report – Traditional animal –assisted therapies to improve social, emotional and cognitive development in children (Autism, Attention Deficit Hyperactivity –ADHD)

Biological rhythm – circular & lunar.

IMMUNOLOGY AND MICROBIOLOGY - PRACTICAL

(Subject code: 26PZOC24)

Semester: II

CORE: 8

Credits: 2

Hours: 4

Course Objective:

This course aims to provide hands-on training in fundamental techniques of immunology and microbiology, including microbial culture, identification, and antimicrobial assays.

(CO)	Course Outcome Statement	K-
CO1	Prepare solid and liquid culture media and perform isolation of microorganisms using aseptic techniques.	K3
CO2	Identify and characterize microorganisms using staining, motility, and plating techniques.	K4
CO3	Perform and interpret antibacterial assays and basic biochemical tests.	K3
CO4	Apply immunological techniques such as haemagglutination, ELISA, immunodiffusion, and lymphocyte separation.	K3
CO5	Understand the principles and applications of advanced techniques including PCR, blotting methods, and cell culture.	K2

1. Solid and Liquid Culture media preparation
2. Isolation of bacteria - serial dilution technique
3. Plating techniques
4. Motility of microorganism (Hanging drop method)
5. Measuring the Bacterial or Yeast Cells
6. Gram staining method- Identification of bacteria
7. Antibacterial assay using disc diffusion method
8. Methylene Blue Reductase with Milk
9. Separation of lymphocytes from whole blood
10. Single Radial immunosorbent technique
11. Haemagglutination test
12. Demonstration of Western blotting and Southern blotting technique.
13. Cell culture demonstration
14. Isolation of bone marrow cells from chick
15. Bursa and thymus from chick
16. Cell viability test – blood cells
17. Demonstration of immune electrophoresis
18. ELISA –Demonstration
19. PCR- Demonstration

Spotters: Immunology: lymphoid organ- thymus, spleen, lymph node, bursa of fabricius, peyer's patches, Macrophages, Natural killer cells, Immunoglobulin, Phagocytosis, Antibiotics, Recombinant vaccine, Edible vaccines, ELISA, Mucosa associated lymphoid tissue, Vaccination schedule, monoclonal antibodies.

Microbiology: Pure culture techniques, Colony appearance, Culture characteristics, Anthrax, Streptococci, *Clostridium tetani*, *Vibrio cholerae*, Morphology of virus particles, Hepatitis B virus, HIV, Bacteriophage, Candidiasis, Dermatophytosis, Growth curve, Biochemical events of inflammation and Microbial sources of antibiotics

IMMUNOLOGY AND MICROBIOLOGY

(Subject code: 26PZOE21)

Semester: II

EC: 3

Credits: 3

Hours: 4

Course objective: To provide cells, and organs involved in immunity of animals and also to provide an overview of the human parasites, vectors and their diseases; host-pathogen interactions and laboratory diagnostic methods.

Course outcomes: At the end of the course the students will be able to

CO1	Remember the basic classification and the role immune system	K1
CO2	Explain the fundamentals of immune system	K2
CO3	Demonstrate immune response of various parasitic infections	K3
CO4	Summarize microbial classification and their economic importance	K4
CO5	Explain the inevitable role of microbes in human life	K5
CO6	Develop microbial products of industrial and medical importance	K6

(K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6- Create)

Unit I: Immune System

(12 Hours)

Cells of the immune system: B lymphocytes, T lymphocytes, Macrophages, dendritic cells, NK cells, Null cells, Cytokines, Lymphokines and Chemokines; Antigen-Definition, Classification and characteristic features; Antigenic determinants and their types; Immunoglobulins-structure and functions; Lymphoid organs-Primary and Secondary lymphoid organs; Lymphatic tissues - Peyer's patches and Kupffer cells, MALT, GALT and BALT.

Unit II: Immunity – principles & types

(12 Hours)

Innate and Adaptive immunity - Active, Passive, Natural, artificial immunity; MHC-Structure, classes and functions; Antigen antibody interactions, precipitation reaction, agglutination reaction, Complement- Complement activation in Classical, alternate and Lectin pathway - mode of activation, Biological function.

Unit III: Hypersensitivity, Autoimmunity disorders and Transplantation

(12 Hours)

Hypersensitivity- type I, II, III and IV reactions. Autoimmunity: Organ and non-organ specific autoimmune diseases ; Immunodeficiency-Deficiency of T and B lymphocytes, combined immune deficiencies, deficiency of complement and phagocytic system; Transplantation- Allograft rejection, mechanism of graft rejection.

Unit IV: Microbes and their role in humans

(12 Hours)

Morphology and characters- bacteria, fungi, viruses, bacteriophages, cyanophages, myxoviruses, actinomycetes, mycoplasma, archaeobacteria, autochthonous microbes and rickettsiae. Bacterial genetics-Methods of genetic transfers-transformation, conjugation and transduction, Mapping genes by interrupted mating, fine structure of analysis of genes; Bacterial Physiology-Growth

yield and characteristics, strategies of bacterial cell division; Microbes on human life (contact, infection and diseases).

Unit V: Applications of immunology and microbiology (12 Hours)

Applications of immunology and immune techniques - immune therapies, immunization and vaccine production, Types of Monoclonal antibodies, radioimmunoassay, ELISA Applications; Fermentation products - penicillin and vitamin B₁₂; Bio-fertilizers and biopesticides; Role of microbes in biogas production and pollution management; Economic importance of bacteria with special reference to industry and medicine.

Textbooks:

1. C. VamanRao. (2011). Immunology. 2nd edition. Narosa Publishers. 692 pages.
2. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A. Owen. (2018). Kuby Immunology. 8th edition, W. H. Freeman. 944 pages.
3. R. Ananthanarayan, CK JayaramPaniker, Reba Kanungo, SonalSaxena. (2022). Ananthanarayan and Paniker's Textbook of Microbiology. 12th edition. Universities Press. 672 pages.

Reference books:

1. Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7th edition), Mosby / Elsevier, Philadelphia, pp-472
2. Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Peter J. Delves. (2017). Roitt's Essential Immunology 13th edition. Wiley-Blackwell. 576 pages.
3. F. H. Khan. (2009). Elements of Immunology, Pearson Education. 508 pages.
4. R. C. Dubey, D. K. Maheshwari. (2013). A Textbook of Microbiology. 4th edition. S. Chand Publishing. 1056 pages.
5. Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton. (2017). Prescott's Microbiology. 10th edition. Mc-Graw Hill. 1104 pages.

1. <https://microbenotes.com/>
2. https://repository.stikesbcm.ac.id/id/eprint/168/1/books_5453_0.pdf
3. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBMA1302.pdf
4. <https://www.mbbcollege.in/db/notes/474.pdf>
5. <https://youtu.be/YIKLpQEWILg>

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	M	S	M	S	S
CO2	S	S	M	M	L	S	S	S
CO3	S	M	M	L	M	S	L	L
CO4	M	M	S	S	M	L	L	S
CO5	M	S	S	M	S	M	L	M

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

Research Methodology
(Subject code: 26PZOE22)

Semester: II

Elective: 4

Credits: 3

Hours: 4

Course objective: To provide students with fundamental knowledge and practical understanding of microscopy, separation, analytical, histological and immunotechnical methods, and to develop skills in research design, data analysis and scientific thesis writing.

Course outcomes: Upon the successful completion of the course, student will be able to

CO1	Recall the principles, components and uses of microscopes and laboratory techniques.	K1
CO2	Explain the working mechanisms and applications of separation, analytical and imaging techniques.	K2
CO3	Apply microscopy, chromatography, electrophoresis, PCR and spectroscopic techniques in experiments.	K3
CO4	Analyze experimental data obtained from molecular, analytical and histological techniques.	K4
CO5	Evaluate suitable techniques, research methods and data reliability for biological studies.	K5
CO6	Design research plans, write thesis reports and prepare research proposals.	K6

Unit I: Microscopy

12 Hours

Principle, working mechanism, resolving power and uses of Light, Phase contrast, Fluorescent and Electron (SEM & TEM), confocal microscopes. Freeze-etch and freeze-fracture methods for electron microscope image processing methods.

Unit II: Separation techniques

12 Hours

Chromatography - Thin layer and Column chromatography, HPLC, GC and GCMS; Principles and working methods; AGE and PAGE; PCR and blotting techniques; Centrifugation – principles and types (differential and density gradient).

Unit III: Analytical techniques

12 Hours

pH meter; Colorimeter; Visible and UV spectrophotometer; bomb colorimeter and Atomic absorption spectrophotometer; Isolation and purification of RNA; RFLP and RAPD.

Unit IV Histological and Immunotechniques

12 Hours

Differential fixation and preservation; blocking; embedding; sectioning; staining; histochemical techniques; *In situ* localization by techniques using FISH; Immuno- fluorescence techniques, ELISA, RIA and EMIT.

Unit V Thesis writing

12 Hours

Research Problem, Research Design, Developing a Research Plan, Literature survey, e-resources, documentation, Collection of Data, data processing; Parts of a thesis and thesis writing; Research report Presentation; Proof correction – symbols, M.S. word review option and other tools, plagiarism; Evaluation of a research project; Funding agencies (DST, DBT, UGC, CSIR, ICMR, ICAR, TNSCST & SXCRG) and research proposal writing.

Textbooks:

1. Pearse, A.G. (1968). Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J & A Churchill Ltd, pp-758. Lillie, R.D. (1954) Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.
2. Hoppert, M. (2003). Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.
3. Kothari C. R, (2023). Research Methodology -Methods and Techniques, 5 th edition, New age publications, pp-418.

Reference books:

1. Chandler, D.E. and Roberson R.W. (2009). Bioimaging: Current Concepts in Light and Electron Microscopy, Jones and Bartlet Publishers, Sudbury, MA, USA, pp440.
2. Engelbert, B. (1960). Radioactive Isotopes in Biochemistry, Elsevier Applied Science, pp-376.
3. Wolf, G. (1964). Isotopes in Biology, Academic Press, pp-173.
4. Srivastava, B. B. (2005). Fundamentals of Nuclear Physics, Rastogi Publications, pp-500.
5. Pantin, C. F. A. (1948). Microscopical Techniques, Cambridge University Press, London.

E-resources

1. <https://iipseries.org/assets/docupload/rs120249617EF326142B7D.pdf>
2. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7151845/>
3. <https://pmc.ncbi.nlm.nih.gov/articles/PMC5206469/>
4. https://www.magnusopto.com/blog/post/microscopy-techniques-a-comprehensive-guide-for-scientists-and-students.html?srsId=AfmBOopbMNTcAhMjVZpLc7IA8WtMSjTzx6IE89QlFRz5G_ltQTkdmQa1
5. https://cw.fel.cvut.cz/b172/_media/courses/a6m33zsl/microscopic_techniques.pdf

Mapping with programme outcomes								
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	S	M	S	M	S	M	S
CO2	S	S	M	S	S	S	M	M
CO3	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	M	S	S
CO5	S	S	S	M	M	S	M	L

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

STEM CELL BIOLOGY

(Subject code: 26PZOS21)

Semester: II

SEC: 1

Credits: 2

Hours-4

Course objectives: To provide students with a comprehensive understanding of stem cell biology, including types, molecular regulation, differentiation, aging, and therapeutic applications, enabling critical analysis of current stem cell-based research and therapies.

Course outcomes: At the end of the course the students will be able to

CO1	Recall the definition, origin, properties, potency and classification of stem cells.	K1
CO2	Explain the molecular mechanisms regulating pluripotency, self-renewal and differentiation of embryonic and adult stem cells.	K2
CO3	Apply knowledge of stem cell sources, characterization methods and differentiation pathways in biological and medical contexts.	K3
CO4	Analyze the role of stem cells in aging, tissue repair, regeneration and disease conditions.	K4
CO5	Evaluate the advantages, limitations, ethical issues and clinical outcomes of current stem cell therapies.	K5
CO6	Design conceptual research strategies or therapeutic approaches involving stem cells and induced pluripotent stem cell technologies.	K6

(K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create)

UNITI: Introduction to stem cell biology

(12 Hours)

Introduction to stem cell biology: Stem cell definition, origin and hierarchy, stem cell properties, potency and differentiation, niche of stem cell, overview of different stem cell types (embryonic stem cells, adult stem cells and induced pluripotent stem cells)

UNITII: Embryonic stem (ES) cell

(12 Hours)

Characterization and properties of ES cells, potency and self-renewal of ES cells; molecular mechanisms regulating pluripotency and maintenance of the stem state, progressive differentiation of ES cells into ectoderm lineage organs (skin, brain and nerve), mesoderm lineage organs (heart, kidney, muscle, bone and blood), and endoderm lineage organs (lung, liver, stomach, pancreas and intestine).

UNITIII: Adult stem cells

(12 Hours)

Mesenchymal stem cells (MSCs) - sources, properties (plasticity, homing and engraftment), potency and characterization; Haematopoietic stem cells (HSCs) - sources, properties, potency and characterization; steps involved in production of induced pluripotent stem cells (iPSCs); role of Yamanaka factor in iPSCs.

UNIT IV: Stem cell and aging**(12 Hours)**

Stem cell and aging: aging theory; cell cycle; telomere and telomerase; senescence of stem cell; role of stem cell in aging; tissue repair and regeneration of adult stem cell. Cancer stem cells

UNIT V: Current stem cell therapies**(12 Hours)**

Current stem cell therapies: Advantages and disadvantages of ES cells and adult stem cells (MSCs and HSCs) therapy; Ethical concern on stem cell therapy; current stem cell therapy for various diseases; clinical outcome of stem cell therapy; state of clinical trials in adult stem cells for various diseases.

Text Books :

1. Quesenberry, P.J., G.S. Stein, B. Forget and S. Weissman. (2001) Stem Cell Biology and Gene Therapy, Wiley Publishers, pp-584.
2. Sell, S. and Totowa, N.J. (2004) Stem Cells Handbook, Humana Press, pp-534.
3. Sullivan, S., C. A. Cowan and K. Eggan. (2007) Human Embryonic Stem Cells: The Practical Handbook, Wiley Publishers, pp-424.

Reference books :

1. Kiessling, A.A. (2006) Human Embryonic Stem Cells (Second Ed.), Jones & Barlett Publishers.
2. Lanza, R. and A. Atala. (2005) Essentials of Stem Cell Biology. Academic Press, pp-712.
2. Turksen, K. (2004) Adult Stem Cells. Humana Press, Inc, pp-429.
3. Lanza, R. et al. (2004) Handbook of Stem Cells: Embryonic/Adult and Fetal Stem Cells (Vol. 1 & 2). Academic Press, pp-1626.
4. Institute of Medicine, (2002). Stem cells and the future of regenerative medicine. National Academy Press, pp-112.
5. Marshak, D., R.L. Gardener and D. Gottlieb. (2001) Stem Cell Biology, Cold Spring Harbour Monograph Series, 40, pp-550.

E-resources

1. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7367472/>
2. https://en.wikipedia.org/wiki/Stem_cell_theory_of_aging
3. <https://www.ncbi.nlm.nih.gov/books/NBK223693/>
4. <https://www.aboutstemcells.org/info/biology>
5. <https://byjus.com/biology/stem-cells/>

Mapping with programme outcomes								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	S	M	S	M	S	M	S
CO2	S	S	M	S	S	S	S	S
CO3	S	M	S	S	S	S	M	L
CO4	S	S	S	S	S	M	M	S
CO5	S	S	S	M	M	S	S	S

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

EVOLUTION

(Subject code: 26PZOC31)

Semester: III

Core: 9

Credits: 5

Hours: 5

Course objective: To understand the concepts, trends and patterns of evolution as well as evolution of selected groups.

Course outcomes: At the end of the course the students will be able to

CO1	Describe origin of life patterns.	K1
CO2	Comprehend the evolutionary forces on adaptation.	K2
CO3	Summarize molecular studies with evolution	K2
CO4	Illustrate natural selection and speciation	K4
CO5	Analyze the evolutionary changes in selected animals	K5
CO6	Create new concepts in the field of population genetics	K6

(K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create)

Unit I: Origin of cells and evolutionary thoughts

(15 Hours)

Origin of biomolecules, chemical and biological evolution of life; origin of prokaryotes and eukaryotes, concepts of Oparin and Haldane, experimental evidences of Urey-Miller; Lamarckism, Darwinism-natural selection, mutation theory and modern synthetic theory.

Unit II: Evolutionary history and Palaeontology

(15 Hours)

Evolutionary time scale: eras, period, and epoch; Major events in the evolutionary time scale; Physical and cultural evolution of Man. Origin of unicellular and multicellular organism. Fossils (museum specimens)

Unit III: Molecular phylogeny

(15 Hours)

Methods of molecular evolution studies; Principles of molecular evolution studies; Molecular clock, origin of new gene functions; phylogenetics and future prospects of evolutionary biology; Gene duplication and divergence.

Unit IV: Patterns of evolution

(15 Hours)

Speciation: Allopatricity and Sympatricity, Sequential and divergent evolution, isolating mechanisms; micro and macro evolution; Adaptive radiation, Convergent evolution. Mimicry and coloration- Batesian and Mullerian mimicry. Co-evolution, migration, navigation, domestication and behavioral changes of human being.

Unit V: Population genetics

(15 Hours)

Gene pool, gene frequency, Hardy-Weinberg law. Natural selection in action, Variation – pre-adaptation and post adaptation; normalizing, directional and diversifying selection; Group selection, Kin selection, Reciprocal altruism.

Textbooks:

1. Veer BalaRastogi. (2015) Organic Evolution, Medtech, New Delhi.
2. Verma, P.S. and Agarwal, V.K. (1998) Concept of Evolution, Chand and Company Ltd., New Delhi.
3. SanjibChattopadhyay, (2008) Life Evolution, Adaptation Ethology, ArunabhaSen, Kolkatta. Emlen D.J (2020), Evolution Making Sense Of Life 3rd Edition, Springer/Macmillan Publishers, pp-752

Reference Books:

1. Brian K. Halland BenediktHallgrímsson. (2015) Strickberger Evolution, Fourth Edition, Jones & Bartlett publishers, Canada.
2. Dobzhansky, T., Ayala, J., Stebbins, G. and Valentine, W. (1973) Evolution, Surjeet Publication, New Delhi.
3. Charles W. Fox & Wolf. (2006) Evolutionary genetics, Oxford University press, New Delhi.
4. Peter Stiling, (2002) Ecology Theories and Applications, Fourth edition, Prentice Hall, India.
5. Mohan P. Arora and Arora, H. (2013) Organic evolution, Himalaya Publishing House, Mumbai. Mark Ridley (2020), Evolution, Oxford University Press, pp-472

E-resources

1. <https://openstax.org/books/biology/pages/18-1-understanding-evolution>
2. <https://evolution.berkeley.edu/triggering-adaptive-radiation/>
3. <https://www.khanacademy.org/science/biology/her/x324d1dcc:more-about-natural-selection/a/lines-of-evidence-for-evolution>
4. <https://adntro.com/en/blog/genetic-curiosities/theory-of-evolution-throughout-history/?srltid=AfmBOopJXbaJyWQ8NvYVcGMIFNpp2CDFQSV-I7i1ZmoL-m7S1u6PkqF7>
5. [https://bio.libretexts.org/Courses/Lumen_Learning/Fundamentals_of_Biology_I_\(Lumen\)/05%3A_A_Module_2-_History_of_Life/5.04%3A_The_Theory_of_Evolution](https://bio.libretexts.org/Courses/Lumen_Learning/Fundamentals_of_Biology_I_(Lumen)/05%3A_A_Module_2-_History_of_Life/5.04%3A_The_Theory_of_Evolution)

Mapping with programme outcomes								
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

ANIMAL PHYSIOLOGY
(Subject code: 23PZOC32)

Semester: III

Core:10

Credits:5

Hours:5

Course objective: To provide a strong conceptual foundation in the organization and basic constitution of major physiological systems and the functional significance of endocrine organs; interpreting the role of endocrine organs and hormones in the regulation and maintenance of homeostasis in animals.

Course outcomes:At the end of the course the students will be able to

CO1	Recall the fundamental organization and basic constitution of major physiological systems in animals.	K1
CO2	Describe, explain, and comprehend the detailed structure and physiological functions of organs.	K2
CO3	Illustrate and analyze the structure and functional mechanisms of nerves, muscles, and sensory receptors.	K3
CO4	Compare and evaluate the functional significance of reproductive and endocrine organs.	K4
CO5	Evaluate the regulatory and integrative roles in animal physiology in coordination and response of various organs and systems.	K5
CO6	Interpret, integrate, and apply the functions of endocrine organs and hormones in regulating and maintaining homeostasis.	K6

(K1-Remember;K2-Understand;K3-Apply;K4-Analyze;K5-Evaluate;K6–Create)

Unit I: Nutrition and Digestion

(15 Hours)

Nutrition:Composition of food, Biological importance of carbohydrate, protein, fat, minerals and vitamins; Calorific value, daily requirements, low and high intake implications. Standard, active and routine metabolism, balanced diet, BMR and BMI.

Digestion:Digestive system-general structure of alimentary canal and digestive glands, physiology of digestion and Hormonal control of digestion - gastrointestinal hormones.

Unit II: Respiration and circulation

(15 Hours)

Respiration: Respiratory organs and pigments in animals. Structure of human lungs and mechanism of respiration; Transportation of gases; Acid base balance (buffer system), Bronchitis & asthma, Physiological effects of smoking.

Circulation: Types of heart (neurogenic and myogenic); Structure of human heart and blood vessels, Blood - volume composition and functions; Heart beat, cardiac cycle, ECG; circulation of blood, haemodynamics and blood pressure; Haemostasis; Haemopoiesis; Angiogram.

Unit III: Excretion and Endocrine system

(15Hours)

Excretion: Excretory organs, structure of kidney, physiology and mechanism of excretion – adaptations of excretion to the environment - Excretory products.

Endocrines: Endocrine glands, Feedback regulation - Pituitary – gonadalaxis, Role of reproductive hormones - gamete formation; fertilization; embryonic development; parturition; lactation; neuroendocrineregulation.

Unit IV: Nerves, Muscles and Sense Organs (15Hours)

Nervous system: Central nervous system - Structure of Human brain and spinal cord; peripheral nervous system; Types and structure of neurons; neuronal and sympathetic transmission, action potential and neurotransmitters.

Muscles: Ultrastructure-types and composition; Neuromuscular junction.

Sense organs: Gustatory, olfactory, mechano, photo and phono receptors – structure and functions; bioluminescence.

Unit V: Reproduction and Homeostasis (15Hours)

Reproductive system: Structure of Human reproductive organs – puberty, menstrual cycle, menopause. Infertility and Management.

Homeostasis: Endothermy and physiological mechanism of regulation of body temperature, Physiological adaptation to osmotic and ionic stress; mechanism of cell volume regulation - Osmoregulation in aquatic and terrestrial environments. Physiological response to oxygen deficient stress.

Textbooks:

1. William S. Hoar. 1983. General and Comparative Physiology, Prentice Hall Pvt. Ltd., New Delhi.
2. Rastogi, S.C., 2019. Essentials of Animal Physiology, New Age International Publishers, PP- 596.
3. Verma, Tyagi and Agarwal, 2000. Animal Physiology. Chand and Company Ltd., New Delhi.

Reference books:

1. Animal Physiology: From Genes to Organisms. 2012. Lauralee Sherwood, Hillar Klandorf, and Paul H. Yancey. Cengage Learning publications.
2. Knut Schmidt - Nielsen, 2008. Animal Physiology: adaptation and environment, Fifth Edition, Cambridge University Press.
3. Schmidt-Nielsen, K. 2002. Animal Physiology – Adaptation and Environment, Cambridge Press, Cambridge.
4. Bhabesh Mili, 2022. Multiple Choice Questions in Animal Physiology, Brillion Publishing, PP-206.
5. Arora, M. P., 2018. Animal Physiology For B Sc and M Sc, Himalaya Publishing House Pvt. Ltd. PP - 260.

E-resources:

1. <https://library.viu.ca/c.php?g=189003&p=1247721>
2. <https://louis.oercommons.org/curated-collections/56>
3. <https://learninglink.oup.com/access/butler>
4. <https://bookeshi.com/best-physiology-free-online-resources-for-medical-students-2/>
5. <https://open.umn.edu/opentextbooks/textbooks/introductory-animal-physiology>

EVOLUTION & GENETICS- PRACTICAL

(Subject code: 26PZOC33)

Semester: III

CORE: 11

Credits: 2

Hours: 4

Course objective: To apply the evolutionary and genetic concepts, trends and patterns of evolution as well as evolution of selected groups.

Course outcomes: At the end of the course the students will be able to

CO1	Describe evolutionary adaptation in birds.	K1
CO2	Comprehend the serial homology.	K2
CO3	Summarize evolutionary significance of fossils	K2
CO4	Illustrate natural selection and speciation	K4
CO5	Verify Mendel's law and Hardy-Weinberg's equilibrium	K5
CO6	Create new concepts in the field of population genetics	K6

EVOLUTION

1. Adaptive modifications in feet, beaks and wings of birds.
2. Study of ecological morphology of animals.
3. Embryological evidence for evolution
4. Serial homology in appendages of prawn
5. Study of human skull
6. Study of fossils (museum specimens)
7. Comparative study of Animal Skull (pig, horse, dog and deer)
8. Osteology of vertebrates (museum specimens)
9. Visit to Athichanallur/ Ariyaloor fossil site/ Keezhadi Archaeological Site/ Govt. Museum, traditional animal breeding centre.

Spotters: Homologous organs, Analogous organs, Vestigial Organs, Mesozoic reptiles (Allosaurus, Tyrannosaurus, Brontosaurus, Iguanodon, Stegosaurus, Triceratops, Rhamphorhynchus, Pteranodon, Dimetrodon), Connecting link (Archaeopteryx), Living Fossil (Limulus), Fossils (Gastropod – Tertiary, Ammonite – Jurassic).

GENETICS

1. Study of phenotypic variation in *Drosophila*
2. Verification of Mendel's law - monohybrid cross using coloured beads
3. Verification of Mendel's law - dihybrid cross using coloured beads
4. Hardy-Weinberg's equilibrium with complete selection (using coloured beads).
5. Hardy-Weinberg's equilibrium with partial selection (using coloured beads).
6. Quantitative inheritance – Serration in neem leaves
7. Quantitative inheritance – Height and weight
8. Variation in thumb impression

Spotters: Multiple alleles (Blood grouping), Complete linkage in *Drosophila*, Haemophilia, Sickle cell anaemia, Rh Factor (Erythroblastosis foetalis), Albinism, Klinefelter's syndrome, Turner's Syndrome, Down's Syndrome, Lytic and lysogenic cycle, Conjugation, Transformation, Transduction, Sexduction.

Report : On ethno veterinary practices to treat genetic disorders & maintain the health of breeding populations.

ANIMAL PHYSIOLOGY– PRACTICAL

(Subject code: 26PZOC34)

Semester: III

Core: 12

Credits: 2

Hours: 4

Course objective: This course aims to provide students with hands-on experience in understanding the physiological processes of animals through practical experiments.

Course outcomes:

CO1	Recall basic concepts, terminology, and physiological parameters related to animal physiology and human health.	K1
CO2	Explain the functional significance of digestive, respiratory, circulatory, and excretory processes in animals through practical observations.	K2
CO3	Apply standard laboratory techniques to perform physiological experiments such as enzyme activity, oxygen consumption, and blood analysis.	K3
CO4	Analyze experimental data to interpret the effects of environmental factors like temperature and salinity on physiological functions.	K4
CO5	Evaluate physiological results and compare normal and altered conditions in animals and humans based on experimental findings.	K4
CO6	Design and present systematic laboratory records, observations, and conclusions using appropriate scientific methods and representations.	K6

Experiments:

1. Digestive enzymes profile in cockroach
2. Salt loss in a fresh water fish
3. Salt gain in a fresh water fish
4. Effect of salinity on opercular movement of a freshwater fish
5. Effect of temperature on opercular movement of fish
6. Effect of temperature on human salivary amylase activity
7. Determination of the rate of oxygen consumption rate by the given fish
8. BMI analysis using height and weight
9. Estimation of haemoglobin
10. Preparation of Haemin crystals
11. Enumeration of blood platelets
12. Estimation of blood glucose during fasting and PP.
13. Preparation of Urate crystals
14. Preparation of Uric acid crystals –Bird, Rat, Fish

Spotters: Human brain, heart, lungs, eye, tongue, ear, Pancreas, Kidney, circulatory system, digestive system, Pituitary gland, Thyroid gland, Parathyroid gland, Adrenal gland, L.S. of testis and Ovary, ECG, Oxygen dissociation, Endocrine glands, Menstrual cycle, Gastro intestinal hormone action and Types of muscles.

Report – Traditional dietary practices, food that promote health and prevent diseases.

GENETICS
(Subject Code: 26PZOE31)

Semester: III

Elective: 5

Credits: 4

Hours:4

Course Objective: To study hereditary biology, mechanism involved in hereditary diseases and disorders and also to know the fundamental processes of life.

Course outcomes: At the end of the course the students will be able to

CO1	Define the principles of modern genetics	K1
CO2	Explain concepts, methods and applications of gene mapping	K2
CO3	Demonstrate the basic and applied genetics of microbes and human	K3
CO4	Analyse types, mechanism and implications of mutation	K4
CO5	Evaluate genetic disorders and importance of genetic counselling	K5
CO6	Integrate genetic methods with agriculture, aquaculture, animals and human welfare.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit I : Modern genetics and its principles (12 Hours)

Eukaryotic genome –C-value paradox, Repetitive DNA, General concept of a gene, Gene families, Non-coding genes; DNA polymerases, RNA polymerases; Somatic or mitotic crossing over, germinal or meiotic crossing over.

Unit II: Gene mapping methods (12 Hours)

Complete and incomplete linkage, Linkage maps, LOD score for linkage testing, Tetrad analysis, Mapping with molecular markers, Mapping by using somatic cell hybrids; Extra chromosomal inheritance- Mitochondrial inheritance, Kappa particles.

Unit III: Microbial and Human Genetics (12 Hours)

Microbial genetics-Methods of genetic transfers – transformation, conjugation, Transduction and sexduction, mapping genes by interrupted mating; Human genetics- Pedigree analysis, genetic disorders (Brachydactyly, Huntington's chorea, Sickle cell anemia); Genetic counseling - eugenics, euthenics and euphenics.

Unit IV: Mutation (12 Hours)

Mutation -Types (Spontaneous, Induced, lethal, conditional, biochemical), causes, loss of function, gain of function, Germinal verses somatic mutants, insertional mutagenesis; Quantitative genetics - Polygenic inheritance, Types of quantitative traits (continuous, meristic and threshold); examples (skin colour and height in humans), Mapping of Quantitative trait loci (QTL mapping).

Unit V: Applied genetics (12 Hours)

Animal Selective Breeding; Crime and Law DNA Finger Printing; Agriculture (food production), Disease prediction (colour blindness and dwarfism), Aquaculture (breeding and production)

Textbooks:

1. Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley & Sons. INC. New York, pp-740.
2. Brooker, R. J. 2014
2. Monroe W. Strickberger, (2012) Genetics, Third Edition, Prentice Hall of India, Pvt.Ltd,India.
3. Dr. P S Verma& Dr. V K Agarwal (2022) Genetics: Library Edition,S Chand and Company ltd,pp-1312.

Reference Books:

1. Benjamin Lewis, (2007) Genes IX, Jones and Bartlett Publishers, U.S.A.
2. Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics, John Wiley Publications, pp-784.
3. Cummings, K. and William S. Klug (2016) Concepts of Genetics. 11th Edition, Pearson Education India, 896 pp.
4. Tamarin, R.H. (2002) Principles of Genetics, Tata McGraw Hill Publishing Company, New Delhi.
5. Singh B. D. (2023) Genetics Cytogenetics , 2nd Edition ,Medtech Science Press-pp230.

E- resources

1. https://onlinecourses.swayam2.ac.in/cec21_bt02/preview
2. <https://www.youtube.com/watch?v=vnm99DUxWd0>
3. <https://www.youtube.com/watch?v=YErqLILYEDY>
4. https://www.youtube.com/watch?v=S_3C7R6UbAI
5. <https://www.youtube.com/watch?v=frvV84FR6K4>
6. <https://www.youtube.com/watch?v=mg6tXQaiBaI>

Mapping with programme outcomes								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	M	M	S
CO3	S	S	S	M	S	S	M	S
CO4	S	S	S	M	L	M	S	S
CO5	S	S	S	S	M	S	S	S
CO6	S	S	S	M	L	M	S	M

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

ANIMAL HUSBANDRY
(Subject code: 23PZOS31)

Semester: III

SEC: 2

Credits: 3

Hours: 4

Course objective: The objective of this course is to provide students with a fundamental understanding of animal husbandry and its importance in Indian agriculture.

Course outcomes: Upon completion of this course, students would be able to

CO1	Recall the basic concepts, definitions, and scope of animal husbandry and classify common domestic animals.	K1
CO2	Explain the principles of breeding, dairy farming, poultry farming, and small ruminant management.	K2
CO3	Apply knowledge of nutrition, housing, and management practices in dairy, poultry, goat, sheep, and rabbit farming.	K3
CO4	Analyze the causes, symptoms, and preventive measures of common livestock and poultry diseases.	K4
CO5	Evaluate different breeds, farming systems, and productivity-enhancing practices for effective livestock management.	K5
CO6	Design simple farm management plans incorporating breeding, feeding, and disease control for sustainable animal production.	K5

(K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6- Create)

Unit I: Introduction

(12 Hours)

Animal husbandry: Definition - Scope of Animal husbandry in India; Classification of common domestic animals- non ruminants and ruminants; breeding of farm animals - artificial insemination

Unit II: Dairy farming

(12 Hours)

Scope of dairy farming - types of cattle breeds; dairy products; nutritive value of milk; Lactometer

Unit III: Poultry farming

(12 Hours)

Poultry farming in India; Common poultry breeds in India; Nutritive value of eggs; sexing; construction of poultry house; rearing of broilers; poultry diseases.

Unit IV: Goat and sheep farming

(12 Hours)

Breeds of Indian goats and sheep; Exotic breeds of goats and sheep; Nutrition requirements; diseases and vaccination (disease symptom, treatment and vaccination)

Unit V: Rabbit farming

(12 Hours)

Scope of rabbit farming; types of breeds; nutritional requirement; farm management

Textbooks:

1. Banerjee, G.C. (2010). Text book of animal husbandry , Oxford & IBH Publishing company Pvt. Ltd, New Delhi, India
2. Arumugam, N., Jeyasurya, Nair, N.C., Soundarapandian, N., THangamani, A., Narayanan, L.M., Leelavathi, S., Murugan, T., Prasanna Kumar, S., Johnson Rajeshwar, J. and Ram Prabu, R. (2013). Economic zoology, Saras publication, Nagercoil. Harish Kumar Verma and Jaswinder Singh (2023)A Text Book of Veterinary and Animal Husbandry ,New Delhi Publishers,pp-590
3. Harilal, and Sathish (2015) Organic Animal Husbandry, serial Publishing House,pp-66.

Reference Books :

1. P.N. Bhat ,M.P. Yadav ,(2018) Animal Husbandry: Research, Education and Development, Scientific publishers (India),pp-280.
2. Chetraj Upreti, Dr. Niraj Baskota, Sujaya Upreti (2020) Introductory Animal Husbandry, Heritage Publishers & Distributors Pvt.Ltd,pp-304.
3. Chandrama Singh (2023)HandbookOf Animal Husbandry, Bio Green books Publishers,pp-256.
4. Titus Miracle (2024) Animal Husbandry : How to start Animal Husbandry Business a Complete Guide,Independentlypublished ,pp- 52.
5. Singh, Chandrama (2021) Textbook Of Animal Husbandry,Bio Green books Publishers,pp-256.

E-resources:

- 1.https://agritech.tnau.ac.in/animal_husbandry/animhus_index.html
- 2.<https://www.agrimoon.com/wp-content/uploads/Livestock-Production-and->
- 3.https://agritech.tnau.ac.in/animal_husbandry/animhus_cattle_care&management.html
- 4.<https://www.agriexam.com/animal-husbandry-study-material>
- 5.<https://basu.org.in/study-materials/>

ANIMAL BIOTECHNOLOGY
(Subject Code: 26PZOS32)

Semester: III

SEC: 3

Credit: 3

Hours: 4

Course Objective: The course aims to develop understanding of transgenic organisms, animal cell culture, and modern biotechnological applications in medicine, agriculture, and livestock improvement.

Course outcomes: At the end of the course the students will be able to

CO1	Describe the principles, tools, and steps involved in recombinant DNA technology and vector systems.	K2
CO2	Apply molecular techniques such as restriction digestion, cloning, transformation, blotting, and library construction in gene manipulation	K3
CO3	Analyze methods used for the production of transgenic animals and plants and assess their biotechnological applications.	K4
CO4	Demonstrate knowledge of animal cell culture techniques, including media preparation, tissue isolation, and establishment of cell lines.	K3
CO5	Evaluate the applications of biotechnology in pharmaceuticals, diagnostics, vaccines, pest management, and livestock improvement.	K5
CO6	Design or propose basic biotechnological strategies for solving problems related to human health, agriculture, and animal production.	K6

Unit I: rDNA technology

12Hours

Recombinant methods-construction of recombination DNA, Introduction of recombinant DNA into host cells Restriction enzymes: Nomenclature, detailed study of Type II.; Selection and multiplication of recombinant host cells; Expression of cloned gene, vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics). CRISPR gene

Unit 2: Molecular Techniques in Gene manipulation

12Hour s

Transformation techniques: Calcium chloride method and electroporation. Construction of genomic and cDNA libraries and screening by colony and plaque. Hybridization. Southern, Northern and Western blotting.

Unit 3: Genetically Modified Organisms

12 Hours

Production of cloned and transgenic animals: Nuclear Transplantation, Retro viral method, DNA microinjection .Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice. Production of pest- and herbicide-resistant plants. Biopharming.

Unit 4: Animal cell culture

12 Hours

Characteristic features of animal cells in growth; Requirement - culture media, Equipments; Isolation of animal cells- physical and chemical methods; Establishment of cell culture - primary, secondary cell culture and cell lines – applications.

Unit-5 :Biotechnological Applications

12 Hours

Monoclonal antibodies, DNA finger printing, interferons, Recombinant vaccines, insulin and somatotropin production, transgenic animals, Gene therapy and immunotoxins, stem cell

research: basic design, types and uses of bioreactors .Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia).. Biotechnological approaches for the management of pests, mosquitoes and nematodes. Live stock improvement.

Text books:

1. Dubey,R.C. 2014. Advanced biotechnology, S.Chand& Company, New Delhi.
2. Satyanarayana, U. 2008. Biotechnology, Book and Allied Ltd, India.
3. Das, H.K. 2006. Text book of biotechnology, Fourth Edition, [Wiley indiaPvt. Ltd](#), India.

Reference books:

1. Yadav Rajiv Tyagi, P.R. 2006. Biotechnology and Animal tissues, Discovery Publishing house, New Delhi.
2. Singh, B.D. 2014. Biotechnology expanding horizons, KalyaniPublishers, Ludhiana, Punjab
3. Prakash S. Lohar. 2012. Text book of biotechnology, MJP publishers, Chennai.
4. Sandy B. Primerose . 2006. Principles of gene manipulation and genomics, Oxford
5. Gupta, P.K. 2004. Biotechnology and Genomics,Rastogi Publication Corporation, Meeret.

E. Resources:

1. https://www.researchgate.net/publication/281773836_Animal_Biotechnology
2. http://www.lonestar.edu/departments/biotech/plant_biot_chapterwlinks.pdf
3. <https://ncert.nic.in/textbook/pdf/lebo112.pdf>
4. <https://www.ncbi.nlm.nih.gov/books/NBK215771/>
5. <https://www.everyersreport.com/reports/RL33334.html>

Mapping with programme outcomes								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	S	M	S	S	M	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

INTERNSHIP

Semester : III

Sub. Code: 26PZOI31

Credits: 2

- All PG students will undergo internship during the summer holidays of the First year after completing II semester.
- Two credits will be given for internship.
- Minimum working days: 30
- Minimum working time per day: 3 Hrs. & Maximum working Time: 5 Hrs.
- The places of internship can be government offices, Panchayats, MP, MLA offices, private institutions, companies, production units etc.
- The HoD of the departments will give a letter of introduction to each student.
- The students will identify the company / institution for internship.
- The students will be divided equally based on the number of professors available in the departments. Each professor will serve as a guide to the assigned students.
- The students will finalize the institutions / companies for the internship in consultation with the guides.
- The students shall maintain a work diary which will be countersigned by the managers/ authorities of the company in which the students do the internship on daily basis.
- The work diary, Work completion certificate obtained from the company and a comprehensive report on the learning outcomes will be submitted to the guides at the end of the internship.
- Viva will be conducted based on the experience of the internship in the month of August. The guide will be the internal examiner and another faculty from the same department will serve as the external examiner.

ECOLOGY

(Subject code: 23PZOC41)

Semester: IV

Core :13

Credits:4

Hours:4

Course Objective: Study the basic components of the environment and ecosystem structure, functions, and interactions among biotic and abiotic factors, and ecological principles to identify environmental pollution problems and propose suitable management and monitoring measures.

Course outcome: At the end of the course the students will be able to

CO1	Describe and explain the structure and functioning of ecosystems, including energy flow, food chains, food webs, ecological pyramids, and species interactions.	K2
CO2	Explain population characteristics, growth patterns, and the functioning of major biogeochemical cycles.	K2
CO3	Analyze the role and interrelationship of major biogeochemical cycles (carbon, nitrogen, oxygen, phosphorus, and sulphur) in maintaining ecosystem balance.	K4
CO4	Compare and assess freshwater, marine, estuarine, and terrestrial habitats along with the sustainable use of renewable and non-renewable animal resources.	K4
CO5	Evaluate conservation strategies, protected areas, biodiversity management approaches, and the status of endangered and endemic animals in India	K5
CO6	Identify, analyze, and propose solutions for various forms of environmental pollution and assess the role of biological indicators in environmental monitoring and climate change studies.	K3,K6

Unit I: The environment and ecosystem (12 Hours)

The Environment - Atmosphere, Hydrosphere, Lithosphere, abiotic and biotic factors and its interaction; Ecosystem structure and function; Natural and Man-made ecosystem, energy flow, food chain and web; Ecological pyramids, primary productivity and its measurement. Animal associations-symbiosis, commensalism, mutualism, parasitism, predators and competition.

Unit II: Population and nutrient cycles (12 Hours)

Characteristics of a population - growth curves, density, natality, mortality, age distribution; Life study tables; Factors affecting population growth, regulation of population size; Biogeochemical cycles-Carbon, Oxygen, Nitrogen, Phosphate and Sulphur cycle; Interaction between nutrient cycles.

Unit III: Habitat and resources ecology (12 Hours)

Ecology of fresh water, marine, estuarine, terrestrial habitat, Renewable and non-renewable resources - animal resources.

Unit IV: Environmental conservation and management (12 Hours)

Principles of conservation, biodiversity management approaches, Wild life resources and protected areas, endangered and endemic animals in India; Conservation strategies (project tiger and biosphere reserve); Environmental stress and their management

Unit V: Pollution and management

(12 Hours)

Environmental pollution and its biological effects; Air, water, soil and noise Pollution; Thermal radioactive and greenhouse effect; Ozone and global warming; Acid rain Biomagnifications; Biological indicators and their role in environmental monitoring and climate change.

Textbooks:

1. T. K. Saha. (2013). Ecology and Environmental biology, Books and Allied (P) Ltd. 628 pages.
2. Mohan P Arora. (2017). Ecology, Himalaya Publishing House. 554 pages.
3. P. D. Sharma. (2018). Fundamentals of Ecology. Rastogi Publications. 340 pages.

Reference books:

1. Eugene P. Odum. (2017). Fundamentals of Ecology. 5th edition. Cengage Learning. 624 pages.
2. R. Rajagopalan. (2023). Environmental Studies. 4th edition. Oxford University Press. 344 pages.
3. R. Rajagopalan. (2022). Environment and Ecology. 3rd edition. OakBridge Publishing. 598 pages.
4. J. L. Chapman, M. J. Reiss. (2018). Ecology: Principles and Applications. 2nd edition. Cambridge University Press. 330 pages.
5. P. D. Sharma. (2017). Environmental Biology and Toxicology. 3rd edition. Rastogi Publications. 589 pages.

E-resources:

1. http://gdcganderbal.edu.in/Files/a8029a93-30ad-4933-a19a-59136f648471/Link/EcologyandEnvironment_44344ff9-021a-4e6b-ab1f-cf8a148398f2.pdf
2. <https://uou.ac.in/sites/default/files/slm/MSCBOT-602.pdf>
3. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SAR1614.pdf
4. <https://nios.ac.in/media/documents/333courseE/4.pdf>
5. <http://ndl.ethernet.edu.et/bitstream/123456789/32226/1/Environment%20and%20Ecology.pdf>

Mapping with programme outcomes								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	L	L	L	L	L	M	S
CO2	L	M	L	M	L	M	M	S
CO3	M	S	L	L	L	M	L	L
CO4	M	S	M	S	M	M	L	L
CO5	M	M	L	M	M	L	L	L

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

AQUACULTURE
(Subject code: 26PZOC42)

Semester: IV Core: 14 Credits: 4 Hours:4

Course objective: To familiarize the knowledge on fish pond construction, management, culture, feeding, breeding and disease control of fin and shell fishes.

Course Outcomes: At the end of the course the students will be able to

CO1	Define basic principles and scope of aquaculture	K1
CO2	Describe construction and management of fish ponds	K2
CO3	Apply appropriate preparation and management practices in the pond	K3
CO4	Outline fish nutrition and breeding technology	K4
CO5	Summarize various components of fish genetics	K5
CO6	Develop strategies to prevent and treat fish diseases.	K6

(K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6- Create)

Unit I: Pond construction and management (12 Hours)

Scope and principle of aquaculture - Fish pond construction: Criteria for site selection, types of ponds, construction and conditioning of pond, water quality analyses, pond maintenance and management.

Unit II: Patterns of aquaculture (12 Hours)

Fresh water - Monoculture-culture of Tilapia; Composite fish culture, integrated fish farming and ornamental fish culture; Coastal-Traditional and modern methods, culture of marine prawns, edible and pearl oysters; Murrel farming (Dr. Haniffa's contribution), culture of sea weeds.

Unit III: Feeding, breeding and rearing technology (12 Hours)

Culture of live feed organisms - *Artemia*, rotifers - Artificial feed - types, formulations and preparation. Induced spawning - use of natural and synthetic hormones, artificial fertilization; seed production, rearing of hatchlings, post larvae, fry and fingerlings.

Unit IV: Fish genetics (12 Hours)

Genome and genomics of fishes; Selective breeding- Hybridization, androgenesis, gynogenesis, induction of ploidy; Gene manipulation-sex reversal; Transgenic fishes; Cryopreservation.

Unit V: Diseases diagnosis and management (12 Hours)

Ecto- and endo-parasites; Bacterial, fungal, EUS and viral diseases - agents, causes, symptoms, control and preventive measures; vaccines and chemotherapy, resistant strain production; Environmental factors and disease spreading; Consequences of consumption of diseased fishes.

Textbooks:

1. R. K. Rath. (2011). Fresh water Aquaculture. 3rd edition. Scientific Publishers. 587 pages.
2. B. Ahilan. (2013). Textbook on Freshwater Aquaculture. Daya Publishing House. 244 pages.
3. S. S. Khanna, H. R. Singh. (2014). Textbook of Fish Biology and Fisheries. 3rd edition. Narendra Publishing House. 610 pages.

Reference books:

1. ICAR. (2006). Handbook of Fisheries and Aquaculture. Indian Council of Agricultural Research. 755 pages.
2. A. S. Ninawe, G. D. Khadkar. (2010). Nutrition in Aquaculture, Narendra Publishing House. 432 pages.
3. S. K. Dubey, Bandana Ghosh. (2012). Fish Biotechnology, Wisdom Press. 316 pages.
4. M. R. Saravanan, K. L. Santhanam. (2008). Introduction to Encyclopaedia of Fishery Science and Technology, Vol. 2: Fish nutrition and biochemistry; Vol. 6. Inland and freshwater aquaculture; International Scientific Publishing Academy.
5. W. S. Lakra, S. A. H. Abidi, S. C. Mukherjee, S. Ayyappan. (2008). Fisheries Biotechnology, Narendra Publishing House. 240 pages.

E-resources

1. http://agritech.tnau.ac.in/fishery/fish_freshwaterprawn.html
2. <http://www.fao.org/3/contents/6c2f5977-bc3e-528e-b90f-ee63c7605e27/AC417E00.htm>
3. http://nacogdoches.agrilife.org/files/2011/06/feeding_fish_7.pdf
4. <https://www.slideshare.net/SameerChebbi1/freshwater-brackish-water-and-marine-fish-culture-of-india-by-dr-s-g-chebbi>
5. <https://agriculture.vikaspedia.in/viewcontent/agriculture/fisheries/marine-fisheries/culture-fisheries/culture-of-fin-fishes/marine-fin-fish-culture?lgn=en>

Mapping with programme outcomes								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

ENTOMOLOGY- PRACTICAL

(Subject code: 23PZOC43)

Semester:IV

Core:15

Credits:2

Hours:4

Course objective: To enable students to identify and document economically important insect orders; develop practical skills in insect morphology and anatomy through temporary mounting techniques and to develop management strategies and toxicity assessment.

Course outcomes: At the end of the course the students are expected to

CO1	Identify and record the salient features of the insect morphology and classify the insect at the order level.	K1
CO2	Collect and record the characteristic features of economically important insect orders, including harmful, beneficial, and productive insects	K2
CO3	Develop practical skills in insect morphology and anatomy through temporary mounting techniques and summarize the pest biology.	K3
CO4	Develop and apply pest management strategies, including the preparation and evaluation of botanical pesticides and kairomones.	K4
CO5	Perform toxicity assessment and quantitative data analysis of toxicity and interpretation using statistical tools such as SPSS.	K5
CO6	Improve experiential learning through insect collection, mini-projects, and field visits.	K6

(K1-Remember;K2-Understand;K3-Apply;K4-Analyze;K5-Evaluate;K6–Create)

Experiments:

1. Identify and record the salient features of economically important insect orders (preserved specimens and paper cuttings)
2. Temporary mounting of tarsi (preserved specimens of any insect)
3. Study of mouth parts in insects (Grasshopper, plant bug, mosquito, housefly)
4. Study of sexual dimorphism in insects
5. Sting apparatus–honeybee
6. Preparation of crude kairomone extract of a pest(s)
7. Qualitative profiling of secondary metabolites of pesticidal plant (Neem extract, neem oil and commercial neem formulation).
8. Preparation of emulsifiable concentration of botanical pesticide (neem or pungam oil)
9. Determination of corrected mortality and LC₅₀ using SPSS
10. Phyto toxicity of conventional pesticides/ biopesticides (seed germination method)
11. Physical methods and natural fumigation techniques.
12. Mini project - Insect box: Collection, preservation and submission of insects (Representatives of insect orders, Beneficial, Harmful and productive insects)
13. Spotters related to theory
Harmful insects: Pests - Sap feeders (aphid, mealybug, bugs); Defoliators (Lepidopteron); Borers (Coleopterans); Soil pest (termites); storage pest (internal and external feeder).

Vectors - animal vectors (Mosquitoes, houseflies, horsefly, Cockroaches) and plant vectors (Aphids and plant hoppers).

Beneficial insects (preserved specimens) – predators (reduviids, dragon and damselflies, Chrysoperla, ladybird beetle), parasitoids (*Trichogramma*), pollinators (butterflies and wasps)

Productive insects (preserved specimens): honey bees, mulberry silkworm, eri silkworm, lac insect

14. Mini group project: Collection and model making related to biology of important insects, commercial pesticides, pest control devices.

15. Visits to Agro-ecosystems, Agriculture College/ Research Institute.

PROJECT WITH VIVA VOCE

(Subject code: 26PZOC44)

Semester: IV **Project** **Credits: 7** **Hours: 10**

Course objective: To promote original thinking, insemination of knowledge, modulation and innovation of thought, as an exercise, in order to transport the young minds to the expanding horizon of their chosen area of knowledge and transform them into knowledge generators.

Process and dissertation frame work: All the students must undertake dissertation work at the final semester (IV semester). Lot system will be followed for allotting students under the faculty from the Zoology Department at St. Xavier's College to work on the dissertation. The topic of research should relate to Zoology that the student intends to undertake.

This process includes:

- a) The conceptualization of the independent research that will comprise the dissertation,
- b) The preparation of and satisfactory defense of the dissertation proposal,
- c) The collection, analysis and interpretation of data,
- d) Presentation of findings in the dissertation format and oral defense of the dissertation.

Dissertation activity must be completed within the prescribed time frame for the semester.

Submission, chapters and format of the report: Candidates must submit three copies of the report duly signed and endorsed by the Head and the Guide to the Head. Following is a brief guideline for the sections / chapters in the report and the formatting of the report. The report will have three main parts:

- a. Initial Pages—in the following sequence.
 - i. Title Page
 - ii. Certificate from the guide and declaration by the candidate
 - iii. Endorsement by the Head of the Department
 - iv. Plagiarism report
 - v. Acknowledgement.
 - vi. Table of Contents
 - vii. List of figures, photos, drawings, tables etc.
 - viii. List of abbreviations
 - ix. Abstract
- b. Main body of the report consists of i.) Introduction with objectives, Background information (Literature review), ii.) Methodology, iii) Results (Data Analysis and Findings) and discussion, iv.) Conclusions Summary, v.) Recommendations and vi.) Citations (references)
- c. Appendices (if any)

The system of evaluation shall be as follows:

1. Project work would be assigned at the beginning of the IV Semester to enable students to initiate work on the same.
2. The candidate should submit: Tentative title, review of literature, objectives and proposed methodology during the first week of the semester IV. This component would be evaluated for 25 marks.
3. In addition, 30 and 60 working days, the candidate should submit results and these components would be evaluated for 25 marks each
4. There shall be a closed *viva-voce* examination at the end of Semester IV on the Dissertation that shall be evaluated by External and Internal examiners.
5. Project report / dissertation shall be presented by Power point.

Dissertation: 75 marks (25 + 25 + 25 – evaluated by the guide and another faculty member from the department); *Viva voce* examinations: 25 marks.

AQUACULTURE AND ECOLOGY - PRACTICAL

(Subject code: 26PZOE41)

Semester: IV

Elective: 6

Credits: 2

Hours: 4

Course objective: To provide students with practical knowledge of aquaculture techniques and ecological assessment methods.

Course outcomes:

CO1	Identify cultivable finfish, shellfish, parasites, aquatic insects, weeds, fish diseases, and aquaculture techniques through spotters.	K1
CO2	Explain principles and procedures involved in fish feed preparation, induced breeding, age determination, and morphometric measurements.	K2
CO3	Apply standard methods to assess fish growth, population density, GSI, HSI, and length–weight relationship using field and laboratory data.	K3
CO4	Analyze physicochemical parameters of pond water, primary productivity, and nutrient levels to assess ecosystem health.	K4
CO5	Evaluate aquaculture and ecological practices such as integrated fish farming, sewage-fed fish culture, and conservation strategies.	K5
CO6	Design basic field-based assessments and propose sustainable aquaculture and environmental management strategies based on observations and data.	K6

AQUACULTURE

1. Preparation of fish feed- Demonstration
2. Collection and preparation of pituitary extract (Hypophyztion, demonstration in a fish farm).
3. Estimation of Dissolved Oxygen content in different pond water samples.
4. Morphometric measurements of fin fish and shell fish
5. Determination of fish age –Otolith method
6. Length weight relationship - (data analysis)
7. Population density assessment- capture and release method (Peterson's method).
8. Assessment of GSI and HSI in fishes

Spotters: (Any 25)

Freshwater fishes – *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Anguilla anguilla*, *Channa striatus*, Cat fishes: *Heteropneustes fossilis*, *Mystus sp.*, *Chanos chanos*;

Marine fishes –*Pampus argenteus*, *Scoliodon*; Shell fishes - *Lobster*, *Penaeus monodon*, *Perna viridis*, *Perna indica*, *Scylla serrata*,

Fish parasites – *Gyrodactylus*, *Ichthyophthirius*, *Trichodina*, *Costia*, *Saprolegnia*, *Argulus*;

Predatory Aquatic insects: *Laccotrephes*, *Lethocerus*, *Diplonychus*, *Cybister*;

Aquatic weeds- *Spirogyra*, *Nymphaea*, *Hydrilla*, *Eichhornia*, *Azolla*;

Fish diseases: Dropsy, Gill rot disease, Epizootic ulcerative diseases, Tail rot disease and Vibriosis;

Techniques - Sewage fed fish farm, Composite fish culture, Induced Breeding, Integrated fish farming and Breeding Hapa

Ecology

1. Physicochemical analysis of fish culture pond water (Temperature, turbidity, pH and alkalinity) - demonstration in a fish farm.
2. Morphometry of pond (Enclosed rectangular method (or) Shore length/ shore area and shore line development)
3. Measurement of primary productivity (dark and light bottle method)
4. Estimation of total dissolved solids and suspended solids
5. Estimation of nitrates and phosphates in water samples
6. Visit to Aqua farm / ecosystem/ industries (Optional)

Spotters: Biogeochemical cycle (Oxygen, Phosphorous, Nitrogen and Carbon) Renewable (Biomass /energy, windmill, Tidal energy, Solar energy) and non renewable resources (Nuclear, fossil fuel etc.), Insitu and exsitu conservation, endangered animal list, diagram related to air, water, soil and noise pollution, Transparency - Secchi disc, Green house effect, Ozone layer, Global warming, Biomagnification and Biological indicators.

ENTOMOLOGY
(Subject code: 26PZOS41)

Semester: IV

SEC: 4

Credits: 3

Hours: 4

Course objective: To enable students to identify commonly occurring insects and their life cycles; harmful insects, their damage potential and management strategies; beneficial insects and their ecological and economic importance; insect vectors of human and animal diseases and disease transmission.

Course outcomes: At the end of the course the students will be able to

CO1	Identify and document commonly occurring insects,	K1
CO2	Understand the taxonomy, classification, and evolutionary position of insects.	K2
CO3	Analyze the distribution and abundance of insects in different habitats.	K3
CO4	Explain the life cycle, rearing techniques, and disease management of beneficial insects, with reference to their economic importance.	K4
CO5	Analyze the economic status of insects and describe their life cycle, damage potential, and management strategies, including natural and eco-friendly pest control methods.	K5
CO6	Recognize insects acting as vectors of diseases in humans and animals, and analyze their role in disease transmission.	K6

(K1-Remember;K2-Understand;K3-Apply;K4-Analyze;K5-Evaluate;K6–Create)

Unit I: Insect Morphology and classification

(15 Hours)

General morphology of head and its segmentation (Antennae, Mouthparts); Thorax and its Segmentations; Morphology of abdomen and its appendages; Special organs- Auditory, chemo, thermo and photoreceptors - sense, tympanel, Light and Sound Producing Organs (Brief account)

Unit II: Insect classification

(15 Hours)

Classification of insects up to families; General characters and economic importance of Collembola, Thysanura, Coleoptera, Lepidoptera, Hemiptera, Hymenoptera, Isoptera, Odonata, Diptera, Placoptera, Dermptera, Phasmatidea, Orthoptera, Blattodea.

Unit III: Economically important Pestiferous Insects

(15 Hours)

Bionomics and damage potential, symptoms and management of crop [*Scirpophagaincertulas*, *Altherigonasoccata*, *Chilo infuscatellus*, *Amsactaalbistriga*, *Acheajanata*, *Phenococcussolenopsis*, *Helicoverpa armigera*, *Leucinodesorbonalis*, *Oryctes rhinoceros*, *Spodoptera litura*], stored products [*Sitophilus oryzae* and *Tribolium castaneum*], invasive (*Leptocybeinvasa*) and forest (*Hyblacapuera*) pests

Unit IV: Natural and Applied Control and Chemical Control

(15 Hours)

Natural control, Applied control -Physical, cultural, mechanical and legal methods); Electronic devices; Organochlorine (DDT), Organophosphate (malathion), Cyclodiene (endosulfan), Carbamates (carbaryl); Pyrethroids (cypermethrin, neonicotinoids); Formulations - ingredients,

solids (dusts, granular, wettable powder), liquid, fumigants, electronic devices for fly and mosquito management.

Unit V: Biological Control and Concepts of IPM

15 Hours

Predators- Dr DPA's contribution (reduviid) and parasitoids (any three Indian example each); Microbial insecticides –*Bt*, *Metarizhium*, NPV's; Botanicals – (Azadirachtin, pyrethrins, rotenone, oils); Semiochemicals – Mating disruption, Diflubenzuron, Chitosan; IPM – principles, components, IPM in cotton; Bio-intensive IPM; Sterile insect technique (SIT).

Text books:

1. Vasantharaj David, B. and V. V. Ramamurthy, 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.
2. General and Applied Entomology (2nd Ed. 2004). K.K. Nayar, T.N. Ananthakrishnan and B.V. David, Tata McGraw-Hill. Publication.
3. The Insects: Structure, Function and Biodiversity, D.P. Ambrose, 2015. Kalyani Publishers; 2nd edition; Kalyani Publishers

Reference books:

1. Robert F. Norris, Edward P. Caswell-Chen, Marcos Kogan. 2003. Concepts in Integrated Pest Management, Prentice Hall, the University of Michigan.
2. Chapman, R.F., S.J. Simpson and A.E. Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
3. Imms, A.D., O.W. Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.
4. Prasad T.V. 2019. Handbook of Entomology, New Vishal Publication, Fourth Edition, pp-536.
5. Anilkumar B. Pardeshi. 2017. General and Economic Entomology, Oxford book company, pp-252.

E-resources:

1. <http://agritech.tnau.ac.in/pdf/6.pdf>
2. http://books.irri.org/9712200280_content.pdf
3. <http://oar.icrisat.org/2424/1/Pest-Control.pdf>
4. http://hau.ernet.in/hisar_admin/newspdf/1421384695eco-friendlymanagement%20.pdf
5. <http://www.nasda.org/File.aspx?id=30498>

ADD ON COURSE

DAIRY FARMING

(Subject Code: 26PZOVA11)

Value added Course 1/II:

Credits: 3

Hours:30

Course Objectives: This course aims to provide students with fundamental knowledge of dairy farming, including cattle breeds, breeding methods, housing, nutrition, and management practices. It helps students understand scientific feeding, milk production, processing, and disease prevention.

Course Outcomes: Upon completion of this course, students would be able to

CO1	Describe the scope of dairy farming, advantages of dairying, and classification of indigenous and exotic cattle breeds.	K1
CO2	Explain breeding methods, artificial insemination, and selection of dairy cattle.	K2
CO3	Apply knowledge of housing, seasonal management, and feeding practices for calves, adults, and pregnant animals.	K3
CO4	Analyze the nutritional value, composition, processing, and spoilage of milk and milk products.	K4
CO5	Evaluate the role of dairying in income generation, employment, and human nutrition.	K5
CO6	Design basic disease prevention, vaccination, and biosecurity measures for effective dairy farm management.	K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6– Create

Unit I : Introduction

Introduction to Dairy Farming- Advantages of dairying- Classification of breeds of cattle- Indigenous and exotic breeds- Selection of dairy cattle. Breeding-artificial insemination-Dairy cattle management-General Anatomy.

Unit II : Dairy Farming

Construction of Model Dairy House - Types of Housing - Different Managerial Parameters - Winter Management - Summer Management.

Unit III :Nutrition and feeding(6 Hours

Feedstuffs available for livestock- Roughages -Concentrates - Energy rich concentrates - Protein rich concentrates - Mineral Supplements - Vitamin Supplements - Feed additives - Feeding management - Calves Feeding - Feeding of adults - Feeding of pregnant dairy animals - Feeding pregnant heifer.

Unit IV :Dairy farm Management

Milk-Composition of milk-milk spoilage-pasteurization - Role of milk and milk products in human nutrition – Dairying as a source of additional income and employment.

Unit V : Dairy farm Diseases

Contagious disease - Common Bacterial - Protozoal - Helminth and Viral Diseases - Parasitic Infestation - Vaccination - Biosecurity.

Text Books:

1. Chandrama Singh (2023) Handbook Of Animal Husbandry, Bio Green books Publishers, pp- 256.
2. Titus Miracle (2024) Animal Husbandry : How to start Animal Husbandry Business a Complete Guide, Independently published, pp- 52.
3. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, New York.

Reference Books:

1. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea & Fabiger Publisher.
2. Singh, Chandrama (2021) Textbook Of Animal Husbandry, Bio Green books Publishers, pp- 256.
3. Handbook of animal husbandry TATA, S.N ed., ICAR 1990.
4. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.
5. The Veterinary Books for Dairy Farmers by Roger W. Blowey.

E-resources:

1. <https://kvk.rkmvu.ac.in/wp-content/uploads/2019/02/Dairy-Farm-Management>.
2. <https://old.bansdoc.gov.bd/sub-3/105/105Dairy%20Farming%20Handbook.pdf>
3. <https://dairyschool.co.il/books-about-dairy-farming/>
4. <https://www.manage.gov.in/publications/eBooks/Dairy>
5. https://www.nsdcindia.org/scmp/assets/image/822061347-Dairy_Farmer

Mapping with programme outcomes								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	S	L	L	S	S	M	S
CO2	M	S	S	S	M	S	M	L
CO3	M	S	S	S	S	S	S	S
CO4	M	S	S	S	S	M	L	L
CO5	S	S	S	S	M	M	S	L
CO6	S	S	S	M	S	M	S	S

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

ZOOLOGY FOR COMPETITIVE EXAMINATIONS

(Subject code: 26PZOVA12)

Semester: I / II

Credits: 3

Hours: 30

Objective: Enhance analytical, experimental, and problem-solving skills required for biological research and applied sciences. Prepare students for higher studies, research, and careers in biotechnology, biomedical sciences, environmental sciences, and allied fields.

Course Outcomes: At the end of the course the students will be able to

CO1	Evaluate structure–function relationships of macromolecules using concepts like Ramachandran plots, motifs, and domains.	K1
CO2	Describe cell structure, organelles, membrane transport, and cytoskeleton organization.	K2
CO3	Interpret gene interactions, linkage mapping, mutations, and chromosomal abnormalities.	K3
CO4	Evaluate ecological principles including population dynamics, ecosystems, and conservation biology.	K4
CO5	Apply statistical methods and understand biosafety, bioethics, and intellectual property rights in research.	K5
CO6	Design basic experimental approaches for biological investigation.	K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6– Create

Unit I: Biomolecules, Biophysics and Metabolism

Structure of atoms, molecules and chemical bonds, Stabilizing interactions, Principles of thermodynamics and reaction kinetics, pH, buffers and colligative properties, Carbohydrates, lipids, proteins, nucleic acids and vitamins, Ramachandran plot, motifs and domains, , Stability of macromolecules, Enzyme kinetics, regulation and mechanism, Isozymes and catalytic strategies, Glycolysis, TCA cycle, oxidative phosphorylation, Coupled reactions and biological energy transducers, regulation of metabolism.

Unit II: Cellular Organization and Fundamental Processes

Cell wall and membrane structure, Membrane transport ,Organelles: nucleus, mitochondria, ER, Golgi, lysosomes, plastids, Cytoskeleton and cell motility, Operon concept, Chromatin structure, Transposons and gene families:mitosis and meiosis, Cell cycle regulation, Apoptosis, necrosis and autophagy:DNA replication, repair and recombination, Transcription and RNA processing, Translation and post-translational modification, Gene regulation and epigenetics

Unit III: Genetics, Cell Communication and Development

Mendelian genetics, Gene interactions, linkage and mapping, Mutations and chromosomal alterations, Quantitative and population genetics, Human genetics: Hormones and receptors Signal transduction pathways, GPCR and second messengers, Cell adhesion and extracellular matrix, Neurotransmission: Innate and adaptive immunity, Antigen–antibody interactions, MHC and antigen presentation, Vaccines and immunodeficiencies, Oncogenes and tumor suppressor genes,

Pathogen entry and infection mechanisms: Gametogenesis and fertilization, Early embryonic development, Morphogenesis and organogenesis, Stem cells, aging and senescence

Unit IV: Physiology, Evolution and Ecology

Cardiovascular and respiration, Nervous and excretion systems, Endocrinology, reproduction, Digestion and thermoregulation: Origin of life Mechanisms of evolution, Speciation and extinction, Diversity of microbes, fungi, plants and animals; Population and community ecology, Ecosystem dynamics, Biodiversity and conservation, Climate change and environmental impacts, Behavioural ecology.

Unit V: Biotechnology, Bioinformatics and Research Methods

Molecular cloning, Genome editing, Gene expression analysis, Stem cell technology, Transgenic plants and animals, Marine and environmental biotechnology, Bioremediation and waste management: Bioreactors and fermentation, Enzyme engineering, Downstream processing, Metabolic engineering: Biological databases, Sequence analysis (BLAST, alignments), Molecular modeling, Drug design, Systems biology: Molecular and biophysical techniques, Omics technologies, Microscopy and electrophysiology, Statistical methods, IPR, biosafety and bioethics.

Text Books:

1. U. Satyanarayana, U. Chakrapani. 2020. Biochemistry, 5th edition, Elsevier. 777 pages
2. Gupta, P. K. (2025). Cell and molecular biology (5th rev. ed.). Rastogi Publications.
3. Kothari C. R, (2023) Research Methodology - Methods and Techniques, 5th edition, New age publications, pp-418.

. Reference Books:

1. J. L. Jain, Sunjay Jain, Nitin Jain. 2016. Fundamentals of biochemistry, S. Chand & Co. Ltd., New Delhi. 1264 pages.
2. Cooper, G. M., & Adams, K. (2023). The cell: A molecular approach (9th ed.). Oxford University Press.
3. Dr. P S Verma & Dr. V K Agarwal (2022) Genetics: Library Edition, S Chand and Company Ltd, pp-1312.
4. Eugene P. Odum. (2017). Fundamentals of Ecology. 5th edition. Cengage Learning. 624 pages.
5. Dubey, R. C. 2014. Advanced biotechnology, S. Chand & Company, New Delhi.

E- resources:

1. <http://jpkc.gmu.cn/swhx/book/Biochemistry.pdf>
2. <http://www.louisbolk.org/downloads/1282.pdf>
3. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SAR1614.pdf
4. <https://ncert.nic.in/textbook/pdf/lebo112.pdf>
5. https://onlinecourses.swayam2.ac.in/cec21_bt02/preview

INDUSTRIAL ZOOLOGY

(Subject code: 26PZOVA13)

Semester: I / II

Credits:3

Hours: 30

Course Objective: To introduce students to the practical and industrial applications of zoology in agriculture, medicine, fisheries, sericulture, apiculture, poultry, and dairy industries.

Course Outcomes: At the end of the course the students will be able to

CO1	Explain the scope, types of culture, breeding methods, and seed transport techniques in finfish and shellfish culture.	K2
CO2	Describe poultry and dairy farming practices including breeds, nutrition, management, diseases, and preventive measures.	K2
CO3	Illustrate the morphology, social organization, management practices, and economic importance of honeybees in apiculture.	K2
CO4	Explain the components of sericulture, silkworm rearing methods, diseases, and types of commercial silk.	K3
CO5	Apply vermicomposting techniques, vermiwash preparation, and evaluate the economic value of vermiculture products.	K3
CO6	Analyze the role of animal culture technologies in sustainable agriculture, rural development, and income generation.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6- Create

UNIT I :Finfish and Shell Fish Culture

Explain the components of sericulture, silkworm rearing methods, diseases, and types of commercial silk. Extensive culture, Pokkali culture and Semi intensive culture); Induced breeding in carps; Transport of fish seeds; Common cultivable shellfish species; culture of freshwater prawn; culture of edible oyster.

Unit II :Poultry and Dairy Farming

POULTRY: Poultry breeds in India, poultry feed and its composition, broiler and layers ,rearing , nutritive value of egg and meat. List of poultry diseases and their preventive measures , poultry farm management,

DAIRY FARMING : Popular breeds of cattle , nutritional requirements, milk and milk products, processing , preservation and marketing of milk , cattle breeding techniques, artificial insemination , breeding programs to improve local breeds.

UNIT III: Apiculture

Honeybee morphology , structural adaptation of mouthparts, honey sac, wax glands and sting apparatus , social life , different species and races , management of bee keeping (modern methods) , economic importance of honey, wax, pollen venom and bee pollination , a note on production of honey , its chemical composition and honey bee disease.

UNIT IV: Sericulture

Components of sericulture: Moriculture –different species of mulberry, cultivation methods, silkworm rearing, life cycle and morphology of *Bombyxmori*, environmental conditions needed for rearing, modern rearing house; rearing appliances ,chawki worm and adult worm rearing methods, non-mulberry silkworm , pest and predators , Silkworm diseases – pebrine, muscardine, flacherie and grasserie, types of commercial silk, importance of sericulture in India and by-products of sericulture .

UNIT V: Vermiculture

Ecotypes of earthworms; collection and preservation of earthworm; composting material; small scale techniques of vermicomposting and economics; Value addition of vermicompost, Vermiwash preparation and its applications.

Text Book:

1. Shukla, G. S. and Upadhyay, V.B. 2000. Economic Zoology, Rastogi Publication, Meerut
2. Christy, A.M.V. 2008. Vermibiotechnology, MJB Publications, Chennai
3. Upadhyay V. B. and G. S. Shukla. 2014. Applied and Economic Zoology, Rastogi Publications.

Reference Books

1. V.G.Jhingran - Fish and fisheries of India, Hindustan Publishing Corporation, Delhi, 1991.
2. Shanmugam, K. - Fishery Biology and Aquaculture, Hindustan Pub. Corporation, New Delhi, 1990.
3. G.C. Banerjee - A Text book of Animal Husbandry – Oxford & IBH Publication, New Delhi.
4. Ganga, G. & Chetty, J. S.(1991),*An Introduction to Sericulture*, Oxford & IBH Publishing Co.
5. Sharma, R. D. & Chakrabarti, R. (2009),*Applied Zoology*, Oxford & IBH Publishing Co., New Delhi.

E- Resources:

1. <https://www.aquaculturealliance.org/advocate/genetic-improvement-in-re,to%20disease%2C%20a>
2. <https://www.notesonzooology.com/bees/apiculture-of-bees-meaning-and-methods-zooology/6553>
3. <https://krishijagran.com/agripedia/sericulture-an-introduction-to-silk-cultivation-and-production-in-india->
4. <https://dairyschool.co.il/books-about-dairy-farming/>
5. http://agritech.tnau.ac.in/animal_husbandry/ani_chik_poultry%20mgt.html

Extra Credit Courses (ECC)

BIODIVERSITY

(Subject code: 26PZOE1)

Semester: II/IV

Credits:3

Course objective: To understand the basic classification, concepts of biodiversity and organization of related animals.

Course Outcomes: At the end of the course the students will be able to

CO1	Describe principles of taxonomy.	K1
CO2	Comprehend the salient features of invertebrates	K2
CO3	Demonstrate the general characters of chordates	K3
CO4	Classify animals.	K4
CO5	Summarize adaptive features of highlighted animals	K5
CO6	Integrate adaptation with the survival of animals.	K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6– Create

Unit I: Principles and Methods of Taxonomy

Concepts of species and hierarchical taxa, biological nomenclatures, classical (Wittakers, five Kingdom concept) and quantitative methods of taxonomy of animals. Levels of structural organization, Zoogeographic zones.

Unit II: Protozoa- Nematodes

General characters - Classification up to classes, salient features and examples of protozoa, porifera coelenterate, ctenophore and helminthes. Type study – *Paramecium caudatum*, *Obelagenticulata*, *Taeniasolium*, *Plurobrachia*; General topic - Affinities of Ctenophora, parasitic diseases, parasitic adaptations and life cycle.

Unit III: Annelid- Echinodermata

General characters -

Classification up to classes, salient features and examples of Annelida, Arthropoda Mollusca and echinodermata. Type study- *Megascolex mauritii* and *Periplaneta americana*, *Pilaglobosa* and *Asterias rubens*. General topic: Larval forms, Affinities of Peripatus.

Unit IV: Prochordates, Pisces and Amphibian

General characters - Classification up to classes, salient features and examples of Prochordates, Pisces and Amphibians. Type study- *Amphioxus*, *Balanoglossus*, *Ascidia*, *Holocephali*, *Dipnoi* and *Rana*. General topic, metamorphosis in *Ascidia*, migration in fishes, parental care in amphibian.

Unit V: Reptiles, Aves and Mammals

General characters - Classification up to orders, salient features with examples. Type study- *Columba livia*, Rabbit; Poisonous and non poisonous snakes, mechanism of biting and first aid. Flight adaptation in birds, Adaptations of aquatic mammals.

Textbooks:

1. Kohli, K.S. and Kavita Sahni 2010. Animal Diversity and Evolution, Ramesh Book Depot, 65 Shivaji Nagar, Civil Lines, Jaipur.
2. Jordan, E.L. and Verma P.L. 2003. Invertebrate Zoology, S. Chand & Company Ltd., Ramnagar, New Delhi.
3. Ekambaranatha Ayyar 1993. Outlines of Zoology, Vol. I., S. Viswanathan (Printers & Publishers) Pvt. Ltd. Chennai.

Reference books:

1. Jan A. Pechenik, 2002. Biology of Invertebrates, 4th edition, TATA McGraw-Hill Edition.
2. Kenneth V. Kardong, 2005. Vertebrates, 4th edition, TATA McGraw-Hill Edition.
3. D.T. Anderson, 2001, Invertebrate Zoology. 2nd edition, Oxford university press.
4. Singh, B.K. 2004. Biodiversity conservation and management, Mandal Deep Publications, Jaipur.
5. Ekambaranatha Ayyar 1993. Outlines of Zoology, Vol. I., S. Viswanathan (Printers & Publishers) Pvt. Ltd. Chennai.

E - Resources

1. https://www.researchgate.net/profile/Seema-Saxena-2.2/publication/383398812_Text_Book_of_Animal_Taxonomy/links/66cadbe5c2eaa5003.2314da81/Text-Book-of-Animal-Taxonomy.pdf
2. <https://uou.ac.in/sites/default/files/slm/MSCZO-501.pdf>
3. <https://uou.ac.in/sites/default/files/slm/MSCZO-501.pdf>
4. <https://uou.ac.in/sites/default/files/slm/MSCZO-501.pdf>
5. [WWW.Redditit.com](https://www.Redditit.com), ask questions to get good answer

MEDICAL ENTOMOLOGY

(Subject code: 26PZOEC2)

Semester: II

Credits:3

Course objective: This course aims to provide students with a comprehensive understanding of medically important arthropods and their role as vectors of human diseases.

Course outcomes: At the end of the course the students will be able to

CO1	Recall the classification, distribution, and salient features of medically important insect vectors and arthropods.	K1
CO2	Explain the morphology, life cycle, and biology of major vectors such as mosquitoes, flies, bugs, lice, ticks, and mites.	K2
CO3	Apply knowledge of vector biology to identify disease transmission patterns and public health significance of vector-borne diseases.	K3
CO4	Analyze the relationship between vectors, pathogens, and environmental factors influencing disease spread.	K4
CO5	Evaluate different physical, chemical, and biological vector control methods and eradication programmes.	K5
CO6	Design effective vector management and prevention strategies based on epidemiological and ecological considerations.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6– Create

Unit I: Mosquitoes

Distribution, Salient features, Morphology, Biology of medically important vector species *Anopheles* (*An. stephensi*), *Aedes* (*Ae. aegypti*), *Culex* (*Cx. Quinque fasciatus*), *Mansonia* (*Ma. annulifera*), *Culex* and *Aedes* mosquitoes; Mosquito borne diseases - Malaria, Filariasis, Dengue, Elephantiasis and Chikungunya.

Unit II: Flies and Public Health

Biology, disease transmission and control methods of Black flies (Simuliidae), Horse flies (*Tabanus*), Tsetse flies (*Glossina*) and House flies (*Musca*)

Unit III: Bugs, Lice and Cockroach

Salient features, biology, disease transmission, prevention and control measures of Bed bugs, Triatomine bugs, Head and Body louse and Cockroach (Give biological names)

Unit IV: Ticks and Mites

Salient features, biology, disease transmission and management of ticks (soft and hard ticks) and mites.

Unit V: Vectors Control Methods

Physical, Chemical and biological methods; Commercial products; National and international Eradication Programmes of Vector control.

Textbooks:

1. Service. M. 2002. Medical Entomology for students, Cambridge University Press.

2. Tyagi B.K. 2003. Medical Entomology, Scientific Publishers, Jodhpur.
3. Tembhare, D.B.2024. Modern Entomology, Himalaya Publishing House, New Delhi.

Reference books:

1. Rathinasamy G.K. 1974. A Handbook of Medical Entomology and ElementryParastitology, S.Viswanathan Printers and Publication Pvt., Ltd., Chennai.
2. Parthiban, M. and B. Vasantharaj David. 2007. Manual of Household and Public Health pests and their control, Namrutha Publications, Chennai.
3. Jeyaparvathi,S., Rushikesh G. Pawar, UshaJinendra, Surekha A. Saraf and M. Baranitharan (2025) Medical Entomology, JPS Scientific Publications, India
4. Dunston P Ambrose (2018) The Insects: Beneficial and Harmful Aspects, Kalyani publishers, New Delhi.
5. Gary R. Mullen and Lance A. Durden 2009. Medical and Veterinary Entomology, Academic Press, New York,

E-resources:

1. <http://agritech.tnau.ac.in/pdf/6.pdf>
2. http://books.irri.org/9712200280_content.pdf
3. <http://oar.icrisat.org/2424/1/Pest-Control.pdf>
4. http://hau.ernet.in/hisar_admin/newspdf/1421384695eco-friendlymanagement%20.pdf
5. <http://www.nasda.org/File.aspx?id=30498>

ANIMAL BEHAVIOUR
(Subject code: 26PZOEC3)

Semester: III

Credits:3

Course objective: To introduce students to the fundamental principles of animal behaviour, emphasizing innate and learned behaviours, ecological adaptations, and social interactions.

Course outcomes: At the end of the course the students will be able to

CO1	Explain the basic concepts, terminology, and classification of animal behaviour with reference to ethology and animal psychology.	K2
CO2	Apply principles of neural, hormonal, and genetic control to interpret behavioural patterns in animals.	K3
CO3	Demonstrate the application of ecological theories such as optimal foraging, territoriality, and dispersal in understanding animal behaviour.	K3
CO4	Analyze learning processes, biological rhythms, and cognitive abilities in animals using experimental and observational evidence.	K4
CO5	Evaluate social and reproductive behaviours in different animal groups in relation to survival and evolutionary fitness.	K5
CO6	Critically assess behavioural strategies in animals by integrating ecological, physiological, and evolutionary perspectives.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6- Create

Unit I: General and innate behaviour

Definitions of ethology and animal psychology - ethogram; classification of behavioural patterns - neural and hormonal control of behaviour - communication - genetic and environmental components in the development of behaviour.

Unit II: Ecological aspects of behaviour

Habitat and food selection -optimal foraging theories- aggression - homing - territoriality - dispersal- host-parasite relationship

Unit III: Biological rhythms, learning and memory

Circadian and circannual migration of fishes and birds; conditioning, habituation - insight learning - association learning - reasoning - cognitive skills

Unit IV: Social behaviour

Aggregation, Schooling in fishes, Flocking in birds, Herding in mammals; Social living in bees, ants and primates

Unit V: Reproductive behaviour

Reproductive strategies - mating systems - mate choice - sex differences - courtship - sexual selection - parental care in invertebrates and vertebrates

Textbooks:

1. McFarland, D. (1985). *Animal behaviour*. Longman Group Ltd.
2. Manning, A., & Dawkins, M. S. (1998). *An introduction to animal behaviour*. Cambridge University Press.
3. Verma, P. S., & Agarwal, V. K. (2019). *Animal Behaviour*. S. Chand Publishing, New Delhi.

Reference books:

1. Alcock, J. (2013). *Animal Behavior: An Evolutionary Approach* (10th ed.). Sinauer Associates, Sunderland, MA.
2. Davies, N. B., Krebs, J. R., & West, S. A. (2012). *An Introduction to Behavioural Ecology* (4th ed.). Wiley-Blackwell, Oxford.
3. Krebs, J. R., & Davies, N. B. (1997). *Behavioural Ecology: An Evolutionary Approach* (4th ed.). Blackwell Science, Oxford.
4. Dugatkin, L. A. (2014). *Principles of Animal Behavior* (3rd ed.). W. W. Norton & Company, New York.
5. Drickamer, L. C., Vessey, S. H., Jakob, E. M., & Herberholz, J. (2016). *Animal Behavior: Mechanisms, Ecology, Evolution* (5th ed.). McGraw-Hill Education, New York.

E-resources:

1. <https://www.bbau.ac.in/dept/dz/TM/ZL%20202%20Animal%20Behaviour.pdf>
2. <https://uou.ac.in/sites/default/files/slm/MSZO-509.pdf>
3. <https://wildwelfare.org/wp-content/uploads/Behaviour.pdf>
4. https://press.uchicago.edu/dam/ucp/books/pdf/course_intro/978-0-226-44838-1_course_intro.pdf
5. <http://www.vpscience.org/materials/Animal%20behaviour%20UNIT%204.pdf>

BIOINFORMATICS
(Subject code: 26PZOE4)

Semester: IV

Credits:3

Course objective: To understand the science for decoding complex biological systems via analysis and integration of data and to introduce fundamental applications of Bioinformatics to the students in Life Sciences..

Course outcomes: At the end of the course the students will be able to

CO1	Explain the fundamentals, history, importance, and applications of Bioinformatics along with biological databases and metabolic pathway resources.	K2
CO2	Apply sequence alignment methods and algorithms for analyzing biological sequences using local and global alignment techniques.	K2
CO3	Analyze substitution patterns and construct phylogenetic trees using evolutionary models and distance matrix methods.	K3
CO4	Interpret protein and nucleic acid sequence data using pattern discovery, gene prediction, and classification methods.	K4
CO5	Predict protein secondary and tertiary structures using computational approaches such as Chou–Fasman, homology modeling, and threading techniques.	K2
CO6	Develop skills in using bioinformatics tools and databases for biological data analysis, sequence interpretation, and protein structure prediction.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6– Create

Unit I: Introduction

Definition, history and importance of bioinformatics, aims of bioinformatics analysis, sequence revolution and information deluge, biological data bases –protein: SWISS PROT- and TrEMBI; genome, EMBI and gene bank; metabolic pathways, KEGG

Unit II: Sequence alignment

DOT plots, single alignment, gaps, gaps penalties, scoring matrices, pairwise alignment, sequence repeats dynamic programming – Needleman, and Wunsch algorithm, Smith - Waterman algorithm, local and global alignments .

Unit III: Substitution pattern and evolutionary analysis

Substitution matrices, pattern of substitution,PAM, BLOSSUM, molecular phylogenetics- phylogenetic trees, distance matrix methods, UPGMA, and neighbor joining methods

Unit IV: Protein and DND sequence analysis

Pattern discovery and sequence classification in proteins, artificial neural network and hidden Markov models, pattern discovery and sequence classification in nucleic acids, gene discovery, gene mark and GRAIL.

Unit V: Protein structure prediction

Secondary structure prediction, Chou – Fasman, tertiary structure prediction, homology modeling and threading.

Text Books:

1. 1997 Roger Hunt, John Shelley, 1997, Computers and Common Sense (Fourth Edition)- Prentice Hall of India Private Ltd.

2. S. Ignacimuthu, s.j. , 2005, Basic Bioinformatics Narosa Publishing House
3. T.K. Attwood & D.J. Parry- Smith, 2003, Introduction to Bioinformatics (Fourth Edition) Pearson Education (Singapore) Pvt. Ltd.

Reference Books:

1. Arthur M. Lesk ,2003, Introduction to Bioinformatics Oxford University Press
2. S.C. Rastogi, N. Mendiratta & P. Rastogi , 2005, Bioinformatics- Methods and Applications- Genomics, Proteomics & Drug Discovery Prentice Hall of India Private Ltd.
3. N. Gautham – 2006, Bioinformatics- Databases and Algorithms Narosa Publishing House
4. .Malcolm Campbell & Laurie J. Heyer, 2003, Discovering Genomics, Proteomics & Bioinformatics Pearson Education (Singapore) Pvt. Ltd.
5. Zoe Lacroix & Terence Critchlow, 2003, Bioinformatics- Managing Scientific Data Morgan Kaufmann Publishers.