THIRUVALLUVAR UNIVERSITY

SERKKADU, VELLORE–632115

B.Sc. ZOOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR

2023 – 2024

CONTENTS

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc., Zoology**
Programme Code:	
Duration:	**UG - 3 Years**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software

	for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability toembrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one"s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Specific Outcomes:	**PSO1 – Placement:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations **PSO3 – Research and Development:** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society:** To contribute to the development of the society by collaborating with stakeholders for mutual benefit

THIRUVALLUVAR UNIVERSITY

BACHELOR OF SCIENCE
B.Sc. DEGREE COURSE

(With effect from 2023 - 2024)

		SEMESTER III					**CIA**	**Uni. Exam**	**Total**
15	I	Language	Paper-3	6	3		25	75	100
16	II	English	Paper-3	6	3		25	75	100
17	III	Core Theory	Paper-IV	4	3	Cell and molecular Biology	25	75	100
18.	III	Core Theory	Paper -V	3	3	Genetics	25	75	100
19	III	Allied-II	Paper-I	4	3	Chemistry-I Botany-I (To choose any one)	25	75	100
	III	Core lab course	Core practical -III	3	3	Cytogenetics lab course	25	75	100
20	IV	Skill Enhancement course -IV	SEC-IV	2	2	1.Ornamental fish farming and management. 2.Biocompostingfor entrepreneurship 3.Aquarium keeping 4.Medical laboratory techniques (To choose any one)	25	75	100
21	IV	Skill Based Elective -V	SEC-V	2	2	1.Biophysics and biostatistics 2.Basic course in ornithology 3.Basics of marine biology 4.Economic zoology 5.Bioinstrumentation (To choose any one)	25	75	100
		Sem. Total		**30**	**22**		**200**	**600**	**800**

		SEMESTER IV					**CIA**	**Uni. Exam**	**Total**
22	I	Language	Paper-4	6	3		25	75	100
23	II	English	Paper-4	6	3		25	75	100
24	III	Core Theory	Paper-VI	5	5	Developmental biology	25	75	100
25	III	Core Theory	Paper - VII	5	5	Wild life conservation and management	25	75	100
27	III	Allied--II	Paper-II	4	2	Chemistry-II Botany-II (To choose any one)	25	75	100
28	III	Allied Practical - 2	Practical-2	2	1	Allied Chemistry practical Allied Botany Practical (To choose any one)	25	75	100
29	IV	Skill Enhancement coures-VI	SEC-VI	2	2	1.Ornamental fish farming and management. 2.Biocompostingfor entrepreneurship 3.Aquarium keeping 4.Medical laboratory techniques (To choose any one)	25	75	100
30	IV	Skill Enhancement coures -VII	SEC-VII	2	2	1.Biophysics and biostatistics 2.Basic course in ornithology 3.Basics of marine biology 4. Economic zoology 5..Bioinstrumentation (To choose any one)	25	75	100
		Sem. Total		**32**	**23**		**200**	**600**	**800**

		SEMESTER V					**CIA**	**Uni. Exam**	**Total**
31	III	Core Theory	Paper-VIII	3	3	Evolutionary biology	25	75	100
	III	Core Theory	Paper-IX	4	3	Animal physiology	25	75	100

32	III	Core Theory	Paper-X	4	4	Environmental biology	25	75	100
	III	Core lab course	Practical-IV	2	1	Animal Physiology and Developmental biology lab course	25	75	100
33	III	Core lab course	Practical-V	2	1	Environmental biology and toxicology lab course	25	75	100
34	IV	Discipline specific elective	Elective-2	4	3	1.Animal behaviour 2.Nanobiology 3.Human reproductive biology. 4. Agricultural entomology 5. Food,Nutrition and health (To choose any one)	25	75	100
35	IV	Discipline specific elective	Elective-3	4	3	1.Animal behaviour 2.Nanobiology 3.Human reproductive biology. 4. Agricultural entomology 5. Food,Nutrition and health (To choose any one)	25	75	100
36	IV	Value education		2	2		25	75	100
37	III	Project-Group/Individual		5	4			100	100
	V	Internship		-	2		100		100
		Sem. Total		**30**	**26**		**200**	**600**	**800**
		SEMESTER VI					**Uni. Exam**		**Total**
37	III	Core Theory	Paper-XI	5	3	Animal biotechnology	25	75	100
38	III	Core Theory	Paper-XII	5	3	Microbiology	25	75	100
39	III	Core Theory	Paper-XIII	5	3	Immunology	25	75	100
40	III	Core lab course	Practical-VI	3	3	Microbiology, Immunology and Biotechnology-Lab course	25	75	100

41	III	Discipline specific elective	Elective -4	5	3	1.Animal behaviour 2.Nanobiology 3.Human reproductive biology. 4. Agricultural entomology 5. Food,Nutrition and health (To choose any one)	25	75	100
42	III	Discipline specific elective	Elective-5	5	3	1.Animal behaviour 2.Nanobiology 3.Human reproductive biology. 4. Agricultural entomology 5. Food,Nutrition and health (To choose any one)	25	75	100
43	IV	Professional competency skill		2	2	Professional competency skill in zoology	25	75	100
44	V	Extension Activities		0	1		100	0	100
		Sem. Total		**30**	**21**		**275**	**625**	**900**
		Grand Total			**142**				

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	12	14	12	12	21	20	91
Part IV	4	4	4	6	2	2	22
Part V	-	-	-	2	-	1	3
Total	22	24	22	26	23	23	**140**

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

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

METHODS OF ASSESSMENT	
Remembering (K1)	• Thelowestlevelofquestionsrequirestudentstorecallinformationfromthecoursecontent • Knowledgequestionsusuallyrequirestudentstoidentifyinformationinthetextbook.
Understanding (K2)	• Understandingoffactsandideasbycomprehendingorganizing,comparing,translating,interpolatingandinterpretingintheirownwords. • Thequestionsgobeyondsimplerecallandrequirestudentstocombinedatatogether
Application (K3)	• Studentshavetosolveproblemsbyusing/applyingaconceptlearnedintheclassroom. • Studentsmust usetheir knowledgetodetermineaexactresponse.
Analyze (K4)	• Analyzingthequestionisonethatasksthestudentstobreakdownsomethingintoitscomponentparts. • Analyzingrequiresstudentstoidentifyreasonscausesormotivesandreachconclusionsorgeneralizations.
Evaluate (K5)	• Evaluationrequiresanindividualtomakejudgmentonsomething. • Questionstobeaskedtojudgethevalueofanidea,acharacter,aworkofart,orasolutiontoaproblem. • Studentsareengagedindecision-makingandproblem–solving. • Evaluationquestionsdonothavesinglerightanswers.
Create (K6)	• Thequestionsofthiscategorychallengestudentstogetengagedincreativeandoriginalthinking. • Developingoriginalideasandproblemsolvingskills

Highlights of the Revamped Curriculum:

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

Value additions in the Revamped Curriculum:

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

	Quality Control, Official Statistics, Bioinformatics	providers • Generates Industry ready graduates • Employment opportunities enhanced
II year Vacation activity	Internship / Industrial Training	• Practical training at the Industry/ Banking Sector / Private/ Public sector organizations / Educational institutions, enable the students gain professional experience and also become responsible citizens.
VI Semester	Project with Viva – voce	• Self-learning is enhanced • Application of the concept to real situation is conceived resulting in tangible outcome
VI Semester	Introduction of Professional Competency component	• Curriculum design accommodates all category of learners; 'Statistics for Advanced Explain' component will comprise of advanced topics in Statistics and allied fields, for those in the peer group / aspiring researchers; • 'Training for Competitive Examinations' –caters to the needs of the aspirants towards most sought - after services of the nation viz, UPSC, ISS, CDS, NDA, Banking Services, CAT, TNPSC group services, etc.
Extra Credits: **For Advanced Learners / Honors degree**		• To cater to the needs of peer learners / research aspirants

Skills acquired from the Courses	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

SEMESTER – III

Course Code CC4	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	CELL BIOLOGY	Core	Y	-	-	-	3	4	25	75	100

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

UNIT	Details	No. of Hours	Course Objectives
I	**History of Cell Biology**, Tools and Techniques of Cell Biology Cell Fractionation, Homogenization, Centrifugation, Isolation of sub cellular Components.Histological techniques - Staining - Vital Stains. – Cytoplasmic and Nuclear Stains. Micro Technique Methods, Microscopes - Types - Light, Phase contrast, SEM, TEM - Units of measurement.	12	CO1, CO2
II	**The Cell** - Cell theory - Viruses -Types and Structure - Bacteria – Bacterial membrane - Ultra structure of animal cell - Cytoplasm - Structure and Composition, Function - Extra Cytoplasmic Structure - Cilia Flagella - Cytoplasmic Inclusions.	12	CO1, CO2, CO4, CO5
III	**Cell components** - Plasma Membrane Ultra Structure - Different Models - Functions - Ultrastructure, Composition and Function of Endoplasmic reticulam, Ribosomes, Golgi Complex, Lysosomes, Centrioles, Microtubules Microfilaments, Mitochondria and Microsomes.	12	CO1, CO2, CO3, CO4, CO5
IV	**Nucleus** - Ultrastructure, Composition and Functions - Nuclear Membrane - Nucleoplasm - Chromosomes - Heterochromatin and Euchromatin - Nucleolus - Nucleolus Cycle - DNA and RNAs - Protein Synthesis & regulation.	12	CO1, CO2, CO4, CO5
V	**Cell Divisions and Cell Cycle** - Amitosis, Mitosis and Meiosis and their Significance - Cancer, Biology –	12	CO1, CO2, CO4, CO5

	Characteristics of cancer cells, types, theories on Carcinogenesis, Ageing of Cells – Apoptosis and Stem cell studies.		
	Total	**60**	

Course Outcomes

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

Text Books
(Latest Editions)

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

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

1.	Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018) Essential Cell Biology 5th Edn.,(paperback) W.W. Norton & Company p.864.
2.	Burke, Jack. D., 1970. Cell Biology, Scientific Book Agency, Calcutta.
3.	Challoner J. (2015) The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press Ltd., p.193.
4.	Cohn, N. S., 1979, Elements of Cytology, Freeman Book Co., New Delhi – 110007, 495 pp
5.	Cooper G.M. (2019) The Cell – A Molecular Approach, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813.
6.	DeRobertis, E.D.P. and E.M.F. De Robertis, 1988. Cell and Molecular Biology, 8th Edition, International Edition, Info med, Hong Kong, 734pp.
7.	Dowben, R., 1971. Cell Biology, Harper International Edition. Harper and Row

	Publisher, New York, 565 pp.	
8.	Giese, A.C., 1979. Cell Physiology, Saunders Co., Philadelphia, London, Toronto, 609 pp.	
9.	Hardin J. and Bertoni G. (2017) Becker's World of the Cell. 9th Edn (Global Edition). Pearson Education Ltd., p. 923	
10.	Karp G., Iwasa J. and Masall W. (2015) Karp's Cell and Molecular Biology Concepts and Experiments. 8th Edn. John Wiley and Sons. p.832.	
11.	Loewy, A.G. and P.Sickevitz, 1969. Cell Structure and Function, Amerind Publishing Co., NewDeihi - 110 020, 516 pp.	
12.	Mason K.A., Losos J.B. and Singer S.R. (2011) Raven and Johnson's Biology. 9th Edn. Mc Graw Hill publications. p.1406.	
13.	Powar, C.B., 1989. Essential of Cytology, Himalaya Publishing House, Bombay - 400 004, 368 pp.	
14.	Swansen, C.P. and P.L.Webster, 1989. The Cell, Prentice Hall of India Pvt. Ltd., New Delhi - 110 001, 373 pp.	
15.	Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B. (2014) Campbell Biology in Focus. Pearson Education. p.1080.	
Web Resources		
1.	http://www.microscopemaster.com/organelles.html	
2.	https://bit.ly/3tXwDSB	
3.	https://bit.ly/3tWNpRX	
4.	https://bit.ly/3AuYR9M	
5.	https://rsscience.com/cell-organelles-and-their-functions/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

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

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

SEMESTER - III

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

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

UNIT	Details	No. of Hours	Course Objectives
I	**Mendelian Genetics and Inheritance:** Mendelian genetics: Mendelian experiments, laws of Mendel, Monohybrid, Dihybrid, back and test cross; Interaction of genes: Incomplete dominance, co dominance, complementary genes, supplementary genes, inhibiting genes, lethal genes and atavism. Inheritance: Polygenic inheritance- skin colour; multiple alleles- ABO blood groups and coat colour in rabbit; extra chromosomal inheritance- shell coiling, kappa particles; sex linked inheritance – eye colour in Drosophila, colour blindness and hemophilia in man.	12	CO1, CO2
II	**Linkage and Crossing Over**: Linkage: Linked genes, complete and incomplete linkage. Crossing over: molecular mechanisms of crossing over, kinds of crossing over, models of recombination. Chromosome mapping: inference and coincidence, haploid mapping, somatic cell hybridization.	12	CO1, CO2, CO4, CO5
III	**Cytogenetics**: Variation in chromosome number and structure: position effect, chromosomal mutation and evolution. Gene mutation: types, molecular basis of mutation, mutational hot spots, reversion; radiation and chemical agents as mutagens; Detection of mutation - ClB method and muller-5 method.	12	CO1, CO2, CO3, CO4, CO5
IV	**Human and Microbial Genetics:** Human genetics: Karyotype and ideogram; sex determination - Barr body technique, drumstick method; chromosomal abnormalities in humans, Pedigree analysis; diagnosis of genetic abnormalities; Eugenics, Euphenics, and	12	CO1, CO2, CO4, CO5

	Euthenics. Population genetics and evolution: gene pool, gene frequency and genotype frequency; Hardy-Weinberg law of equilibrium.		
V	**Molecular and Bacterial genetics**: Conjugation, transformation, transduction and chromosome mapping .Antibiotic resistance cassettes; lac-operon model.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes

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

Text Books
(Latest Editions)

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

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

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

7.	Lodish, Harvey, Arnold Berk *et al* .,2007. Molecular cell biology. 6th edition, W. H. Freeman.
8.	Russel, Peter J. 2013. iGenetics: A Molecular Approach, Pearson.
9.	Strickberger M. W., 1995. Genetics, Prentice Hall India Learning Private Limited.
Web Resources	
1.	https://go.nature.com/2XE8V1q
2.	https://bit.ly/3zoTt6B
3.	https://bit.ly/2XAm7oa
4.	https://bit.ly/2XEbhxi
5.	https://bit.ly/3AB4bso
6.	https://bit.ly/39pZSE4
7.	https://www.genome.gov/genetics-glossary/Sex-Linked
8.	https://www.vedantu.com/biology/mutagens

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

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

Mapping with Programme Outcomes:

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

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

SEMESTER - III

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	CYTOGENETICS LAB COURSE	Core	Y	-	-	-	3	3	25	75	100

Learning Objectives			
CO1	To encourage students to interpret the organization of genomic material and to research theories of genetic inheritance.		
CO2	To impart the skills required to prepare samples of genetic molecules and to determine their purity, structure and characteristics and to analyze genomic preparations.		
CO3	To study the changes in genetic material and to predict and consider the consequences of those changes.		
CO4	To encourage students to report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**Major practical** 1.Blood smear preparation -Differential count of W.B.C. 2.Total count of RBC using Haemocytometer. 3.Total count of WBC using Haemocytometer	12	CO1
II	**Minor practical- Mitosis and Meiosis** 1. Preparation and Identification of slides of Mitotic divisions with onion root tips. 2. Preparation and Identification of different stages of Meiosis in Grasshopper Testes. 3.Preparation of Buccal smear – Epithelial Cell (Barr body).	12	CO2

III	**Genetics-Minor practical** 1.Staining and observation of polytene chromosomes in salivary glands of chironomous larva. 2..Culturing and Handling of Drosophila-Male and female identification- Study of at least five types of Drosophila, Body color mutant- Ebony body and Yellow body. Wing mutant- Curly wing and Vestigial wing. Eye color mutant- Bar eye, White eye, 3. Human blood grouping.	12	
IV	**Spotters- Cell biology** **Cytometry** Compound microscope, camera Lucida, Stage ad Ocular Micrometers Histochemistry and Micro technique- Fixatives: Types of fixatives, Chemistry of fixation, Microtome: Types of microtomes, Histological stains-Haematoxylin and Eosin.	12	CO3
V	**Study of prepared slides of histology.** Columnar Epithelium, Ciliated epithelium, Glandular Epithelium. Cartilage T.S., Bone T.S., Cardiac Muscle, Striated muscle, Non Striated muscle, Neuron, Male germ cell, Female germ cell. Record work	12	CO4
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.	PO1
CO2	To prepare samples of genetic molecules and to determine their purity, structure and characteristics.	PO1, PO2
CO3	To experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.	PO4, PO6
CO4	To assess the changes in genetic material and to predict and consider the consequences of those changes.	PO4, PO5, PO6
CO5	To report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.	PO3, PO8
Text Books		

(Latest Editions)	
1.	Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
2.	Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.
3.	Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.
4.	Bansal M.P., 2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.
5.	Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.
References Books **(Latest editions, and the style as given below must be strictly adhered to)**	
1.	Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.
2.	Bancroft, J.D. and Gamble, M (2007) Theory and Practice of Histological Techniques, 6 th Edition, Churchill Livingstone.
3.	Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA.
4.	John Kiernan (2008) Histological and Histochemical Methods: Theory and Practice, 4th edition, Cold Spring Harbor Laboratory Press.
5.	Kerr, J. (2013) Functional Histology, Elsevier 6. Kiernan, J.A. (2008) Histological & Histochemical methods: Theory & Practice (4th Ed). Cold Spring Harbor Laboratory Press.
6.	Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Pubilshing Co., NY, USA.
	Luiz Carlos (2005) Basic Histology: Text and Atlas (11th Ed). Mc Graw Hill Medical.
7.	Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.
	Ross, M.H,, Kaye, G.I. & Pawlina, W. (2002) Histology: A text and atlas (4th ed). Lippincoat Williams & Wilkins.
	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.
Web Resources	
1.	https://www.jove.com/
2.	https://vlab.amrita.edu/?sub=3&brch=77
3.	http://cbii-au.vlabs.ac.in/
4.	https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.html
5.	https://www.ibiology.org/biology-techniques/
Methods of Evaluation	

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

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

Mapping with Programme Outcomes:

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

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

CYTOGENETICS LAB COURSE

MARKS DISTRIBUTION FOR PRACTICAL EXAM

Time: 3hrs Max.Marks: 75

Question no.	Experiment	Marks
I.	Major Practical (Cell and molecular biology)	25
II.	Minor Practical (Microscopic Slide Preparation)	10
III.	Spotters	30 (6x5=30)
IV.	Record	10
	Total	75

SEMESTER -IV

Course Code CC1	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Developmental Biology	Core	Y	-	-	-	3	4	25	75	100
Learning Objectives											
CO1	To create an awarenessto the students about the theories, concepts and basics of Developmental Biology.										
CO2	To provide students about the idea of sex cells, fertilization, cleavage, differentiation and development of organs.										
CO3	To make an awareness of the induction, organizers and development of extra embryonic structures.										
CO4	To provide adequate explanation to students about the late embryonic developments and post embryonic development and ageing										
CO5	To give an idea about teratogenesis, invitro fertilization, stem cells and amniocentesis to the students										

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

V	**Human embryology** Reproductive organs, Menstrual cycle and menopause - Pregnancy – trimesters – development. Erythroblastosis foetalis -Twins – types. Infertility – causes - Test tube baby and Assisted Reproductive Technology – Embryo transfer – Amniocentesis.	12	CO5
		60	

Course Outcomes		
CO1	To describe and illustrate the significance of cellular processes in embryonic development.	PO1
CO2	To relate the factors that contribute to the developmental process, construct fate maps and illustrate the steps in morphogenesis and organogenesis.	PO1, PO2
CO3	To correlate the involvement of specific cell types in the formation of specific organs and explain the importance of morphogens.	PO4, PO6
CO4	To distinguish between the different types of developmental mechanisms in various organisms and appraise the species-based differences in development.	PO4, PO5, PO6
CO5	To justify and validate the role of environment and genetics in influencing embryonic development	PO3, PO8

Text Books
(Latest Editions)

1.	Lewis Wolpert 2007. Principles of development, 3rd edition, Oxford University Press, New Delhi, India
2.	Subramoniam, T. 2003. Developmental Biology, Narosa Publishing House, New Delhi, India.
3.	Verma, P.S., Agarwal, V. K.2010.Chordate Embryology: Developmental Biology, S. Chand & Company, New Delhi., India.

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

1.	Gilbert S.F. 2010. Developmental Biology, Sinauer Associates, Massachusetts, USA.
2.	Balinsky, B.I. 1970. Introduction to Embryology, Philadelphia & London, UK.
3.	Berril, N.J.1971. Developmental Biology, McGraw Hill, New York, USA.
4.	Russ Hodge 2010. Developmental Biology, Facts on File, Inc., New York, USA.
5.	Carlson, Bruce, M. 2009. Human embryology and Developmental Biology, Elsevier, Philadelphia, USA

Web Resources

1.	https://www.ncbi.nlm.nih.gov/books/NBK10052/	
2.	https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html	
3.	https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/dvdy.20468	
4.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293490/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

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

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

SEMESTER- V

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
CC6	**EVOLUTIONARY BIOLOGY**	Core	Y	-	-	-	3	5	25	75	100

Learning Objectives	
CO1	Evolutionary biology is a branch of the biological sciences concerned with the origin of life and the diversification and adaptation of life forms over time.
CO2	This course helps to understand the important processes, principles, and concepts on evolution.
CO3	To provide adequate information on the Lamarckism - Neo Lamarckism – Darwinism, Neutral Theory of Molecular Evolution, and Human Genome Project.
CO4	To explain the importance of the fossil records in evolutionary studies, and the role of phylogenetic studies in the wider context of biodiversity and conservation.
CO5	In this course, we will apply the knowledge of human evolutionary history to simulate how genetic variation within and among human populations affects risk, diagnosis, and treatment of modern diseases.

UNIT	Details	No. of Hours	Course Objectives
I	Inorganic and organic evolution-History of evolutionary thought, Primordial earth and primeval atmosphere, Chemical origin of life: Synthesis of organic molecules, Urey-Miller experiment, Origin of prokaryotes and eukaryotes.	12	CO1
II	Lamarckism - Neo Lamarckism - Darwinism - Neo Darwinism and modern synthetic theory - DeVrie's Mutation theory – modern concepts of mutation - Mutation and their role in evolution - Animal colouration and Mimicry.	12	CO2
III	Isolating mechanisms - Modes of speciation- Hybridization is an evolutionary catalyst- Law of Adaptive Radiation- Adaptive radiation in reptiles and mammals - Convergence and parallelism - Evolutionary constancy.	12	CO3
IV	Morphological, physiological and biochemical, embryological, Taxonomical and geographical evidences -Palaeontological evidences – evolutionary genomics. Types of rocks - Geological time scale –	12	CO4

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

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

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

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

Mapping with Programme Outcomes:

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

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

SEMESTER - V

Course Code CC9	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ANIMALPHYSIOLOGY	Core	Y	-	-	-	3	5	25	75	100

Learning Objectives	
CO1	TofamiliarisestudentswiththeprinciplesandbasicfactsofAnimalPhysiology
CO2	Togivestudentsaninsightaboutthemolecularandcellularbasisofphysiologicalfunctionsin animals.
CO3	Togiveanideaabouttheregulationoforgansystemfunctionsinawholeanimalusingaconceptualmodel offeedback to explain homeostasis.
CO4	Tomakethe students awareabouthowthestructure-functionrelationships and its synchronisationwiththemolecularsignals.

UNIT	Details	No. of Hours	Course Objectives
I	**Nutrition&Respiration** Nutrition:Digestion and absorption of carbohydrates proteins and lipids. Minerals& Vitamins. Hormonalcontrolofdigestion. Types of Respiration, Respiratorypigments,Transportationofgases-Bohreffect-Regulationofrespiration-bronchitis,asthma –Physiologicaleffects of smoking	12	CO1
II	**Circulation&Excretion** Blood- composition and functions, Mechanism of clotting. Types of Hearts – Heartbeat and its regulation -pace maker – Cardiac cycle – ECG - Pulse and blood pressure. Mammalian Kidney, Nephron structure &mechanismof urine formation, Regulation of acid base balance, Excretoryproducts, Osmoregulation infishes.	12	CO2
III	**Muscle&NervePhysiology** Types of muscles – Ultra structure of striated muscle, Muscle contraction & properties,Neurons–structure&types-Impulsepropagation,synaptictransmission,neurotransmitters - Reflex action, Nerve disorders – epilepsy, Alzheimer's disease, Parkinson'sdisease.	12	CO3
IV	**SenseOrgans** Structure of eye, physiology of vision, visual elements and pigments, photo chemistry ofvision - Eye defects –	12	CO4

	myopia, hyperopia, presbyopia, astigmatism, cataract - Structureof ear and mechanism of hearing - Hearing impairments – deafness, labyrinthine disease - Olfactory,gustatoryandtactile sense organs		
V	**ReproductivePhysiology** Endocrine glands in man - Hormones, action and disorders - Feed-back mechanism,Outlinesofmechanismofhormonalactivity. Puberty,adolescence,pregnancy,parturition,lactation andbirth control.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	beabletoexplainhowthevariousorgansystemsarecoordinatedand controlled.	PO1
CO2	beabletolistthefunctionsofvariousorgansinrelationtophysiologicalprocess.	PO1, PO2
CO3	be able todeveloptheideaofmultilevelcontrollingandfeedbackmechanisminrelationto various physiological functions.	PO4, PO6
CO4	beabletounderstandthebasicphysiologicalprocessrelated toadaptation,metabolism and majorrequirements.	PO4, PO5, PO6
CO5	be able to correlate and understand human physiology.	PO3, PO8

Text Books
(Latest Editions)

1. Agarwal R A., Anil K Srivastava., Kaushal Kumar.,1978. Animal Physiology and Biochemistry, S. Chand & Co. Ltd., New Delhi Publishing., 377 pp.
2. Ambika Shanmugam, 2001. Fundamentals of Biochemistry for Medical students, Karthik Offset Printers, Chennai, 590pp
3. Berry A.K.1998. A text book of Animal Physiology and Biochemistry. Emkay Publications, New Delhi, 320 pp.
4. Parameswaran, Ananta krishnan and Ananta Subramanian, 1975. Outlines of Animal Physiology, S. Viswanathan (Printers & Publishers) Pvt. Ltd., 329 p p.
5. Verma P.S., Tyagi B.S & Agarwal V.K., 2010. Animal Physiology, S. Chand & Co. Ltd., New Delhi Publishing., 417 pp.

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

1. Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore., 1064 pp.

Ganong, W.F., 2019. Review of Medical Physiology, McGraw Hill, New Delhi., 340 pp.

Hill, W.R., Wyse, G.A and Anderson, M. 2016. Animal Physiology (4thedn). Sinauer Associates is an imprint of Oxford University Press; USA, 828 pp.

2. Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi, 928 pp.
3. Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 pp.

4.	Sarada Subrahmanyam, Madhavan Kutty, K., & Singh H.D., 2018. Text Book of Human Physiology, S. Chand & Co, New Delhi.
5.	Singh, H.R and Kumar, N. 2017. Animal physiology and biochemistry, Vishal publishing company, Jalandhar, 864 pp.
6.	Sreekumar, S. 2010. Basic physiology, PHI learning private ltd., New Delhi.210 pp
7.	Tortora G.J. & Derrickson B., 2016. Principles of Anatomy and Physiology, John Sons, Inc. 1232 pp.
	Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London., 342 pp.
Web Resources	
1.	https://microbenotes.com/category/biochemistry/
2.	https://www.stem.org.uk/resources/collection/3931/animal-physiology
3.	https://animalphys4e.sinauer.com
4.	https://nptel.ac.in/courses/102/104/102104042/
5.	https://biochem.oregonstate.edu

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

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

Mapping with Programme Outcomes:

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

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

SEMESTER - V

Course Code CC10	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ENVIRONMENTAL BIOLOGY	Core	Y	-	-	-	3	6	25	75	100

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

UNIT	Details	No. of Hours	Course Objectives
I	**Ecosystem** : Concept of an ecosystem-Structure and function of an ecosystem- Producers, consumers and decomposers-Energy flow in the ecosystem-Ecological succession-Food chains, food webs and ecological pyramids-Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem-Grassland ecosystem-Desert ecosystem-Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	12	CO1
II	**Population And Biological Cycles :** Structure and distribution – Growth curves - Groups, natality, Mortality -Density indices, Life study tables - factors affecting population growth -Carrying capacity. Population regulation and human population control. Complete and incomplete biogeochemical cycles - Sedimentary cycle.	12	CO2
III	**Environmental Pollution**: Definition- cause, effects and control measures of: -Air pollution - Water pollution -Soil pollution -Marine pollution - Noise pollution - Thermal pollution -Nuclear hazards.	12	CO4
IV	**Environmental Stresses And Management**:Global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition. Uptake, biotransformation, elimination and accumulation of	12	CO3

	toxicants. Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Bio indicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.		
V	**BiodiversityConservation**: Biodiversity crisis – habitat degradation, poaching of wild life. - Socio economic and political causes of loss of biodiversity. - In situ and ex situ conservation of biodiversity -Hot spots of Biodiversity. Green peace movement - Chipko Movement - Role of government agencies: Central and State Pollution Control Boards - Ministry of Environment and Forests- National Biodiversity Authority. Awareness, Programme, NGOs, Natural Disaster Management, Legislations and Ethics.	12	CO5
	Total	**60**	

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

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

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

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

Mapping with Programme Outcomes:

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

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

SEMESTER - V

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ANIMAL PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY LAB COURSE	Core	Y	-	-	-	3	3	25	75	100

Learning Objectives	
CO1	To demonstrate an understanding of core physiological principles, and define scientific principles and concepts as related to physiology studies.To understand the physiological processes that regulate body functions.
CO2	To demonstrate and understand blood group patters in humans and to understand the embryonic development in animals and man.
CO3	To strive to demonstrate the use of equipment used in physiological experimentation and to study and compare different developmental stages in embryology.
CO4	To attain knowledge of important developmental embryonic stages in chick.
CO5	Measure and interpret experimental data and demonstrate laboratory skills in animal physiology and developmental biology through record work.

UNIT	Details	No. of Hours	Course Objectives
I	**Major practical** 1.Estimation of oxygen consumption in an aquatic animal (Fish) with reference to body weight. 2. Amylase activity in relation to temperature and pH in human saliva. 3. Survey of digestive enzymes in Cockroach, 4. Detection of nitrogenous waste products in fish tank water, frog tank water, bird excreta and mammalian urine/ Kidney.	12	CO1
II	**Minor practical** 1. Human blood grouping with Rh. 2. Placenta of Sheep, Pig and Man-study of preserved specimens. 3. Blood Clotting time – Human blood.	12	CO2
III	**Spotters** 1. Use of Kymograph Unit, B.P. apparatus, stethoscope. 2. Study of the following prepared slides / museum specimens. Section of testis and Ovary [Mammalian].Slides of Mammalian sperm and	12	CO3

	ovum.Study of Egg types - Frog's Egg, Hen's Egg		
IV	**Spotters** Study of cleavage stages 2 Cell, 4Cell, 8Cell - Blastula and gastrula of Frog. Slides of different stages of chick embryo - 18 hours [primitive streak stage], 24 hours, 48 hours 72 hours and 96 hours.	12	CO4
V	**Record Work**:	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	List and recall the basic equipment used in physiology lab and Identify the nitrogenous waste products of animals.	PO1	
CO2	Understand and identify the blood groups in man. To understand various types of placenta in animals.	PO1, PO2	
CO3	Demonstrate the instruments, discuss the clinical importance and its applications, To understand the gamete forming structures and gamete cells.	PO4, PO6	
CO4	Examine the various cleavage patters and embryonic developments.	PO4, PO5, PO6	
CO5	Summarise the effect of various physical and chemical factors on enzyme activity/. Compile the changes in various physiological parameters in man and other animals using various tools and techniques through record work.	PO3, PO8	
Text Books (Latest Editions)			
1.	Widmaier, E.P., Raff, H. and Strang, K.T. 2008. Vander's Human Physiology, XI Edition., McGraw Hill., 770 PP.		
2.	Bishop, ML.,Fody, E.P., Schoeff, LE. 2010. Clinical Chemistry: Principles, Procedure, correlations. Wolters Kluwer, Inida, 298 PP.		
3.	Burtis, C.A. and Ashwood, E.R. 2008. Tietztext book of Fundamentals of clinical chemistry and molecular diagnostics, Elsevier, Philadelphia.		
4.	Tortora G.J.&Derrickson B.., 2016. Principles of Anatomy and Physiology, John Wiley and Sons, Inc. 1232 PP.		
5.	Agarwal R A., Anil K Srivastava.,Kaushal Kumar.,1978. Animal Physiology and Biochemistry, S. Chand & Co. Ltd., New Delhi Publishing., 377 PP.		
6.	Abhijit Dutta, 2009. Experimental biology: A Laboratory Science, Narosa, New Delhi.		
7.	Michael, P, 1984. Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill, New Delhi.		
8.	APHA, 1992. Standard Methods for the examination of water and waste		

	water, American Public Health association, Washington D.C.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi., 928 PP.
2.	Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 PP.
3.	Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London.,342 PP.
4.	Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore., 1064 PP.
5.	Wilson, J.A. 1984, Principles of Animal Physiology, Macmillan Publishing., 426 PP.
6.	Eugenia, 2008. Environmental Biotechnology and cleavers Bioprocesses, London.
7.	Ramesh, R & M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.
Web Resources	
1.	https://bit.ly/3hNyeFN
2.	https://www.medicinenet.com/alp_test/article.htm
3.	https://vlab.amrita.edu/?sub=3&brch=63
4.	https://www.asbmb.org/education/online-teaching/online-lab-work
5.	https://open.umn.edu/opentextbooks/textbooks/687
	https://bit.ly/3lO29yP

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

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

Mapping with Programme Outcomes:

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

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

Animal physiology and Developmental Biology lab course

Mark distribution for practical exam

Time: 3hrs Max.Marks: 75

Question no.	**Experiment**	**Marks**
I.	**Major practical Animal physiology** (Experiment – any one)	20
II	**Minor practical – Types of placenta**	10
III	**Developmental biology** Chick embryo Developmental stage – any one stage	10
IV.	**Spotters** Animal Physiology – 2 Developmental biology – 3	25(5X5=25)
V.	**Record**	10
	Total	75

SEMESTER - V

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ENVIRONMENTAL BIOLOGY AND TOXICOLOGY LAB COURSE	Core	Y	-	-	-	3	3	25	75	100

Learning Objectives	
CO1	To demonstrate an understanding of core ecological principles, and define scientific principles and concepts as related to environmental studies and sustainability.
CO2	To provide practical knowledge and hands on tools and techniques for dose-response assessment of hazardous substances.To explain the main mechanisms of environmental toxicants in causing a toxic response in living organisms
CO3	To provide an understanding on diversity of animals in different ecosystem and animal association.
CO4	The use of different equipment biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes.
CO5	To provide exposure on the sustainable ecosystem practice through field visit and project.

UNIT	Details	No. of Hours	Course Objectives
I	**Major practical.** **Estimation Methods**: 1.Estimation of dissolved Oxygen in water samples. 2. Determination of bicarbonate and carbonates in water samples. 3.Estimation of Ammonia, 4.Determination of salinity of water samples,	12	CO1
II	**Minor practical** 1.Estimation of dissolved carbon-di-oxidein water samples. 2. Use of pH meter/ P^Hpapers for estimation of pH in water and soil samples. **Toxicity Testing**: Methodology of toxicity testing – acute and chronic tests (demonstration), Use of LC50 values – sub lethal effects of critical pollutants on fish.	12	CO2

III	**Spotters** 1. Identification of marine and freshwater plankton. 2. Study of sandy shore fauna- Study of rocky shore fauna. **3.** Study of animal Association 4. Nutrient agar. 5. Identification and significance of major algae with regard to pollution.	12	CO3
IV	**Spotters** Reflux condenser, BOD incubator, Spectrophotometer, Colorimeter, Atomic absorption spectroscopy, Ultracentrifuge, Incubator, HPLC.	12	CO4
V	Mini Project and Field visit, Study of a vermicompost plant. Bio gas production -. Visit to wastewater and drinking water treatment plants. Record work	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the properties of toxicants, effects, origin and occurrence in the environment and explain the principle and procedure for quality evaluation, monitoring and remediation of contaminated environments.	PO1
CO2	Estimate the toxic chemicals in the environment. Apply tools and techniques for experimenting with environmental problems. Identify and implement solutions to the problems.	PO1, PO2
CO3	Analyse the consistent and inconsistent range of elements. Interpret the role of the elements in environmental pollution and the effects on organisms.	PO4, PO6
CO4	Relate the metabolic activity, diseases, ill health and death with reference to exposure to chemicals. Select the suitable experimental design to assess the toxic effects of pesticides and pollutants.	PO4, PO5, PO6
CO5	Discuss the applicability of chemical analysis and toxicity data, both individually and together, in risk assessment and environmental monitoring.	PO3, PO8

Text Books (Latest Editions)	
1.	Abhijit Dutta, 2009. Experimental biology: A Laboratory Science, Narosa, New Delhi.
2.	DAS H.K.,2005. Text Book of Biotechnology. Wiley Dreamtech Pvt Ltd,

	New Delhi.
3.	Rastogi, S.C., 2005. Experimental physiology, New age International publishers, New Delhi.
4.	Ramesh, R and M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.
5.	Micheal, P, 1984. Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill, New Delhi.
6.	Agarwal, A. State of India's Environment: A Citizens Report, Centre for Science and Environment, New Delhi.
7.	Goel, P.K. Water Pollution: Causes, Effects and Control. New Age International, Publishers, New Delhi (2006).
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Allan S. Cragg, 2010. Environmental Biotechnology, Oxford University Press. UK.
2.	APHA, 1992. Standard Methods for the examination of water and waste water, American Public Health association,Washington D.C.
3.	APHA, 2005. Standard Methods for the examination of water and waste water, 21st Ed., American Public Health association, Washington D.C.
4.	Boyd C.E., 1992. Water Quality and Pond Soil Analysis for Aquaculture, C.E. Boyd, C.S. Tucker,Auburn University.
5.	Csuros, M., 1994. Environmental Sampling and Analysis for Technicians, M. Lewis Publishers,Boca Raton.Florida.
6.	Eugenia et al, 2008. Environmental Biotechnology and cleaner Bio Process, Taylor& Francis London, UK.
7.	Francis, B.M., 1994. Toxic Substances in the Environment, John Wiley and Sons.
8.	Hauser, B.A., 2001. Drinking Water Chemistry: A Laboratory Manual, Lewis Publishers,Boca Raton, Florida
9.	Maier, R. M., Pepper I.L. and C. P. Gerba, 2009. Environmental Microbiology. 2nd ed. AcademicPress. USA
10.	Rastogi, S.C., 2005. Experimental physiology, New age International Pvt. Ltd. New Delhi.
11.	Rump, H.H., 1999. Laboratory Manual for the Examination of Water, Wastewater and Soil,3rd Ed., Wiley-VCH, New York.
Web Resources	
1.	http://www.envexp.com/technical/method-downloads/cod-method-410
2.	https://bit.ly/3u6o0Fb
3.	https://bit.ly/3hX8Ux0
4.	https://bit.ly/3EN2nz0
5.	https://www.ncbi.nlm.nih.gov/pubmed/2170158
Methods of Evaluation	
Internal Evaluation	Continuous Internal Assessment Test / Assignments — 25 Marks

	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

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

Mapping with Programme Outcomes:

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

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

Environmental biology and toxicology lab course
Mark distribution for practical exam

Time: 3hrs Max.Marks: 75

Question no.	**Experiment**	**Marks**
I.	**Environmental Biology** Experiment – Estimation/ Titration	25
II	Identification of plankton(1)/ instruments(1)	10(2x5=10)
III.	**Spotters(Any five)**	30 (5x6=30)
IV.	**Record and Field report**	10
	Total	75

SEMESTER - VI

Course Code CC14	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ANIMAL BIOTECHNOLOGY	Core	Y	-	-	-	3	5	25	75	100

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

UNIT	Details	No. of Hours	Course Objectives
I	**Fundamentals of Biotechnology** : Animal cell culture: Basic requirements and techniques of cell culture, natural and synthetic culture media, primary culture and cell lines; Stem cells: types, culture and applications; r-DNA technology: Enzymes; Vectors – pBR322, Phage lambda, Cosmid, HAC, BAC, YAC; Host cells; Gene cloning: steps in cloning, selection of clones – chromogenic substrate, antibiotics.	12	CO1
II	**Techniques in Animal Biotechnology** : Isolation and purification: DNA and mRNA; Blotting techniques: Methods of different types of blotting; DNA sequencing: Sanger method, microarray; PCR: principle, types and application; Gene library: Gene transfer in animal cells: transfection, liposomal, viral mediated, electroporation, biolistic, direct DNA injection.	12	CO2
III	**Transgenic Animal Technology**: Transgenesis: Concept, transgenes, transgenic animal models - knock out mice, sheep; Applications of transgenesis: Transgenic fishes, transgenic live stocks, and animals as bioreactors.	12	CO3
IV	**Animal Biotech and Health Care** : Medical	12	CO4

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

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

Text Books
(Latest Editions)

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

6.	Ruby, R.C., 2012. A text book of biotechnology, S. Chand Company, New Delhi.	
7.	Sambamurthy K., Ashutosh Kar., 2009. Pharmaceutical Biotechnology, New Age International (P) Ltd.	
8.	Ramdoss P.,2009. AnimalBiotechnology- Recent concepts and developments, MJP publishers.	
9.	Sathyanarayran U., 2008. Biotechnology, Books and Allied, Kolkata.	
10.	Ignacimuthu, S., 2008. Basic Biotechnology, Tata McGraw hill, New Delhi.	
11.	Rastogi S. C., 2007. Biotechnology: Principles and applications, Alpha Science publishers. Ranga, M.M., 2003. Animal biotechnology, Agrobios, New Delhi.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Veer Bala Rastogi, 2016. Principles of Molecular biology, Medtech, Maine, USA.	
2.	Michael Crichton, 2014. Essentials of Biotechnology, Medtech, Maine, USA.	
3.	Godbey W.T., 2014. An Introduction to Biotechnology, Academic press, New York, USA.	
4.	Peters, P., 2009. Biotechnology – A guide to genetic engineering, WMC brown publisher, UK.	
5.	Ramawat, K.G and Shailey Goyal, 2009. Comprehensive biotechnology, S.Chand company, New Delhi, India.	
6.	Primrose S.B., R. M. Twyman and R. W. Old, 2001. Principles of gene manipulation, Wiley- Blackwell, UK.	
7.	Primrose S. B., 2001. Molecular Biotechnology, Panima Publishing Corporation, New Delhi, India.	
8.	Hames B.D. and Higgins S.J. 1995. Gene Probes: A Practical Approach, Oxford University Press, UK.	
Web Resources		
1.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3612824/	
2.	https://www.isaaa.org/resources/publications/pocketk/40/default.asp	
3.	https://www.ncbi.nlm.nih.gov/books/NBK207574/	
4.	https://iopscience.iop.org/article/10.1088/1755-1315/492/1/012035/pdf	
5.	https://go.nature.com/3zAZmO9	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	

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

Mapping with Programme Outcomes:

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

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

SEMESTER - VI

Course Code CC15	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	MICROBIOLOGY	Core	Y	-	-	-	3	5	25	75	100

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

UNIT	Details	No. of Hours	Course Objectives
I	**Introduction to microbiology** History, scope, branches of microbiology. Contribution of Leeuwanhoek, Jenner, Pasteur, Koch, Fleming, Iwanowsky, Waksman, Luria, M. J. Thirumalachar, Subba Rao, Sambhu Nath De. Evolution of Microbial diversity. Systematic position: 5 kingdom classification of Whittaker and 3 kingdom classification of Carl Woese. Comparison of Bacteria, Archaea, Eukarya (tabular and diagrammatic). Controlling microbes.	12	CO1
II	**Microscopy** Principles of microscopy ii. Compound microscope (Monocular and Binocular microscopes) – construction and function of parts, ray diagram of path of light, objectives, oculars, condensers, sources of illumination and uses iii. Dark field, Phase contrast and Fluorescence microscopes, Confocal microscopes, Atomic Force Microscope - principle, construction, ray diagram and applications iv. Electron microscopy – TEM and SEM – principle, construction, ray diagram and uses.	12	CO2
III	**Introductory Mycology** General characteristics and outline classification of fungi, Morphology of some common fungi - Mucor, Rhizopus, Aspergillus, Penicillium and Fusarium. Yeasts: General characteristics and outline classi fication of yeasts 3. General characteristics of Lichens and Mycorrhiza.	12	CO3
IV	**Introductory Bacteriology**	12	CO4

	Classification of bacteria. Anoxygenic photosynthetic bacteria: general characteristics of purple bacteria and green bacteria. Oxygenic photosynthetic bacteria: General characteristics of Cyanobacteria – external and internal features, physiology and ecology. Magnetotactic bacteria- General characteristics, Magnetosomes, Enrichment and isolation of Magnetotactic bacteria. Types of staining.		
V	**Introductory Virology** Virus Structure and Classification. Virus Entry and Viral Pathogenesis. Positive-strand RNA viruses: Picornaviruses, Flaviviruses, Togaviruses, Coronaviruses. Negative-strand and double-strand RNA viruses: Paramyxoviruses, Rhabdoviruses, Filoviruses, Bunyaviruses, Orthomyxoviruses and Reoviruses. DNA viruses: Parvoviruses, Polyomaviruses, Papillomaviruses, Adenoviruses and Baculoviruses, Herpes viruses and Poxviruses.	12	CO5
	Total	**60**	

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

Text Books
(Latest Editions)

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

	16th edition. ELBS, Churchill living stone.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.
2.	Thomas M. Bell, 1965. An Introduction to General Virology, William Heinemann Medical books, London.
3.	Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.
4.	Salle A.J., Fundamental Principles of Bacteriology, Tata McGraw – Hill Publishing Company Limited, New Delhi.
5.	Pelczar .J. Chan E.C.S. and Krieg N.R., Microbiology, McGraw Hill Book Company, New York.
6.	Benson Harold J, Microbiological Applications, WCB McGraw – Hill, New York.
7.	Brock T.D. and Madigan M.T., Biology of Microorganisms, Prentice Hall of India Private Limited.
8.	Collins CH, Patricia M, and Lyne JM (1995). Collins and Lynes Microbiological Methods 7th edition. Grange, Butter Worth, Oxford.
9.	Cappucino JG and Sherman N (1996). Microbiology, A Laboratory Manual 4th edition. Benjamin Cumings Inc. California.
10.	Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill.
11.	Madigan MT, Martinko JM and Parker J (2012). Brock Biology of Microorganism, 11th edition Prentice Hall International Inc. London.
Web Resources	
1.	https://vlab.amrita.edu/?sub=3&brch=73
2.	https://learn.chm.msu.edu/vibl/
3.	https://mvi-au.vlabs.ac.in/
4.	https://virtuallab.tlc.ontariotechu.ca/intro.php
5.	https://www.merlot.org/merlot/viewMaterial.htm?id=79694
Methods of Evaluation	
Internal Evaluation	Continuous Internal Assessment Test / Assignments / Seminars / Attendance and Class Participation — 25 Marks
External Evaluation	End Semester Examination — 75 Marks
	Total — 100 Marks
Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application	Suggest idea/concept with examples, Suggest formulae, Solve problems,

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

Mapping with Programme Outcomes:

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

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

SEMESTER VI

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
CC16	**IMMUNOLOGY**	Core	Y	-	-	-	3	5	25	75	100

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

UNIT	Details	No. of Hours	Course Objectives
I	**Immune Cells and Organs**: Overview of Immune System - General concepts and Haematopoeisis. Cells of the immune system - T and B-lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils -Mast cells and dendritic cells. Organs of the Immune system: Primary lymphoid organs - Thymus and bone marrow; Secondary Lymphoid organs - Lymph nodes and spleen; Lymphatic tissues - Peyer's patches and Kupffer cells, MALT, GALT and CALT.	12	CO1
II	**Innate and Adaptive Immunity:** Innate and Adaptive Immunity; Anatomical barriers, Inflammatory response, Cells and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral). Receptors and Signaling: Cytokines and Chemokines - General Properties of Cytokines and Chemokines. Major Histocompatibility Complex (MHC): Organization and inheritance of the MHC. Structure and cellular distributionof HLA antigens.	12	CO2

III	**Antigen and Antibodies**: Antigens- Antigenicity and immunogenicity: Properties -foreignness, molecular size, heterogeneity. B & T epitopes, T-dependent and T-independent B cell responses. Antibodies: Structure, function and properties of the Immunoglobulins, Different classes of Immunoglobulins; antigenic determinants on antibodies (isotype, allotype and idiotype). Hybridoma technology - production of monoclonal antibodies and catalytic antibodies (abzymes).	12	CO3
IV	**Hypersensitivity and Autoimmune Diseases**: Hypersensitivity: classification and brief description of various types of hypersensitivities. Autoimmunity: cause of autoimmune diseases - classification of autoimmune diseases. Transplantation immunology: Types of grafts, immunologic basis of graft rejection, immunosuppressive therapy and clinical transplantation.	12	CO4
V	**Clinical Immunology:** Immunity and tumors- tumor antigens (TSTA and TAA), immune response to tumors. Tumor evasion of the immune system, Immunotherapy for tumors. Immunity against - viral, bacterial and parasitic infections. Vaccines: Types and uses - Immunization schedule for children.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand and recall the basic structural and functional components of the immune system, compare and contrast cells with respect to origin and maturation.	PO1
CO2	Classify and explain types of immunity, state the significance of antigen and examine their relevance to immunizations.	PO1, PO2
CO3	Describe and differentiate the biological characteristics of the antibodies, analyze and formulate the procedure for antibody production	PO4, PO6
CO4	Compare and rate the mechanism of various types of hypersensitivity reactions, assess and identify the different types of autoimmune diseases.	PO4, PO5, PO6
CO5	Summarize immune responses against pathogens	PO3, PO8

Text Books (Latest Editions)	
1.	Kuby, J, Punt, J, Stranford, S, Jones,Pand Owen, J, 2018. Immunology, 8th

	Edition, W.H.Freeman Publishing, New York, 944 pp.
2.	Roitt, M, Peter J. Delves, Seamus J. Martin and Dennis R. Burton, 2017. Essential Immunology, 13th Edition, Wiley-Blackwell Publishing,USA, 576 pp.
3.	Coleman,R.M., 2014. Fundamental Immunology, 2nd Edition, Published by Mc Graw Hill Education India, 357 pp.
4.	Raj Khanna, 2011. Immunology, Oxford University press, New Delhi. 428 pp.
5.	Rao.C.V. 2011. Immunology, Narosa Publishing House, New Dehli, 426 pp.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Abul A. Andrew, Lichtman. H, Shiv. P, 2014. Cellular and Molecular Immunology, 8th Edition, Published by W.B. Saunders, 544 PP.
2.	Chapel. H, Haeney. M, Misbah. S, and Snowden. N, 2006. Essentials of Clinical Immunology, 5th Edition. Blackwell Publishing, 368 PP.
3.	William R. Clark, 1985. The Experimental Foundations of Modern Immunology, Published by Johns Hopkins University Press, New York. 326 PP.
4.	Kenneth Murphy & Casey Weaver, 2016. Janeway's Immunology, Garland Science publishers, 924 pp.
Web Resources	
1.	https://www.aaaai.org/
2.	https://www.bsaci.org/
3.	https://www.immunology.org/
4.	https://nptel.ac.in/courses/102/103/102103038/
5.	https://microbenotes.com/category/immunology/

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

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

Mapping with Programme Outcomes:

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

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

SEMESTER - VI

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	MICROBIOLOGY,IMMUNOLOGY AND BIOTECHNOLGY LAB COURSE	Core	Y	-	-	-	3	3	25	75	100

Learning Objectives	
CO1	To encourage students to interpret the organization of genomic material and to research theories of genetic inheritance. To impart the skills required to prepare samples of genetic molecules and to determine their purity, structure and characteristics and to analyze genomic preparations.
CO2	To learn different methods of staining bacteria and demonstrate proficiency in handling aseptic bacteriological specimen.
CO3	To study the different techniques applied in biotechnology.
CO4	To encourage students to report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.

UNIT	Details	No. of Hours	Course Objectives
I	**Major practical** **1.** Morphological identification of some common fungi - Mucor, Rhizopus, Aspergillus, Penicillium and Fusarium 2. **Isolation of genetic molecules:** Isolation of DNA from spleen. Total RNA isolation from plant/animal cells(Demonstration) 3. Qualitative and quantitative analysis of genetic molecules: Determination of the purity of isolated DNA and RNA samples by UV spectrophotometry.	12	CO1
II	Minor practical 1. Study of Antigen - Antibody reaction - Human Blood grouping [ABO and Rh]. 2. Observation of polymorphic forms of leukocytes in human blood sample. 3. Microscopic observation of gram positive and gram negative bacteria	12	CO2

III	**Spotters** Study of prepared slides, Models or specimen: Escherichia coli, Bacteriophage, Plasmid. Demonstration of P.C.R technique: Southern blot, Electrophoresis. Elisa, Western Blot.	12	CO3
IV	Spotters Study of prepared slides of histology: Thymus, Spleen, Bone marrow, Lymph node. Radio Immuno diffusion and Double Immuno diffusion Technics.	12	CO4
V	Basic animal cell culture technique- Creation of transgenic flies through virtual lab activity (https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.ht ml) Visit to Biotechnology lab and Report – compulsory Record work	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.	PO1
CO2	To prepare samples of genetic molecules and to determine their purity, structure and characteristics.	PO1, PO2
CO3	To experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.	PO4, PO6
CO4	To assess the changes in genetic material and to predict and consider the consequences of those changes.	PO4, PO5, PO6
CO5	To report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.	PO3, PO8

Text Books (Latest Editions)

1. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
2. Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.
3. Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.

4.	Bansal M.P., 2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.	
5.	Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.	
2.	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.	
3.	Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Pubilshing Co., NY, USA.	
4.	Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.	
5.	Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA.	
Web Resources		
1.	https://www.jove.com/	
2.	https://vlab.amrita.edu/?sub=3&brch=77	
3.	http://cbii-au.vlabs.ac.in/	
4.	https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.html	
5.	https://www.ibiology.org/biology-techniques/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

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

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

MICROBIOLOGY,IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY

Mark distribution for practical exam

Time: 3hrs Max.Marks: 75

Question no.	**Experiment**	**Marks**
I.	Major practical	25
II	**Minor practical**	10(2x5=10)
III.	**Spotters(Any five)**	30(5x6=30)
IV.	**Record work and report**	10
	Total	75

ELECTIVE PAPERS

DISCIPLINE SPECIFIC ELECTIVE COURSES

1. ANIMAL BEHAVIOUR
2. WILDLIFE CONSERVATION AND MANAGEMENT
3. NANOBIOLOGY
4. HUMAN REPRODUCTIVE BIOLOGY

GENERIC ELECTIVE COURSES

1. FOOD, NUTRITION AND HEALTH
2. RADIATION BIOLOGY
3. AGRICULTURAL ENTOMOLOGY

ABILITY ENHANCEMENT COURSES

1. BIOPHYSICS AND BIOSTATISTICS
2. BASIC COURSE IN ORNITHOLOGY
3. BASICS OF MARINE BIOLOGY
4. ECONOMIC ZOOLOGY
5. BIOINSTRUMENTATION

SKILL ENHANCEMENT COURSES

1. ORNAMENTAL FISH FARMING AND MANAGEMENT
2. BIOCOMPOSTING FOR ENTREPRENEURSHIP
3. AQUARIUM KEEPING
4. MEDICAL LABORATORY TECHNIQUES

ANIMAL BEHAVIOUR

Learning Objectives

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

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

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

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

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

Unit V: Chronobiology : Organization of circadian system in multicellularanimals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo- transduction. The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases - Chronopharmacology, chronomedicine, chronotherapy.

Text Books

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

5. Vinod Kumar, 2002. BiologicalRhythms. NarosaPublishingHouse, Delhi.

Suggested Readings

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

Web Resources

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

Course Outcomes (COs)

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

WILDLIFE CONSERVATION AND MANAGEMENT

Learning Objectives

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

Unit I :Biodiversity Extinction and Conservation Approaches :

Perspectives and Expressions. Identification and prioritization of Ecologically sensitive area (ESA). Coarse filter and fine filter approaches. Regional and National approaches for biodiversity conservation.

Unit II: Theory and Analysis of Conservation of Populations :

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

Unit III: National and International Efforts for Conservation :

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

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

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

Text Books:

1. Robinson W L and Eric G Bolen, 1984. Wildlife Ecology and Management, Maxmillan Publishing Company, New York, p 478.
2. Aaron, N.M.1973 Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A.
3. Dasmann R F, 1964. Wildlife Biology, John Wiley & Sons, New York, p 231.
4. Justice Kuldip Singh 1998. Handbook of Environment, Forest and Wildlife Protection Laws in India, Natraj Publishers, Dehradun.
5. Hosetti, B.B. 1997 Concepts in Wildlife Management, Daya Publishing House, Delhi.
6. Sutherland, W.J 2000. The conservation handbook: Research, Management and Policy. Blackwell Science.
7. Caughley.G and Sinclaire, A.R.E 1994 Wildlife ecology and management. Blackwell Science.
8. Woodroffe R, Thirgood, S. and Rabinowitz A. 2005.People and Wildlife, Conflict or Co exsistence? Cambridge University.
9. Sinha, P.C. 1998. Wildlife and Forest Conservation, Anmol Publishing Pvt. Ltd., New Delhi.
10. Singh, S.K, 2005. Text Book of Wildlife Management. IBDC, Lucknow.

Suggested Readings

1. Gilas R H Jr.(ed.), 1984. Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington D.C., Nataraj Publishers, Dehra Dun, p 547.
2. Rodgers W A, 1991. Techniques for Wildlife Census in India - A Field Manual: Technical Manual - T M - 2. WII.
3. Saharia V B, 1982. Wildlife of India, Natraj Publishers, Dehra Dun.
4. Goutam Kumar Saha and SubhenduMazumdar, 2017. Wildlife Biology: An Indian Prospective, PHI Publisher, Delhi.
5. Katwal/Banerjee, 2002. Biodiversity conservation in managed and protected areas, Agrobios, India.
6. Gopal, Rajesh,1992. Fundamentals of Wildlife Management, Justice Home, Allahabad, India.
7. Sharma, B.D, 1999. Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi.
8. Stephen, H.B. and V.B. Saharia,1995. Wildlife research and management. Asian and American Approaches, Oxford University Press, Delhi.
9. Negi, S.S. 1993. Biodiversity and its conservation in India, Indus Publishing Co., New Delhi.

10. Moulton, M. P. & J. Sanderson, 1997. Wildlife Issues in a Changing World. St. Lucie Press.

Web resources

1. https://bit.ly/39oPj44
2. https://bit.ly/3lHdEYJ
3. https://bit.ly/3CwBCfY
4. https://bit.ly/3EDYr3a
5. https://bit.ly/3tVtG4U

Course outcomes (COs)

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

NANOBIOLOGY

LearningObjectives:

This course provides knowledge about the basic concepts of nanobiology.The learners will be able to acquire skills in the assembly, design and types of nanomaterials and nanoparticles, They will be able to appreciate the applications of nanobiology in diverse fields.

Course outcomes(Cos)

Students will be able to:

- Understand basics of Nano-science and Nano-biology.
- Gain knowledge on nanomaterials and nanoparticles.
- Know the biological applications of nanomaterials and nanoparticles.
- Apply their knowledge in their career development in higher education, research anddevelopment.

Unit-I: Nanobiology- Definition-concepts and scope. History of nanotechnology and nanoscience in Nature; Structure and Properties ofnanomaterials: size, surface charge, conductivity, optical properties and biocompatibility.

Unit-II: Synthesis and characterization of nanomaterials, Fabrication of nanostructures, Metallic nanoparticles, semiconductor, biopolymericnano-structures and nanoparticles.

Unit-III: Composition and functional properties of nanostructures: Protein and peptide-based nanostructures, carbohydrate and nucleic acid based nanomaterials; Use of gold, silver and other metallic nanoparticles.

Unit-IV: Strategies to design biologically active nanostructure-based biomaterials. Interaction of nanoparticles with biomolecules to study their conformational and functional properties.

Unit-V: Biological Applications of Nanomaterials and nanoparticles – therapeutics – biomaterials - Immobilized enzymes - drug delivery systems – Biosensors - Cellular imaging tools and diagnostics.

References

1. Pradeep, T. (2017) The Essentials: Understanding Nanoscience and Nanotechnology: McGraw-Hill Education.

2. Phoenix, D.A. and Ahmad, W (2014) Nanobiotechnology. One Central Press Ltd.

HUMAN REPRODUCTIVE BIOLOGY

Learning Objectives:

- Toenablestudentsto understand theendocrine structures and hormones associated with the physiology of reproductive system
- To enable students to learn about the male reproductive system and accessory glands and regulation
- To enable students to learn about the female reproductive system and regulation of its function
- To enable students to comprehend about fertilization, pregnancy, parturition and lactation
- To equip students with knowledge on causes of infertility, reproductive health, assisted reproductive technology and associated ethical issues

Unit I

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation; Puberty

Unit II

Outline and histoarchitecture of male reproductive system; Testis: Cellular functions; Spermatogenesis and its hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract; Andropause

Unit III

Outline and histoarchitecture of female reproductive system; Ovary: oogenesis and its hormonal regulation; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles and their regulation, changes in the female tract; Menopause

Unit IV

Ovum transport in the fallopian tubes; Sperm transport in the female tract, Fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit V

Infertility in male and female: causes, diagnosis and management; Sexually transmitted Infections; Modern contraceptive technologies; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, Stem Cell banks, *in vitro* fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; ethical issues related to ART; Surrogate motherhood; ethical issues; Consanguinity; Fetal Loss and Birth Defects; Adoption

COURSE OUTCOMES

Onsuccessfulcompletionofthecourse,studentswillbeable to

- Recall the structure and functioning of the male and female reproductive system, associated endocrinology, causes for infertility and assisted reproductive technology
- Describethestructure and physiologyfunctionsofmaleandfemalereproductivesystems.
- Explaintheroleof structures, accessory glands and hormonesassociatedwiththereproductivetractsandtheircontrol
- Explainthemechanismofsexdetermination.
- Discussage-associated physiologicalchangesinthereproductivetract
- Describephysiologicalchangesduringpregnancyandbenefitsofbreastfeeding.
- Identify causes for infertility, treatments available and ethical issues related totreatments.
- Discussadvantagesanddisadvantagesofavailablecontraceptives.
- Analyze the different techniques and associated ethical issues related to reproductive technology

BOOKS FOR REFERENCE

Cassan, A. (2005). *Human reproduction and Development (Inside the Human Body).*NewYork: ChelseaClubhouse.

Field,M.A.(1990).*SurrogateMotherhood*.Massachusetts:Harvard University.

Gardner, D. K.(2001). *Textbook of Assisted Reproductive Techniques: Laboratory andClinicalPerspectives.*London: MartinDunitz.

Gardner, D. K.(2006). In vitro Fertilization: A Practical Approach. CRC Press.

Johnson, M. H. (2018). *Essential Reproduction*. New Jersey: Wiley-Blackwell.

Jones,R.E.(2013).*HumanReproductiveBiology*.Amsterdam:Elsevier.

Neill, Jimmy D. ed (2006). Knobil and Neill's Physiology of Reproduction.Volume I. Third edn. Elsevier Academic Press.

Pinon, R. (2003).*Biology of Human Reproduction*. California: University Science Books.

FOOD, NUTRITION AND HEALTH

LearningObjectives:

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

Unit I : Nutrition and dietary nutrients:

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

Unit II: Macro nutrients and micronutrients:

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

Unit III: Malnutrition and nutrient deficiency diseases:

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

Unit IV:

Life style dependent diseases- hypertension, diabetes mellitus, and obesity their causes and prevention. Social health problems- smoking, alcoholism, narcotics.AcquiredImmuno Deficiency Syndrome (AIDS): causes, treatment and prevention.

Unit V: Diseases caused by microorganisms:

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

References

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

6. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.

Course outcomes:

Students will be able to:

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

RADIATION BIOLOGY

LearningObjectives :

The course covers basic knowledge on different types of radiation, biological effects of radiation and risks on cellular level to humans, a deeper knowledge on radiation protection for ionizing and non-ionizing radiation, both in legislation and practical radiation protection technology.

UNIT-I

Scope of Radiation Biology – Sources of Natural Radiation: Terrestrial andcosmic sources - Man made radiations - Medical (occupational and diagnostic). Typesof radiation – Ionizing and non-ionizing radiation.

UNIT-II

Properties of Radiation – Radiation Units (Becquerel, RAD, Gray& Curie, Sievert).Measurement of Radiation in the Environment - Alpha and Beta counters and Scintillometer.

UNIT-III

Biological effects of Radiation - Cellular level – Organ and system level – Geneticeffects (chromosomal aberrations), radiation induced mutations – Radiation sickness – Syndromes – Cancer induction – Dosimetry.

UNIT-IV

Radiation safety measures - Safety standards disposal of radioactive wastemanagement, administrative & legislative aspect of radiation protection.Nuclear reactors – Nuclear energy programme in India. Regulatory authorities– AERB, BARC, DAE, IAEA & ICRP.

UNIT-V

Applications of Radioisotopes in biology- Auto radiography, Radioimmunoassay; Agriculture -insect, pest and disease management- Sterile Insect Technology (SIT); Medicine - (Therapy & diagnosis); Food preservation.

REFERENCES

1. Rao, B.M. (2002), Radioactive Materials, Himalayas publishing House.

2. Sood, D.D. Reddy, A.V.R. and Ramamoorthy, N. (2000) Fundamentals of Radiochemistry, Indian Association of Nuclear Chemists and Allied Scientists, Radiochemistry Division, Mumbai.
3. Sharma, B.K., (1990) Environmental Chemistry, Goel Publishing House, Meerut.
4. Kiefer, J. (1990) Biological Radiation Effects, Springer-verlag.
5. Radiation Biology: A Handbook for Teachers and Students International Atomic Agency (IAEA), 2010 - Training Course Series42.

COURSE OUTCOMES:

- To describe the various types of ionizing radiation.
- To define the radiation units used in measurement/calculations of "dose".
- To describe the biological impact of radiation on living cells and tissues
- To highlight the applications of radiation in different fields
- To create awarenessabout safety precautions when using radioactive isotopes

AGRICULTURAL ENTOMOLOGY

Learning Objectives

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

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

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

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

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

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

Text Books

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

Suggested Readings

1. AbishekShukla, D. 2009.A Hand Bookof EconomicEntomology, VedamseBooks,NewDelhi.

2. MinistryofAgriculture,GovernmentofIndia,1995.ManualonIntegratedPest Management in Rice andCotton.
3. John WilliamS. 1995. Management ofNatural Wealth, Loyola College Publications, Chennai.

Web resources

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

Course Outcomes (COs)

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

BIOPHYSICS AND BIOSTATISTICS

Learning objectives

1. To understand the concepts of diffusion, osmosis, centrifugal force, surface tension.
2. To understand the techniques for the separation of biomolecules.
3. To understand radiology, sonography, Laser techniques for biological and medical application.
4. To know to calculate standard deviation, correlation coefficient, chi-square analysis and student 't' test using the formula.

Unit I:

BiophysicalPrinciples: Physicallawsinlivingsystem:diffusion–Factors affecting diffusion-types of diffusion – Fick's law – Biological significanceofdiffusion–Osmosis–Osmoticpressure(endocytosis, pinocytosis, phagocytosis, exocytosis plasmolysis and haemolysis) Principlesofviscosity–Brownianmovement–surfacetension–turgor pressure–Centrifugation:Principle–types–applications.

Unit II: Applications of Biophysics: Principle and applications of colorimeter – electrophoresis –principle, instrumentation – applications of gel electrophoresis. Radioactivity: Types of radioactive decay – Radioactive isotopes – Autoradiography – biological impacts – Geiger-Muller counter: Principle – working procedure – advantages and disadvantages. Medical and biological uses of X-rays, Ultrasound and Laser

Unit III: Collection and Classification of Data: Introduction to biostatistics: Definition – characteristics, importance and applications of biostatistics. Collection of data: Primary – secondary data. Statistical population and sampling in biological studies. Types of Classification: Qualitative – quantitative. Variables: discrete – continuous. Frequency distributions.

Unit IV: Presentation of Data: Tabulation: Types – Components – advantages. Diagrammatic and graphical representations of data: Bar diagrams (Simple, multiple, subdivided and percentage) – Pie diagram – Frequency diagram: histograms – frequency polygon – frequency curve – line graphs.

Unit V: Descriptive & Inferential Statistics: Measure of central tendency: Arithmetic mean – median– mode. Measures of dispersion: Standard deviation – Standard error– Coefficient of variance. Test of significance: Chi-square test for goodness of fit – Student 't' test.

Text Books

1. Das,D.,1996.BiophysicsandBiophysicalChemistryforMedicalandBiology students, Academic,Calcutta. 302pp.
2. Subramanian,M.A.,2016.Biophysics–PrinciplesandTechniques,MJP,Chennai. 324pp.
3. Gurumani,N.,2005.AnintroductiontoBiostatistics,MJP,Chennai, 250pp.
4. Palanichamy,SandM.Shanmugavelu,1991.PrinciplesofBiostatistics.Palani Paramount.India. 350pp
5. Roy, R.N. 1996. A Text Book of Biophysics, New Central Book Agency Ltd, Calcutta. 992pp.

Suggested Readings

1. Antonisamy, B., Solomon Christopher and P. Prasanna Samuel, 2011. Biostatistics:Principlesandpractices.MacGrawHillEducationPvt.Ltd.New Delhi. 349pp.
2. BettyKarasek,2015.Advancedconceptsofbiophysics,CallistroReference, 198pp.
3. Daniel,W.W.,2000.Biostatistics:Afoundationforanalysisinthehealthsciences, 7thEd.JohnWiley&SonsLtd.NewYork. 328pp.
4. EdwardK.Yeargers,2018.BasicBiophysicsforBiology,CRCPress,USA.195pp
5. Gurumani, N., 2006. Research methodology for biological sciences, MJP, Chennai. 753pp.
6. Harvey Motulsky, 2015. Essentials of Biostatistics. A non mathematical approach.OxfordUniversityPress.NewYork. 208pp.
7. MichaelC.,WhitlockandDolphSchluter,2009.Theanalysisofbiologicaldata, 2ndEd.MacMillanPublishers,NewYork,USA.818pp.
8. Narayanan, R., 2010. Essentials of biophysics, II Ed., New age International publishers,Chennai. 546pp.
9. Pranab Kumar Banerjee, 2014. Introduction to biostatistics (A Text Book of Biometry,S. Chand&CompanyLtd.NewDelhi,India. 208pp.
10. RodneyM.J,Cotterill,2002.Biophysics:Anintroduction,JohnWiley&SonsLtd. NewYork. 400pp.
11. Ronser,B.,2006.FundamentalsofBiostatistics, ThomsonBrooks/Cole,6thEd. Duxbury press,Singapore.784pp
12. Sail Bose, 2000, Elementary Biophysics, Vijaya printers, Maduari.
13. Tanford,C.,1961.Physicalchemistryofmacromolecules,JohnWiley&SonsLtd. England. 710pp.
14. Yadav,B.S.,2020.Textbookofbiophysics,ArjunPublishingHouse,NewDelhi.

Web Resources:

1. https://bit.ly/2XGFuML
2. http://www.life.uiuc.edu/molbio/geldigest/electro.html
3. http://users.stat.ufl.edu/~winner/sta6934/st4170_int.pdf
4. http://www.biostathandbook.com/analysissteps.html
5. https://bit.ly/3nXUIrD
6. https://onlinecourses.nptel.ac.in/noc19_bt19

Course outcomes (COs)

1. Understand and recall the basic biophysical concepts, statistical data and formula.
2. Apply suitable physical techniques and statistical methods to solve biological problems.
3. Identify and relate the bioanalytical techniques and statistical principles for the application of biological experiments.
4. Select suitable biophysical techniques to study the biological process and statistical approach to assess the experimental results.
5. Integrate the bioanalytical techniques and statistical methods to validate research investigations.

BASIC COURSE IN ORNITHOLOGY

Learning Objectives

- Toequipstudentswith the required knowledge to understand the taxonomic position and role played by birds in the ecosystem, their importance to humans and their evolution
- Toenable students to comprehend the biological evolution of birds and their structural adaptations
- To enable students to understand and learn aspects of bird behaviour
- To enable students to learn about the breeding biology of birds
- To equip students with a knowledge of macroecology of birds, bird populations and communities, bird diseases, bird conservation and on the role of citizen science in ornithology.

Unit I

Introduction to Ornithology; Bird Lore; Birds and Humans; Classification of Birds, Bird Evolution and Speciation; Endemism

Unit II

External Morphology of the Bird; Structure of bird feather, Internal Structure of the Bird; Adaptations to Flight

Unit III

Bird Behaviour: Foraging, Roosting, Vocalization, Imprinting, Feather care, Bird Intelligence, Social Behaviour, Mixed Species Flocks, Migration

Unit IV

Breeding Biology: Differential investment of sexes; territoriality, courtship and display behaviour, nesting, eggs, incubation and care of young, brood parasitism

Unit V

Studying bird populations and communities, sampling methods; Macro ecology; Molecular Techniques in Ornithology; Avian Disease; Citizen Science and Ornithology; Threats faced by birds; Bird Conservation with case studies

COURSE LEARNING OUTCOME

On successful completion of the course, students will be able to

- Recall the taxonomic position of birds, their external morphology and internal parts, types of bird behaviour, sampling methods and types of avian diseases.
- Identify the external parts of the bird, internal structures of the bird and different types of bird behaviour
- Differentiate birds based on their morphology, foraging strategies and other behaviour
- Explain and discuss how birds evolved, bird adaptations to flight, different aspects of bird behaviour, threats to birds and the role of citizen science in ornithology
- Discuss and analyse case studies relating to bird conservation

BOOKS FOR REFERENCE

1.Lovette, I.J and Fitzpatrick, J.W. (2016). *Handbook of Bird Biology*, 3rd ed. Wiley.
2.Birkhead, T. (2013). *Bird Sense: What it's like to be a bird?* Bloomsbury, NY.
3.Birkhead, T., Wimpenny, J., and Montgomerie, B. (2014). *Ten Thousand Birds: 4.Ornithology since Darwin*. Princeton University Press, Princeton, NJ.
5.Gill, F.B, and Prum, R.O. (2019). *Ornithology*, 4th ed. Macmillan.

BASICS OF MARINE BIOLOGY

Learning Objective

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

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

Unit II: Physical Oceanography : Physical Properties of Seawater- density, viscosity, surface tension, conductivity and their relationship; temperature distribution in the sea - heat budget, UV radiation; El Nino/La Nina – global impact; Dynamics of the ocean-general surface circulation, Waves, Currents and Tides, Tsunami.

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

Unit IV: Biological Oceanography : Sea as a biological environment- Plankton- classification based on size, mode of life and habitat. Phytoplankton and Zooplankton - methods of collection, estimation of standing crop-wet and dry weight estimation-plankton volume settling and displacement methods.Oxidation as carbon (as organic matter).Primary productivity – estimation and factors affecting primary productivity.

Unit V: Marine Pollution and Ocean Management : Ocean pollution- kinds and quantities of pollutants, toxic effects and control measures – oil spills, plastics, nuclear waste disposal in marine environment, Eutrophication. Role of National and international agencies and organizations in ocean management-FAO, UNEP, DOD, WOCE, WHOI, IOI Malta, IMO INMARSAT- IUCN, SCAR, SCOR, Marpol, Traffic. Ocean policy (India) - research and management.

Text Books

1. Thurman, Harold., 2001 Introduction to Oceanography, Prentice Hall Inc. New Jersey. 506 pp.

2. Bertness, M.D, S. D. Gaines and M.K. Hay 2000. Marine Community Ecology Sinauer Associates.

3. Grant Gross, M., 1993 Oceanography: A view of the earth (sixth edition). Prentice Hall Inc. New Jersey.

4. Fincham A. A, 1984.Basic Marine Biology. Cambridge University Press, England. 157 pp.

5. John Resech Jr.1979, Marine Biology. Reston Publishing Company, Virginia. 257 pp.

Suggested Readings

1. Barbara E. Curry, 2016. Advances in Marine Biology, Volume 74, Ist Edition. Academic Press ISBN: 9780128036075

2. Peter Castro, Michael E. Huber, 2015. Marine Biology; Series Botany, Zoology, Ecology and Evolution.McGraw-Hill Education.

3. Philip V. Mladenov, 2013 Marine Biology: A very short introduction, Ist Edition. Oxford University Press.

4. Venkataraman K, Raghunathan C, Raghuraman R, Sreeraj C. R, 2012. Marine diversity in India.Zoological Survey of India, Kolkata.178 pp.

5. Amy Hill. 2002. Marine Biology: An Introduction to Ocean Ecosystems (Marine Biology Ser) Walch publishing.

6. Pickard, G.L. and W.J. Emery 1995. Descriptive Physical Oceanography. PergamonPress,London.

7. Gage. J.D. and P.A. Tyler, 1991. Deep Sea Biology, Cambridge University Press,Cambridge

8. Raymont J. E. G., 1980. Plankton and Productivity in the oceans: Volume 1: Phytoplankton, Pergamon Press.

9. Van Der Spoel, S. and PierrotBults, A. C (Eds) 1979.Zoogeography and diversity of plankton.Bungs Scientific Publishers Utrecht, 410pp.

10. Riley, J.P. and Skirrow, 1975-1984. Chemical Oceanography Vols. 1 to 8. Academic Press,London

Web Resources

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

Course Outcomes (COs)

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

ECONOMIC ZOOLOGY

Learning Objective

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

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

Lac Culture: Introduction – Life history – Host plants – cultivation of Lac – Enemies of lac cultivation – Economic importance of Lac.

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

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

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

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

Text Books

1. Sastry, N.S.R., C.K.Thomas and R.A.Singh, 2015. Livestock Production Management, 4th Ed.Kalyani Publishers, New Delhi.
   Mary violet Christy, A. 2014. Vermitechnology, MJP Publishers, Chennai.
2. ICAR, 2013. Hand book of Animal Husbandry, 4th Ed., ICAR Publication, Pusa, New Delhi.
3. Awasthi, V.B., 2012. Introduction to General and Applied Entomology, third edition, Scientific publishers, India.
4. Vasanthraj David, B and Ramamurthy, VV., 2012. Elements of Economic Entomology, Seventh edition, Namrutha publications, Chennai.
5. Shukla &Upadhyay, 2014. Economic Zoology, 5th edn. Rastogi Publication, Meerut New Delhi.
6. Gupta, S.M., 2010. Text book of fishery, Ann Backer, Mumbai.
7. ShailendraGhosh, 2009. Fisheries and aquaculture management, Adhyayan, New Delhi.
8. David, B and Ananthakrishnan, T. N., 2006. General and Applied Entomology, Second edition, Tata McGraw hill publishing company Ltd., New Delhi, India.
9. Jagadish Prasad, 2002. Principles and practices of Dairy Farm Management, 3rd Ed. Kalyani Publishers, Ludhiana.
10. Sukumar, D.E., 2002. Outline of Dairy Technology, Oxford University, New Delhi.
11. Rath, R.K., 2000. Freshwater Aquaculture. Scientific Publishers (India), Jodhpur.
12. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.
13. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai.
14. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea &Fabiger Publisher.

Suggested Readings

1. Glenn Munroe, 2017. Manual of on-Farm vermicomposting and vermiculture, Holdanca Farms Ltd, Wallace, Nova Scotia.
2. Hanifa, M.A., 2011. Aquatic resources and aquaculture, Dominent, New Delhi.
3. Gupta, P.K., 2008. Vermicomposting for sustainable agriculture, 2nd Edition, Agrobios, India.
4. Talashikar, S.C., 2008. Earthworms in Agriculture, Agrobios, India.
5. Abishek Shukla, D ., 2 0 0 9 . A Hand Book of Economic Entomology, Vedamse Books, New Delhi .
6. Banerjee, G.C., 2006. Text book of Animal Husbandry 8thEd.Oxford and IBH Publishing Company Ltd., New Delhi.
7. Walstra, P. Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology. CRC Press, New York.
8. Dunham, R.A., 2004. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.

9. Donald.D Bell and William. D. Weaver, 2002. Commercial chicken meat and egg production, Springer, New York.
10. Eckles C.H. and Anthony, E.L., 2001. Dairy Cattle and milk production, Biotech. Tata McGraw Hill Publishing Co.Pvt.Ltd., New Delhi.
11. Edwards, C.A., and Bother, B., 1996. Biology of earthworms, Chapman Hall Publication company.
12. ICAR, 1997. Handbook of Animal Husbandary– The Indian Council of Agricultural Research, New Delhi.
13. Banerjee G.C., 1992. Poultry, Oxford and IBH, New Delhi.
14. Jhingran, AVG, 1991. Fish and Fisheries of India. Hindustan Publishing Co. New Delhi.
15. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.
16. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, NewYork.

Web Resources

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

Course Outcomes (COs)

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

BIOINSTRUMENTATION

Course outcomes

1. To induce interest in the use of various biological instrumentation and employ them for the study of cells, tissues and genetic material.
2. To help students to map the use of specific bioinstrumentation for specific biological experiments and infer the results of such experiments.
3. To study the working principle of different bioinstrumentation and their applications.
4. To enable students to design experiments and justify them with the underlying principles of bioinstrumentation.

Unit I:Good Laboratory Practices : Guide lines, Laboratory symbols; Cleaning and sterilization of labware and reagents; handling and care of laboratory animals; Laminar flow hood: types and use; Concepts of molecular weight, atomic weight, preparation of solutions of a particular molarity and percentage; Buffers: definition and preparation of buffers, pH meter; Safety and ethical issues in laboratory settings

Unit II: Microscopy - Light microscope, SEM, TEM, Atomic force microscope; Cryopreservation - principle and procedure; Fluorescence activated cell sorting; X-ray crystallography.

Unit III: Centrifugation - working principle and types of centrifugation; Spectrophotometry; Mass spectrometry; Chromatography - principle and types of chromatography

Unit IV: Biomedical Instrumentation : ESR measurement, haemoglobin measurement, blood pressure, blood flow, ECG, cardiac pacemakers; X- ray imaging, CT scan and NMR imaging; Ultrasound imaging; medical applications of laser; Biosensors - glucose biosensor, alcohol biosensor, artificial retina, environmental biosensors, cantilever-based biosensors, DNA biosensor.

Unit V: Molecular Techniques : Isolation of DNA, RNA and proteins; Electrophoresis of DNA and proteins; Polymerase chain reaction; ELISA; Immunofluorescence; Fluorescent in situ hybridization; Southern and Western blotting.

Text Books

1. SabariGhosal and Anupama Sharma Avasthi, 2018. Fundamentals of Bioanalytical Techniques and Instrumentation, 2nd Ed., Phi Learning Pvt. Ltd., New Delhi, India.
2. Veerakumari L., 2015. Bioinstrumentation, MJP Publishers, Chennai, India.
3. Prakash Singh Bisen, Anjana Sharma, 2012. Introduction to Instrumentation in Life Sciences, CRC Press, Taylor & Francis Group, New York, USA.
4. Gupta P.C., 2010. Biological Instrumentation and Methodology (Tools & Techniques), S. Chand & Company Limited, New Delhi, India.

5. Ghatak K. L., 2010. Techniques and Methods in Biology, Phi Learning Pvt. Ltd., New Delhi, India.

Suggested Readings

1. Sue Carson, Heather Miller, Melissa Srougi and Scott Witherow, 2019. Molecular Biology Techniques: A Classroom Laboratory Manual, Academic Press, New York, USA.
2. Aysha Divan, Janice Royds, 2013. Tools and Techniques in Biomolecular Science, Oxford Univeristy Press, UK.
3. Gordon M.H., Macrae R., 2012. Instrumental Analysis in the Biological Sciences, Blackie & Son Ltd., UK
4. Leonard Davis, Mark Dibner and James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Publishing Co., New York, USA.
5. Wilson, K.M. and Walker, J.M., 2010. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.

Web Resources

1. https://bit.ly/3i5flym
2. https://pbiol.rsb.org.uk
3. https://www.nature.com/subjects/biological-techniques
4. https://www.ibiology.org

Course outcomes (COs)

1. To describe and explain the steps in the use of various biological instrumentation that are used in the study of different animal specimens.
2. To relate the applications of biological techniques and employ them for the study of cells, tissues and genetic material.
3. To correlate and appraise the use of specific bioinstrumentation for specific biological experiments and infer the results of such experiments.
4. To compare the working principle of different bioinstrumentation and to summarize their applications.
5. To devise experiments and justify them with the understanding of the underlying principles of bioinstrumentation that are ecofriendly, ethical and have national and global relevance.

ORNAMENTAL FISH FARMING& MANAGEMENT

Learning Objectives:

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

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

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

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

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

Unit –V
Identification of locally available ornamental fishes - Egg layers and live bearers.
Identification of locally available live feed organisms.

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

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

Course Outcome:

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

BIOCOMPOSTING FOR ENTREPRENEURSHIP

Learning Objectives:

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

Course outcomes:

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

Unit – I

Biocomposting – Definition, types and ecological importance.

Unit – II

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

Unit – III

Preparation of Biocompost pit and bed using different amendments.

Unit – IV

Applications of Biocompost in soil fertility maintenance, promotion of plant growth, value added products, waste reduction, etc.

Unit – V

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

Practical

- Preparation procedures for Biocompost pit.
- Selection of Biocompost material, separation of Compostable and Non-compostable materials.
- Packing and marketing of Biocompost.
- Field visit to Biocomposting unit.

References

Bikas R. Pati& Santi M. Mandal (2016). Recent trends in composting technology.

Van der Wurff, A.W.G., Fuchs, J.G., Raviv, M., Termorshuizen, A.J. (Editors) 2016. Handbook for Composting and Compost Use in Organic Horticulture. BioGreenhouse COST Action FA 1105, www.biogreenhouse.org.

AQUARIUM KEEPING

Learning Objectives

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

UNIT I
Introduction and scope - Aquarium fish keeping as hobby and cottage industry. Commercial aspects like national and international market. To create knowledge on self employment opportunity.

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

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

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

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

REFERENCE BOOKS:

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

Course Outcome:

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

MEDICAL LABORATORY TECHNIQUES

Learning Objectives

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

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

Unit II: Haematology : Composition of blood and their function- collection of blood & lab procedure-haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time-clotting time- determination of hemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count WBC- blood grouping and typing-haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.

Unit III: Medical Microbiology and Instrumentation Techniques : Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome- Computer tomography (CT scan) – Magnetic Resonance imaging – flowcytometry – treadmill test – PET.

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

Unit V: Diagnostic Pathology : Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining –staining methods- vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.

Text Books

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

Suggested Readings

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

Web Resources

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

Course Outcomes (COs)

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

SEMESTER VI

PROFESSIONAL COMPETENCY SKILL IN ZOOLOGY

Learning objectives

- To make aware on various employment options and plan for your future.
- Creating a network of other professionals in the field of zoology to improve knowledge and skills.
- Understand the different Graphs and Functions of Basic Mathematics
- Provide students with an understanding of the management and planning of ecotourism opportunities.
- To develop various entrepreneurial skills through zoology.
- To get a basic knowledge of statistical methods and computations in biology.

UNIT I- Communication skills

Interpersonal and communication skills- Role of science and technology in human development- Writing and communicating popular articles effectively- Science outreach through visual media- Science popularization through internet- Social media, Websites, Blogs, You tube.

UNIT-II-Personality development

Self-awareness and Self-development- Self appraisal, thoughtful and responsible approach, presentation skills, perception and attitude. Facing interviews. Work-life balance, stress management, coping with failures and depression.

UNIT-III-Entrepreneurship opportunity through zoology

Income and employment generation through bio-fertilizer production- Green manuring and organic fertilizers- Recycling of bio-degradable wastes: municipal, agricultural and Industrial wastes. Methods of making biocompost. vermicompost production- economics -establishment of small scale units.

UNIT-IV-Entrepreneurship opportunity through zoology

Employment generation in sericulture- Bee keeping as an occupation-Harvesting and marketing of bee products. Importance and history of aquarium fish keeping- Breeding and rearing of common ornamental fishes. History and future of Dairy Industry, Major dairy markets of the world, Dairy business profit strategies. Milk products: Cheese, yogurt, gluten etc

UNIT-V- Research and data analysis

Census and sampling methods-collection and presentation of Data. Diagrams and graphs; bar, pie Histogram -Measures of Central tendency: mean, median and mode.Ethics and Art of Scientific Writing- Writing references.Power-point presentation. Poster presentation. Zoology for competitive examinations (UPSC, TNPSC group services)

Suggested readings

Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.

Jolly, M. S. (1986) Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.

Mills, D. (1981). Aquarium Fishes, Arco publishing

Axelord, H.R. (1967). Breeding aquarium fishes, T F H Publications

Sathe, T.V. (2004) Vermiculture and Organic Farming. Daya publishers.

Subba Rao, N.S. (2017). Biofertilizers in Agriculture and Forestry. Fourth Edition. Medtech.

Vayas, S.C.; Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

Klaus, A. J. (2015) Dairy Farming: The Beautiful Way

Green, C.J. (2015) Leadership and soft skills for students: Empowered to succeed in High School, College and beyond. Dog Ear Publishing.

. Velayudhan, A. and Amudhadevi, N. V. (2012) Personality Development for College Students. LAP Lambert Academic Publishing

Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

NPTEL Course on Biomathematics accessible at https://nptel.ac.in/syllabus/102101003/

Biostatistics P. Ramakrishnan Saras Publications 1996 A.R.P. Camp Road, Kottar, Nagarkoil, Kanyakumari District

Gigante, E. Marie (2018). Introducing Science Through Images: Cases of Visual Popularization (Studies in Rhetoric/Communication), University of South Carolina Press

Learning outcomes

- Develop their competence and competitiveness and thereby improve their employability skills.
- Recognise students ability to improve their own competence in using the language
- To determine the value of mean,the median,the mode of grouped data,identifying the relationship among the three measures
- The students could able to learn the future strategies in livestock development for livelihood and revenue generation.
- Help students with a research bent of mind develop their skills in writing reports and research proposals