



माँ शाकुम्भरी विश्वविद्यालय, सहारनपुर
Maa Shakumbhari University, Saharanpur



Syllabus

of

M.Sc. (Zoology)

(For fourth and fifth years of Higher education)

**(As per guidelines of U.P. Government according to National
Education Policy-2020 w.e.f. the session 2022-2023)**



माँ शाकुम्भरी विश्वविद्यालय, सहारनपुर Maa Shakumbhari University, Saharanpur

Post-Graduation in Zoology

**& Pre. Ph.D. Course-WORK PROGRAMME
CURRICULUM & SYLLABUS**

For

**School of Science-Zoology
Maa Shakumbhari University, Saharanpur**

And

**Department of Zoology, Affiliated Colleges
Maa Shakumbhari University, Saharanpur**

Members, Board of Studies (Zoology)

S. No.	Name	Designation	College/University	Signature
1.	Prof. Sandhya Jain	Convener	D.A.V. (P.G). College, Muzaffarnagar	
2.	Prof. Anju Panwar	Member	D.A.V.(P.G.) College, Muzaffarnagar	
3.	Dr. Yogendra Singh	Member	Vijay Singh Pathik Govt. P. G. College, Kairana, Shamli	
4.	Dr. Om Dutt	Member	M.S. College, Saharanpur	
5.	Prof. D. S. Malik	External expert	Gurukul Kangri University, Haridwar	
6.	Prof. Dinesh Kumar Sharma	External expert	Km. Mayawati Govt. Girls (PG)College, Badalpur , Goutam Budhnagar	
7.	Prof. A. K. Verma	External expert	Govt. College, Saidabad, PRG	

SCHOOL OF SCIENCE (ZOOLOGY)

MAA SHAKUMBHARI UNIVERSITY, SAHARANPUR

VISION OF THE SCHOOL

To produce such academicians with morality, global competence, vision and skilled as are necessary to meet the challenges of emerging global knowledge, economy by the power of innovation, creativity and efficient learning ability. Besides these to create an innovative atmosphere for teaching and learning to achieve excellence in field of Zoology.

MISSION OF THE SCHOOL

To emerge among the top institutions in India within next ten years through applicability, humanity, implementing and operating dynamic-academic, administrative and functional process, for optimal use of available resources and a step towards consideration of valuable floral and faunal species in different habitats.

ABOUT THE SCHOOL OF SCIENCE - ZOOLOGY

The School of Zoology is going to establish with the objective of promoting post-graduate studies and research in various branches of Zoology. Zoology is the base of all sciences, therefore the importance of Zoology in any curriculum is self-evident. This is the single science subject that is being used by all other disciplines, that is why its growth over the years has been phenomenal. In view of this, Zoology at Post-Graduate level, is one of the subjects, which is going to introduce in the University since inception. M.Sc./M.A. were also started from the academic session 2021-22 under graduation program (B.Sc./ B.A.) under NEP2020 has already been started.

VISION

- To provide quality education for higher studies and competitive like ICMR, ICAR, ZSI, DBT, DRDO, BARC, NEERI, IPM, CSIR-UGC JRF/NET, GATE, SLET, Civil Services, Scientist, and research programme.
- School of Zoology will try to make our university students competitive with other national and international universities.

MISSION

- To develop and impart excellence in education, training and research in academic field.
- To impart world-class education in an environment of fundamental and applied research in field of Zoology.
- To emerge as a global centre of digital learning, academic excellence and innovative research.
- To include innovative skills, teamwork and bioethical practices and biosafety rules and regulation among academician so as to meet societal expectations.
- To provide quality education for higher studies and competitive like ICMR, ICAR, ZSI, DBT, DRDO, BARC, NEERI, IPM, CSIR-UGC JRF/NET, GATE, SLET, Civil Services, Scientist, and research programme.

M.Sc. Zoology Programme prerequisites

To study this programme a student must have/ had the subject Zoology at UG level.

Programme Outcomes (PO's)

- PO1:** Apply knowledge of Zoology in all the fields of learning including higher research and its extensions.
- PO2:** Innovate, invent and solve complex zoological problems using the knowledge of pure and applied Zoology.
- PO3:** Provide opportunities in higher education and development on the professional front. It also gives the opportunity for career advancement in teaching, research, and in various industries.
- PO4:** Integration of Interdisciplinary thinking and practice.
- PO5:** Analyse a problem, identify and define the computing requirements with respect to organizational factors appropriate to its solution, and plan strategies for their solution.
- PO6:** Design, implement and evaluate information systems, processes, components, or programs and source cost-benefit efficient alternatives to meet desired needs, goals, and constraints.
- PO7:** Deploy and use effective skills, tools, and techniques necessary for information systems practice.
- PO8:** Most importantly, the program inculcates among the students the higher values which enable them to withstand the challenges of life.
- PO9:** Deploy and use effective skills, tools, and techniques necessary for information systems practice.
- PO10:** Effectively communicate about their field of expertise on their activities, with their peer and society at large, such as, being able to comprehend and write effective reports and design documentation.

Programme Specific Outcomes (PSO's)

- PSO1.** After successful completion of this program, the students would be able to apply knowledge of Zoology, in all the fields of learning, including higher research and its extensions.
- PSO2.**To provide students with knowledge and capability in formulating and analysis of mathematical models of real-life applications.
- PSO3.**To provide comprehensive curriculum to groom the students into qualitative scientific manpower.
- PSO3.** Carry out development work as well as take up challenges in the emerging areas of the industry.
- PSO4.**Demonstrate competence in using mathematical and computational skills to model, formulate and solve real life applications.
- PSO5.**To provide students with knowledge, abilities and insight in Zoology and computational techniques so that they are able to work as mathematical professional.
- PSO6.** Crack lectureship and fellowship exams approved by UGC like CSIR– NET and SET/ ISRO/DRDO.
- PSO7.**Victorious in getting employment in different areas, such as industries, laboratories, Banks, Insurance Companies, Educational/Research institutions, administrative positions, since the impact of the subject concerned is very wide.
- PSO8.**Encourage personality development skills like time management, crisis management, stress interviews and working as a team.
- PSO9.**To develop problem-solving skills and apply them independently to problems in pure and applied Zoology.
- PSO10.**To assimilate complex mathematical ideas and arguments.
- PSO11:**To improve your own learning and performance.

Syllabus M.Sc. (Zoology)
LIST OF PAPERS IN ALL FOUR SEMESTERS

Year	Semester	Course Code	Core/Elective/Value Added	Paper Title	Theory/ Practical/ Project	Credits	CIE	External Marks (MinMarks)	Total Marks	Minimum Marks (INT+EXT)	Teaching Hours Theory + Tutorial	
Year-4 as per NEP/Year -1 (P.G.)	Semester -VII as per NEP2020/Semester-I	0727801	Core Compulsory	Biosystematics and Evolution	Theory	4	25	75(25)	100	40	4x30	120 hours
		0727802	Core Compulsory	Diversity of invertebrates	Theory	4	25	75(25)	100	40	4x30	120 hours
		0727803	Core Compulsory	Biotechniques and Bioinstrumentation	Theory	4	25	75(25)	100	40	4x30	120 hours
		0727804	Core Compulsory	Cell and molecular biology	Theory	4	25	75(25)	100	40	4x30	120 hours
		0727865	Core Compulsory	Project	Project	4					4X30	120 Hours
		0727880	Core Compulsory	Practical	Practical	4	25	75(25)	100	40	4X30	120 Hours
		0727850	Minor Elective (from other faculty)	Other faculty (not from science faculty)	Theory	4	25	75(25)	100	40	4x30	120 hours
	Semester VIII as per NEP2020/Semester -II	0827801	Core Compulsory	Genetics	Theory	4	25	75(25)	100	40	4x30	120 hours
		0827802	Core Compulsory	Biochemistry	Theory	4	25	75(25)	100	40	4x30	120 hours
		0827803	Core Compulsory	Biostatistics and Bioinformatics	Theory	4	25	75(25)	100	40	4x30	120 hours
		0827804	Elective	Mammalian physiology	Theory	4	25	75(25)	100	40	4x30	120 hours
		0827805	Elective	Endocrinology and Immunology	Theory	4	25	75(25)	100	40	4x30	120 hours
		0827865	Core Compulsory	Project	Project	4					4X30	120 Hours
		0827880	Core Compulsory	Practical	Practical	4	25	75(25)	100	40	4X30	120 Hours
<p><i>Project evaluated at the end of year (After Second IInd /IVth semester), Total Marks-100, If student publish research in UGC-CARE listed journal, He/She will get 25 marks directly out of 100. Follow the instruction for research project explained in G.O. No-401/Sattar-3-2022 dated 9-2-2022</i></p> <p>Minor Elective- Student can done other faculty course form SWAYAM or other recognised MOOCs</p> <p><i>For CIE purpose follow the G.O. No 2058/Sattar-3-2021-08(33)/2020TC dated 26-8-2021</i></p>												

Syllabus M.Sc. (Zoology)
LIST OF PAPERS IN ALL FOUR SEMESTERS

Year	Semester	Course Code	Core/Elective/Value Added	Paper Title	Theory/ Practical/ Project	Credits	CIE	External Marks (MinMarks)	Total Marks	Minimum Marks (INT+EXT)	Teaching Hours Theory + Tutorial	
Year -5 as per NEP2020/Year – 2 (P.G.)	Semester IX as per NEP2020/ Semester -III	0927801	Core Compulsory	Diversity of chordates	Theory	4	25	75(25)	100	40	4x30	120 hours
		0927802	Core Compulsory	Developmental biology	Theory	4	25	75(25)	100	40	4x30	1200 hours
		0927803	Core Compulsory	Environment, wild life and biodiversity	Theory	4	25	75(25)	100	40	4x30	120 hours
		0927804	Elective	Animal Biotechnology	Theory	4	25	75(25)	100	40	4x30	120 hours
		0927805	Elective	Animal Behaviour	Theory	4	25	75(25)	100	40	4x30	120 hours
		0927865	Core Compulsory	Project	Project	4	25				4X30	120 Hours
		0927880	Core compulsory	Practical	Practical	4	25	75(25)	100	40	4X30	120 Hours
		ANY ONE OF THE FOLLOWING ELECTIVE (Specialization) Semester Xth as per NEP 2020/ Semester IVth										

Elective Course XIII A - PARASITOLOGY												
Year	Semester	Course Code	Core/Elective/Value Added	Paper Title	Theory/ Practical/ Project	Credits	CIE	External Marks (MinMarks)	Total Marks	Minimum Marks (INT+EXT)	Teaching Hours Theory + Tutorial	
		1027801	Core Compulsory	Biology of parasites-(Protozoa, Cestoda and Trematoda)	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027802	Core Compulsory	Biology of parasites-(Nematoda and Arthropoda)	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027803	Core Compulsory	Physiology and biochemistry of parasites	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027804	Core Compulsory	Immunoparasitology	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027865	Core Compulsory	Project	Project	4	25				4X30	120 Hours
		1027880	Core Compulsory	Practical	Practical	4	25	75(25)	100	40	4X30	120 Hours
Elective Course XIII B- Fish and Fisheries												
		1027805	Core Compulsory	General Fish biology	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027806	Core Compulsory	Morphology and physiology of fishes	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027807	Core Compulsory	Fish Culture	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027808	Core Compulsory	Applied Fisheries	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027865	Core Compulsory	Project	Project	4	25				4X30	120 Hours
		1027880	Core Compulsory	Practical	Practical	4	25	75(25)	100	40	4X30	120 Hours

Elective Course XIII C- Cytology and Cytogenetics												
		1027809	Core Compulsory	Chromosome and Genomic Organisation	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027810	Core Compulsory	Genome analysis, Immunogenetics	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027811	Core Compulsory	Human & microbial cytogenetics and molecular biology	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027812	Core Compulsory	Advanced Cell biology	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027865	Core Compulsory	Project	Project	4	25				4X30	120 Hours
		1027880	Core Compulsory	Practical	Practical	4	25	75(25)	100	40	4X30	120 Hours
Elective Course XIII D- Entomology												
		1027813	Core Compulsory	Morphology and taxonomy of Insects	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027814	Core Compulsory	Anatomy and physiology	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027815	Core Compulsory	Applied entomology I	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027816	Core Compulsory	Applied entomology II	Theory	4	25	75(25)	100	40	4x30	120 hours
		1027865	Core Compulsory	Project	Project	4	25				4X30	120 Hours
		1027880	Core Compulsory	Practical	Practical	4	25	75(25)	100	40	4X30	120 Hours

Examination Pattern	
Countious Internal Evaluation (CIE): <i>For CIE purpose follow the G.O. No 2058/Sattar-3-2021-08(33)/2020TC dated 26-8-2021</i>	
	Written Test (1) or Assignment (2) -10 Marks+ 5 Marks Quiz/ Extempore/ Exhibition + 5 Marks Academic Visit/tour/ Book review/ Field study + 5 Marks Seminar
External Examination: Written Exam of 75 marks 3Hrs Duration.	
External Exam Pattern:	
	Unit-I : Attempt all five question . Each question carry 3 marks.
	Unit- II : Attempt Any Two out of three. Each Question carry 7.5 marks each.
	Unit-III : Attempt Any Three out of Five. Each Question carry 15 marks each.
Internal Examination:	
	1. One written Test of 20 Marks.(5 Marks Quiz + 15 Marks (Very Short + Short + Long Question))
	2. Five Marks for Seminar/Assignment/Field study
Minimum Marks:	
	1. In each individual paper Forty Marks i.e. 40% with aggregate of 50% in all courses.
	2. Division: First Division - CGPA 6.5 and Less than 10, Second division - CGPA 5.0 and less than 6.5. There is no provision of Third division.
	Equivalent Percentage = CGPA x 9.5
	Note: Percentage and Grading system applicable as per NEP2020 GO 1032/Sattar-2022-08(35)/2020, Higher Education Division -3, Lucknow Dated 20.04.2022
Project-	<i>Project evaluated at the end of year (After Second IInd /IVth semester), Total Marks-100, If student publish research in UGC-CARE listed journal, He/She will get 25 marks directly out of 100. Follow the instruction for research project explained in G.O. No-401/Sattar-3-2022 dated 9-2-2022</i>
Vlab	25% experiments in each semester done through vLab or other govt/university virtual experiments.
MOOCs Equvalance	20% credits allowed through SWAYAM or other recognised MOOCs, Equivalent MOOCS are defined at the end of paper.

External Examination: Written Exam of 75 marks 3Hrs Duration.

External Exam Pattern:

Unit-I : Attempt all five question . Each question carry 3 marks.

Unit- II : Attempt Any Two out of three. Each Question carry 7.5 marks each.

Unit-III : Attempt Any Three out of Five. Each Question carry 15 marks each.

**Minimum
Marks:**

1. In each individual paper Forty Marks i.e. 40% with aggregate of 50% in all courses.
2. Division: First Division - CGPA 6.5 and Less than 10, Second division - CGPA 5.0 and less than 6.5. There is no provision of Third division.

$$\text{Equivalent Percentage} = \text{CGPA} \times 9.5$$

Note: Percentage and Grading system applicable as per NEP2020 GO 1032/Sattar-2022-08(35)/2020, Higher Education Division -3, Lucknow Dated 20.04.2022

Detailed Syllabus

For

M. Sc. I (ZOOLOGY)

Or

B.Sc. (Research) ZOOLOGY

Programme/Class:	Year: First	Semester: First
Subject: Zoology		
Course code: 0727801	Course Title: Biosystematics and Evolution	
<p>Course outcome: Taxonomy also known as Systematic biology will help the students to have a broad knowledge of classification, cladogenesis and speciation. Phylogenetic taxonomy will aid in understanding and reconstruction of the phylogeny of life.</p> <p>Evolution or evolutionary biology aims to impart the concept of evolutionary thoughts that lead to the evolution of the life on earth from most simple to complex forms along with the mechanism and function of various evolutionary factors and forces.</p>		
Credits: 4	Core	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	<p>a. Science of taxonomy- Definition. Concepts, history, Scope and applications of biosystematics, Taxonomy Vs Systematics</p> <p>b. Principles of Zoological Classification and nomenclature- Theories, rules and principles of biological classification, Nomenclature and their history, hierarchies of categories and the higher taxa, Key v/s hierarchy. Evolutionary relationship among taxa.</p>	
II	<p>a. Concept of Species- Species category, different concepts, and intraspecific categories.</p> <p>b. Modern trends in taxonomy. Behavioral taxonomy, Cladistic taxonomy, Chemotaxonomy, cytotaxonomy and molecular taxonomy, Bioinformatics and taxonomy (Bioinformatics tools for classification)</p> <p>c. Taxonomic collections, preservation, methods and data recording, methods of identification and problems encountered in identification, preparation of taxonomic publication and taxonomic paper.</p>	
III	<p>a. Origin of Life including aspects of pre-biotic environment. Abiotic and biotic Evolution. Emergence of Thoughts and Theories of Organic evolution. Evidences in favour of organic evolution. Evolutionary Bioinformatics</p> <p>b. Concept and evidences of molecular evolution, molecular divergence and molecular clocks: molecular tools in phylogeny: origin of new genes and proteins: gene duplication and divergence, in vitro molecular evolution.</p>	

IV	<p>Mechanism of Evolution:</p> <p>a. Elemental forces of evolution-Isolating Mechanism. Speciation. Allopatricity and Sympatricity: Convergent and Divergent evolution: Sexual Selection: Co-evolution. Natural Selection.</p> <p>b. Adaptation Introduction. Adaptive Radiation and Modifications. Coloration & Mimicry</p>	
V	<p>a. Fossil and Fossilization-Types of fossils, Zoological time scale</p> <p>b. Evolution of Horse and its phylogeny ,Evolution of Man. Human evolutionary history; placing humans on tree of life; genomics and humanness; current issues in human evolution.</p>	
<p>Recommended Books:</p> <ol style="list-style-type: none"> 1. Barton, N.H., Briggs, D.E.G., Eisen, J.A.Goldstein, D.B. and Patel, N.H. (2007). Evolution. Cold Spring, Harbour Laboratory Press 2. Dobzhansky Th. et al. (1976): Evolution. Surjeet Publ. (34) 3. Futuyma D. J. (1998): Evolutionary Biology. Sinauer 4. Hall, B.K. and Hallgrimsson, B(2008) Evolution, IV Edition. Jones and Barlett Publishers 5. Kimura M. (1984): The Neutral Theory of Molecular Evolution. Cambridge. 6. Li Wen-Hsiung and Dan Graur (1991): Fundamentals of Molecular Evolution. Sinauer 7. Ridley,M(2004). Evolution. III Edition. Blackwell publishing 8. Strickberger M. W. (2000): Evolution. Jones and Bartlett 9. White M. J. D. (1978): Modes of Speciation. Freeman 10. G.G.Simpson: Principle of animal taxonomy. E.Mayer: Elements of Taxonomy 		

Programme/Class:	Year: First	Semester: First
Subject: Zoology		
Course code:0727802	Course Title: Diversity of Invertebrates	
<p>Course outcome: Invertebrates are the numerous and widely diverse group of animals from protozoa to Echinodermata. The course will explain the diversity of invertebrates and comparison of various morphological, physiological phenomenon and adaptations in various phyla. This will help and enable the students to take up the research in life sciences.</p> <p>In Economic zoology various types of economically important cultures have been given place to enable the students to be skilled in these and in future can start their own business. Along with it various types of pest and pest management programmes are also included to impart the broad knowledge and to arm the students to deal with the menace of pests.</p>		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	<p>Protozoa .General characters and outline classification, locomotion and reproduction in protozoa.</p> <p>Porifera. General characters and outline classification, canal system skeleton and regeneration in sponges</p> <p>Cnidaria: General characters and outline classification, polymorphism in cnidarians, gradation of metagenesis , coral and coral reefs.</p>	
II	<p>Helminths. General characters and outline classification.</p> <p>Platyhelminthes and nematehelminthes, Parasitic adaptations in helminths.</p> <p>Annelida: Important features, outline classification, segmentation and coelom, excretory system and regeneration.</p>	
III	<p>Arthropoda. Important features, outline classification, Integumentary system, respiratory system and larval forms in crustacean.</p> <p>Onychophora: Important features, outline classification, general organisation and affinities.</p>	
IV	<p>Mollusca: Important features, outline classification, shell, root, and its modifications, torsions and detorsion in gastropoda.</p> <p>Echinodermata- Important features,outline classification, body wall and skeleton, larval forms and regeneration.</p>	
V	<p>Minor non coelomate phyla: General organisation, classification and affinities of phylum rotifer and acanthocephalan.</p> <p>Minor coelomate phyla: General organization, classification and affinities of phylum chaetognatha,pogonophora,phoronida and brachiopoda.</p> <p>Hemichordata:General organisation, classification and affinities.</p>	

Recommended Books-

1. Barnes. Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
2. Barnes et al (2009). The Invertebrates – A synthesis. Wiley Blackwell 17
3. Brusca and Brusca (2016) Invertebrates. Sinauer
4. Hunter. Life of Invertebrates, Collier Macmillan Pub. 1979
5. Jan Pechenik (2014) Biology of the Invertebrates. McGraw Hill
6. R.L.Kotpal. Invertebrate series;Textbook of Invertebrates
7. Marshall. Parker & Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972
8. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001.

Programme/Class:	Year: First	Semester: First
Subject: Zoology		
Course:0727803	Course Title: Biotechniques and Bioinstrumentation	
Course outcome: The students at the end of course will have a deep insight into various biotechniques and enable them to apply these in their future researches. The course is expected to provide sufficient information to enable the students to select a technique that would be appropriate for a particular analysis and would help them to develop a valid and reliable analytical method. They will also able to start their own biotechniques research labs, a further step towards self employment.		
Credits: 4	Core	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	Introduction to Microscopy, Resolving Power, Limit of Resolution and Magnification, Types of microscopes, Basic principles of Light, Electron, Fluorescence and Confocal Microscopy	
II	Buffers, pH meter, Colorimetry, Spectrophotometry, UV/IR spectroscopy, mass spectroscopy, X-ray crystallography, N.M.R, Chromatography and Centrifugation types.	
III	Electrophoretic techniques: Agarose Gel Electrophoresis, Polyacrylamide Electrophoresis (PAGE), Southern, Northern and Western blotting, Autoradiography	
IV	Raising Polyclonal and Monoclonal Antibodies, Antigen-Antibody Interactions Immunodiffusion, ELISA, Radioimmunoassay	
V	Cell culture and its basic requirements. Culture media-Nutrient and Non-nutrient, commonly used media for human cell lines. Sterilization of culture wares and media, Cell harvesting and Storage Methods, Autoclave and Laminar Air Flow, Safe laboratory practices.	
Books Recommended		
<ol style="list-style-type: none"> 1. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed.), Benjamin/Cumin, 1993 2. Clark and Switzer. Experimental Biochemistry. Freeman (2000) 3. Freifelder: Physical Biochemistry (2nd Ed.), Freeman, 1982 4. Holme and Peck: Analytical Biochemistry (3rd Ed.), Tata McGraw Hill, 1998 5. Plumer: An Introduction to Practical Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990 6. R.C.Dubey and D.K.Maheshwari: A textbook of Microbiology 7. S.V.S. Rana :Biotechniques Theory and Practice 8. Sambrook et. al.Molecular cloning Vols I, II, III. CSHL (2001) 9. Wilson and Walker: Practical Biochemistry (3rd Ed.), Cambridge Univ. Press, 2000. 		

Programme/Class:	Year: First	Semester: First
Subject: Zoology		
Course code: 0727804	Course Title: Cell and Molecular Biology	
Course outcome: Today cytology not only attracts the students from life sciences but also from other streams. Physicist have invented a lot of instruments and chemists provide the information of chemical composition and their processing along with synthesis of biomolecules. The course will attract the students to do their best in further advancement in the field of cytology and molecular biology. Advance topics related to molecular biology have been incorporated to enable the students to have a deep insight in the subject and prepare them for research.		
Credits: 4	Core	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	Cell membrane- a) Structural organisation of biomembrane. Functions of plasma membrane (transport. diffusion, active transport, pumps, uniports, symports and antiports). b) Cell organelles-origin. structure and function of nucleus, mitochondria. Endoplasmic reticulum and ribosomes, Golgi complex. endosome. lysosomes, peroxyosomes. centrosome	
II	a) Cytoskeleton, Organisation and dynamics of microtubules. actin filaments (micro-filaments), intermediate filaments, cilia & flagella. b) Cell communication cell- cell signaling, cell surface receptors, second messenger system, kinase pathways, signaling from plasma membrane to nucleus (signaltrans-duction).	
III	Cell adhesion & cell junctions- a) Cellular affinity, cell adhesion molecules (CAMS), Ca ⁺⁺ dependent cell-cell adhesion, Ca ⁺⁺ independent cell-cell adhesion, cadherins, selectins, integrins, cell junctions. b) Cancer. Oncogenes, tumour suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.	
IV	a) DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms. b) Transcription in prokaryotes and eukaryotes, RNA processing, RNA editing, splicing, structure and function of different types of RNA, RNA transport	
V	a) Translation in prokaryotes and eukaryotes, Genetic code, Post- translational modification of proteins, protein targeting. b) Gene regulation, Lac operon, trp operon, Arabinose operon. Gene regulation in eukaryotes	

Book recommended

1. Alberts et al: Molecular Biology of the Cell(4th Ed.),Garland,2002
2. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
3. DeRobertis & DeRobertis: Cell & Molecular Biology, Lea & Febriger, 1987
4. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
5. Michael Jr.: Microbiology, Tata McGraw Hill, 1990s
6. P.K.Gupta,: Cell and molecular biology
7. Karp: Cell and molecular biology : Wiley (2002).
8. Cooper: Cell. A Molecular approach: ASM Press (2000)

Practical Course Syllabus Semester I Credit -4 Time -4
Hrs

- Virtual Dissection
- Major Dissection- Nervous system of Prawn, Pila, Unio, Sepia, Octopus
- Minor Dissection- Setae, nephridia, appendages of Prawn, statocyst, hastate plate, radula, Anatomy of Holothuria
- Mounting- Gemmules, spicules, Obelia colony, medusa of obelia, Pennatula, , Crustacean larva
- Microtomy- Source tissue, fixing, dehydration, block making, section cutting and staining
- Slides and specimens of various invertebrate phyla
- Taxonomy- Cytotaxonomy, collection, identification, nomenclature and preservation of museum specimens. Maintenance of museum
- Evolution- Preparation of coacervates, adaptive radiation in Darwin Finches through chart and models, Weber's line, Wallace line through chart or model.
- Numerical based on gene pool and genetic drift. Demonstration/ photography of mimicry, protective coloration.
- Elementary knowledge about preparation of various reagents used in laboratory
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- Microscopy- Light microscope, phase contrast, confocal microscope
- Flow cytometry, Centrifugation, Electrophoresis, chromatography
- Ag- Ab in tab str, Immunoprecipitation, ELISA, Demonstration / virtual demonstration of monoclonal antibodies,
Hybridoma Technology through chart,
Western blot, DNA isolation and its quantification through stage of mitosis and meiosis ,
Squash technique
- Field study / visit and project (mandatory)

Distribution of Marks-

• Major Dissection	-	10
• Minor Dissection	-	05
• Mounting	-	$(2\frac{1}{2} \times 2)$
• Microtomy	-	10 (4+3+3) (Section cutting, stretching and staining)
• Spotting	-	10 (1x10)
• Evolution	-	5
• Techniques	-	10
• Cell Biology	-	10
• Mol. Biology	-	5
• Collection field visit	-	10
• Viva	-	10
• Record	-	10

Programme/Class:	Year: First	Semester: Second
Subject: Zoology		
Course code:0827802	Course Title: Genetics	
Course outcome: The course will enable the students to apply the skills of genetic technologies in various fields related to pharmaceuticals, biotechnology and diagnostic clinics. It will bring awareness on various genetic disorders, its inheritance patterns and to develop techniques of fighting against these disorders.		
Credits:	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	(a)Mendelian principles-Dominance, segregation, independent assortment, deviations from Mendelian inheritance . (b)Methods of genetic transfer-Transformation, conjugation, transduction, bacteriophages-types, structure and morphology of T ₄ phage.	
II	Chromosomes-Molecular anatomy of eukaryotic chromosomes, heterochromatin and euchromatin, Organisation of genetic material-packaging of DNA as nucleosomes in eukaryotes, repetitive and unique DNA sequences, split genes, overlapping genes and pseudogenes, giant chromosomes, polytene and lampbrush chromosomes, sex chromosomes	
III	(a)Gene mapping-Concept of recombination, linkage map, cytogenetic map, physical map, molecular maps, levels of genome mapping, (b)Genetic code-Properties of genetic code, codon assignments, chain initiation and termination, mutations and the genetic code.	
IV	(a)Genetic techniques-Cloning, PCR, DNA sequencing FISH, GISH, DNA fingerprinting. Chromosome walking and applications of genetic engineering. (b)Somatic cell genetics-cell fusion and hybrid –agents and mechanism of fusion, heterokaryon	
V	(a) Structural and numerical alteration of chromosomes Genetic disorders-chromosomal disorders, inborn errors of metabolism, Tay-sachs disease, albinism, phenylketonuria, Lesch-Nyhan chromosome. (b) Population genetics-Gene pool and gene frequencies, Hardy- Weinberg law of genetic equilibrium and changes in gene frequencies.	
	Books Recommended 1. Brooker: Genetics : Analysis and Principles (Addison-Wesley, 1999) 2. Gardner et al: Principles of Genetics (John Wiley, 1991) 3. Griffith et al: Modern Genetic Analysis (Freeman, 2002) 4. P.K.Gupta: Genetics 5. Lewin, Genes VIII (Wiley, 2004) 6. Russell: Genetics (Benjamin Cummings, 2002) 7. Snustad & Simmons: Principles of Genetics (John Wiley, 2003). 8. Benjamin A. Pierce: Genetics : a conceptual approach	

Programme/Class:	Year: First	Semester: Second
Subject: Zoology		
Course code: 0827801	Course Title: Biochemistry	
Course outcome: Biochemistry is regarded as the mother of all biological sciences disciplines as it unveils the chemical basis of life an all the living organisms from micro-organisms to plants and animals. Keeping in pace with the developing trends in various areas of biochemistry the subject course contains fundamental as well as latest and upcoming developments in the field of biochemistry.		
Credits:4	Core	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Structure of atoms, molecules and chemical bonds b) Composition, structure and function of biomolecules carbohydrates, lipids, proteins, Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds) nucleic acids and vitamins.	
II	a) Principles of biophysical chemistry pH, buffer, reaction kinetics, thermodynamics, colligative properties. b) Enzymes, classification, enzyme kinetics, mechanism of enzyme catalysis, enzyme regulation, isozymes, coenzymes, Abzymes, ribozymes.	
III	a) Bioenergetics, high energy rich biomolecules, phosphoryl transfer reactions, oxidation reduction reactions b) Carbohydrate metabolism: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, pyruvate oxidation, TCA cycle, PPP pathway, oxidative phosphorylation.	
IV	a) Lipid metabolism beta oxidation of fatty acid, steroid synthesis, cholesterol synthesis, fatty acid synthesis (SFA, UFA). b) Protein metabolism (catabolism of carbon skeleton, nitrogen skeleton, urea cycle.)	
V	a) Nucleic acid metabolism (Synthesis of purines and pyrimidines nucleotides and its catabolism) b) Enzyme technology: engineering, immobilization, physical, adsorption, entrapment, covalent modifications.	

Books recommended:

1. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
3. J.L.Jain: Fundamental of Biochemistry
4. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004 (37)
5. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
6. Murray et.al: Harper's Illustrated biochemistry : McGraw Hill (2003) Elliott and Elliott
7. Lubert Stryer: biochemistry
8. Voet & Voet. Biochemistry Vols I &2: Wiley (2004)

Programme/Class:	Year: First	Semester: Second
Subject: Zoology		
Course code:0827804	Course Title: Biostatistics and Bioinformatics	
Course outcome: The course will lead to comprehensive understanding of the principles and various practices of biotechnology. The aim will be to produce the responsible biotechnologists. Bioinformatics is the emerging branch in the field of life science. The course covers the principles and computational methods used to search and compare the DNA, RNA and proteins cast as biological sequences. This will also help in the field of evolutionary biology to solve the mystery evolutionary relationship among different species.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Biostatistics – Basic concepts. Fundamentals of measurement. Qualitative & Quantitative Variables, b) Collection, Classification, Tabulation & Presentation of data Mean, Median, Mode, Dispersion, Standard Deviation and their merits & demerits.	
II	a) Chi-square test & ‘t’ test. Analysis of variance, Probability Distribution and normal distribution (Gaussian Distribution) b) Correlation Analysis – Importance of Correlation Analysis. Types and measures of Correlation. Regression Analysis. Regression of Y on X and X on Y	
III	a). Bioinformatics – Introduction. Components of Computer, b). Internet – Basics for Biologists (Electronic mail, Electronic Mail Servers, Downloading files with anonymous File Transfer Protocol, Gopher, WWW, Mosaic.	
IV	a) Primary & Secondary Databases. Sequence Databases (European Molecular Biology Laboratory, Gene bank). b) DNA Data Base of Japan (DDBJ), SWISS-PORT, Protein Information Resource, TREMBL, Protein Family/Domain Databases (Prosite. Pfam & Prints).	
V	a) Submitting sequence to Database and information retrieval through ENTREZ. b) Collecting & Storing Sequences, Local alignment, c) Global Alignment, BLAST (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX). d) Phylogenetic Prediction, Gene Prediction & Analysis	

Recommended Books :

- 1) Bioinformatics for geneticists: Wiley (2003)
- 2) Lesk: Bioinformatics, Oxford (2003, Indian ed)
- 3) Westhead et al: Bioinformatics Instant Notes, Viva Books (2003, Indian ed)
- 4) Jerrold H. Zarr: Biostatistical Analysis (Fourth edition), Pearson Education Inc., Delhi
- 5) W.W.Daniel and C.L.Cross: Biostatistics(Tenth edition), Wiley
- 6) John E. Havel, Raymond ,E. Hampton and Scott J Meiners :Introductory Biological Statistics (Fourth edition)
- 7) Satguru Prasad: Elements of Biostatistics
- 8) Pranab Kumar Banerjee: Introduction to Biostatistics

Programme/Class:	Year: First	Semester: Second
Subject: Zoology		
Course code:0827803	Course Title: Mammalian Physiology	
Course outcome: The course will enable to students to understand the functions of important physiological systems including the cardiac ,respiratory, renal, metabolic and reproductive systems. They will understand how these various systems interact to yield integrated physiological changes in the body.		
Credits: 4	Elective	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Physiology of Digestion and absorption, Gastrointestinal hormones and regulation, BMR. b) Physiology of respiration Pulmonary ventilation, gaseous exchange through respiratory membranes and tissues. Neural and chemical regulation of respiration	
II	a) Blood -blood corpuscles, haemopoiesis, formed elements, plasma, blood volume, blood groups, haemoglobin, haemostasis. b) Structure of heart, myogenic heart and neurogenic heart, cardiac cycle, neural and chemical regulation of heart, blood pressure, ECG-its principle and significance.	
III	a) Physiology of Neurons, Axonal and Synaptic transmission central and peripheral nervous system. b) Sense organs: Vision(Retinal components and photoreceptors), hearing and tactile response	
IV	a) Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. Stress and adaptation. b) Physiology of muscle, Sequence of events in contraction and relaxation of skeletal muscle, energetics of muscle contraction and its neural regulation	
V	a) Glands, Its classification. Hormones, chemical nature of hormones, hormone action. Hypothalamus. Pituitary, Pineal, thyroid, parathyroid, thymus, adrenal. b) Physiology of excretion: formation of urine and its concentration, Counter current mechanism, electrolyte balance, micturition, Hormonal balance, acid-base balance and homeostasis	

Recommended Books:

1. A.K.Jain: Textbook of Physiology, Vol. 2.
2. C.C.Chatterjee: Human physiology vol 1&2. 11th edition. CBS Publishers (2016)
3. Christopher D. Moyes, Patricia M. Schulte: Principles of Animal Physiology.XI edition John Wiley & Sons(2006)
4. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
5. Guyton and Hall: Text Book of Medical Physiology. XI Edition. Herculourt Asia PTE Ltd./W.B. Saunders, 2006
6. Hill, Richard W., et al. ; Animal physiology Vol. 2. Sunderland, MA:Sinauer Associates, (2004)
7. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
8. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins,1981.

Programme/Class:	Year: First	Semester: Second
Subject: Zoology		
Course code:0827803	Course Title: Endocrinology and Immunology	
Course outcome: The hormones conduct a wide variety of functions ranging from growth, vegetative and sexual development, cellular oxidation to thermal production and the metabolism of carbohydrates, proteins and fats. The course material will allow the students to identify the glands, organs, tissues and cells that synthesize and secrete hormones, hormones precursors and associated compounds along with the regulation of hormones and their biological activities. Immunology deals with the defense mechanism of the body against the pathogens. The course will allow the students to have a deep insight into various concepts of immune system and its detail mechanism		
Credits: 4	Elective	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	(a) Concept, Objectives, Scope and Techniques in Endocrinology, Hormones classification. Autocrine/Paracrine signals. Miscellaneous regulatory substances (erythropoietin, somatomedin growth factors, eicosanoids etc). Neuroendocrine system. Hormonogenesis, Transport and Distribution. Mechanism of hormone action. Cell surface receptors and intracellular signalling. (b)Pituitary gland: Morphology and anatomy of adeno and neurohypophysis, Adenohypophyseal and Neurohypophyseal hormones:structure and biological role, Hypothalamic control of hypophyseal hormones.	
II	(a) Thyroid gland: Morphology and anatomy, Thyroid hormones-synthesis, secretion transport and functions, Thyroid hormone related disorders. (b) Parathyroid gland: Structure and function of parathyroid hormone. (c) Adrenal gland : Anatomy, corticosteroids and catecholamine: structure, nomenclature and function. Renin Angiotensin System. Pineal gland, Ultimobranchial body, Corpuscles of Multihormonal regulation of calcium homeostasis.	
III	Pancreas: Anatomy and cytology, Insulin: structure, biosynthesis, regulation of insulin secretion and functions, Glucagon:structure, biosynthesis and function, Diabetes, Gonadal hormones: Male and female sex steroids: structure and functions. GI tract hormones– types and functions.	
IV	Lymphoid organs of the body, thymus, bone marrow, lymph nodes spleen, GALT, MALT, Types of immunity, Innate immunity, acquired immunity (Humoral and cell mediated immunity), Lymphoid cells (T-lymphocytes, B-lymphocytes), mononuclear cells, granulocytic cells, mast cells, basophils, dendritic cells, MHC molecules and compliments	

V	<p>Basic structure of immunoglobulins, fine structure of IgG, IgM, IgA, IgE, monoclonal antibodies, parasite antigen. Antigen antibody interactions: Strength of antigen-antibody interactions, cross reactivity, precipitation reaction, agglutination reaction. Hypersensitivity, Autoimmunity, Transplantation, Immunodeficiency diseases, Passive immunization active immunization, Vaccines, designing of vaccines for active immunization, whole organism vaccines, recombinant vector vaccines. DNA vaccines, synthetic vaccines.</p>
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Recommended Books :

1. Vertebrate Endocrinology by Norris (Lea and Febigar)
2. Basic & Clinical Endocrinology by Greenspan and Strewler
3. Essentials of Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing
4. Kuby Immunology by Glodsy, Kindt and Osborne
5. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing
6. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing
7. Hadley: Endocrinology, Prentice hall. International Edition. 2000
8. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995
9. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984
10. Larson: Williams Text Book of Endocrinology, 10th edition. W. B. Saunders Company, Philadelphia.

- Numerical related to deviation of Monohybrid and Dihybrid ratio.
- Numerical related to H & W law.
- Barr's Body, Karyotype, Idiotype
- Chromosome banding Pattern.
- Study of (case) of Genetic disorders- Demonstration.
- Pedigree analysis by chart / demonstration
- **Biostatistics-** Histogram, Bar chart, Pie diagram, Central tendency, standard deviation Chi square test, t-test,
- **Bio informatics-** BLAST, FASTA, Protein Data base, primer designing for gene amplification
 - Genomic annotation, using ORF (open reading Frame), construction of phylogenetic Tree, Software to study Protein structure.
- **Physiology-**
 - Histological slides – Pituitary, Thyroid, Parathyroid, Adrenal glands, Kidney, CNS, arteries, veins, Liver, Pancreas, Testes, Ovary.
 - RBC, WBC Count, Bleeding time, Clotting time,
 - Hb %, Haemin Crystals, ESR, Blood group determining test
 - B.P., Muscle twitch, Knee jerk, Reflex action
- **Biochemistry-**
 - Osmosis. pH, Buffers, Biochemistry test related to carbohydrate Protein lipid, Nucleic acid
 - Project report lab related to Bioinformatics and Biochemistry.

Marks Distribution-

• Genetics	1-Numerical	15
• Bio Stat	Numerical	15
• Bioinformatics	(Exp.)	10
<u>Experiments</u>		
• Physiology-2/Endocrinology		10
• Bio chemistry -2		10
• Spotting		10
• Field/ Project report		10
• Viva		10
• Record		10

Programme/Class:	Year: Second	Semester: Third
Subject: Zoology		
Course code:0927801	Course Title: Diversity of chordates	
<p>Course outcome: The course will enable the students to understand the evolutionary history and relationship between the different classes of chordates. It will also help them to understand the significance of the differences in their habits, habitats, their distribution and physiological systems.</p> <p>By studying histology the students will be able to understand and describe the normal structure and function of various cell types, tissues and organs and to differentiate their histological structures from each other.</p>		
Credits: 4	Core	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Protochordata: Origin and evolution of chordates, General Organization & Affinities b) Vertebrate ancestry: Introduction, origin and evolution of vertebrates. c) General and comparative account of integumentary, Cranial nerves and urinogenital system	
II	a) Fish: General Organization and classification ,Affinities of Ostracoderm and Coelacanthiformes, parental care and migration. b) Amphibia: General Organization and classification ,Parental Care, Neoteny and paedogenesis	
III	Reptiles: General Organization and classification, Temporal region in reptiles and its role in the classification, Adaptive radiation in reptiles, General Organization of Chelonia.	
IV	Birds: General Organization and classification, Flight Adaptations, Migration and Territorial Behaviour in birds, birds are glorified reptiles.	
V	Mammals: General Organization and classification a) Organization & Affinities of Prototheria, b) Organisation and affinities of metatheria c) Organisation and adaptation of aquatic mammals d) Dentition in mammals	

Recommended Books:

1. Colbert, E. H., Morales, M. and Minkoff, E. C. Colbert's Evolution of the Vertebrates: A history of the backboned animals through time, 5th edition, John Wiley - Liss, Inc., New York, 2002. (29)
2. H.H.Newman: The phylum chordata
3. Harvey et al.: The Vertebrate Life(2006)
4. Kotpal, R. L. The Birds, 4th edition, Rastogi Publications, Shivaji Road, Meerut, 1999.
5. Marshall, A. J., Biology and Comparative Physiology of Birds, Volume I & II, 1960.
6. Parker, T. S. and Haswell, W. A., TextBook of Zoology, Vol. II, ELBS, 1978.
7. Romer, A. S. and Parsons, T. S., The vertebrate body, 6th edition, CBS Publishing Japan Ltd, 1986.
8. Sinha, A. K., Adhikari, S. and Ganguli, B. B.: Biology of Animals, Vol. II, New Central Book Agency, Calcutta, 1988.
9. Young, J. Z. The life of vertebrates, 3rd edition, ELBS with Oxford University Press, 1981.

Programme/Class:	Year: Second	Semester: Third
Subject: Zoology		
Course code: 0927802	Course Title: Developmental Biology	
Course outcome:		
Course Objectives: The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the historical background along with progressive development of various theories, the patterns and process of embryonic development, body plan, fate map, induction, competence for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences and a unique feature of it. The students will be able to understand the process and causes of aging along with various teratogenic agents.		
Credits: 4	Core	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Introduction -History background and theories of development, theory of preformation, epigenetic theory, theory of pangenesis, recapitulation theory, germplasm theory, mosaic theory, regulated theory, gradient theory and theory of organizers. b) Basic concepts of development: Potency, commitment, specification, induction, competence, determination.	
II	a) Production of gametes, fertilization, post fertilization changes. b) Cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.	
III	a) Axis and pattern formation in Drosophila, amphibia and chick; b) induction, regeneration and keratogenesis	
IV	a) Origin of anterior- posterior axis and dorsal-ventral polarity in Drosophila HOX genes in vertebrates. b) Metamorphosis in insects and amphibians, biochemical and morphological metamorphic changes and hormonal control of metamorphosis.	
V	a) Concepts of aging b) Abnormal development i. Teratology-Causes of abnormal development. therapeutic drugs as teratogens, drug testing, experimental teratology. ii. Assisted reproductive technology, PCOD, cervical cancer, application of cryopreservation in gametes and embryos.	

Recommended Books :

1. Balinsky: An introduction to Embryology (5th ed 1981, Saunders)
2. Gilbert: Developmental Biology (8th ed 2006, Sinauers)
3. P.S.Verma and V.K.Agarwal: Developmental Biology
4. Philip Grant: Developmental Biology
5. Kalthoff: Analysis of Biological development (1996, McGraw)
6. Wolpert: Principles of Development (3rd ed 2007, Oxford)

Programme/Class:	Year: Second	Semester: Third
Subject: Zoology		
Course code: 0927803	Course Title: Environment, wild life and biodiversity	
Course outcome: The primary aim of course will be to provide a broad framework for understanding the delicate relationship between the humans and their environment. It will also prepare the students for careers and environmental stewardship through experimental curricular and co- curricular activities.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	<ul style="list-style-type: none"> a) The Environment: Physical environment; biotic environment; biotic and abiotic interactions. b) Habitat ecology: Concept of habitat, aquatic and terrestrial, c) Biogeography: Major terrestrial biomes: theory of island biogeography; biogeographical zones of India. 	
II	<ul style="list-style-type: none"> a) Population ecology: Characteristics of a population; population dynamics, population regulation: life history strategies (r and K selection): concept of metapopulation-demes and dispersal. interdemic extinctions. age structured populations. b) Species interactions: Types of interactions, interspecific competition, herbivory. carnivory, pollination, symbiosis. c) Community ecology: Nature of communities; community structure diversity, complexity and stability, levels of species diversity and diversity index ; edges and ecotones. 	
III	<ul style="list-style-type: none"> a) Ecosystem: Structure and function: energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest. grassland) and aquatic (fresh water, marine, estuarine). b) niche; niche width and overlap: fundamental and realized niche: resource partitioning; character displacement c) Ecological succession: Pattern, Types and mechanism of succession; concept of climax. 	
IV	<ul style="list-style-type: none"> a) Applied ecology: Environmental pollution; global environmental change; biodiversity status and threats to biodiversity, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. b) Conservation biology: Principles of conservation, Sustainable development, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). 	

<p>V</p>	<p>a) Concept of sustainability and sustainable development with judicious use of land water and forest resource. Conservation of biodiversity In-situ and ex-situ conservation of biodiversity</p> <p>b) Environment laws and act, wildlife protection act, forest conservation act, Montreal and Kyoto protocol.</p> <p>c) Remote sensing and prospects of remote sensing in India, Geoinformatics and GPS technology.</p>	
	<p>Books Recommended</p> <ol style="list-style-type: none"> 1) Odum : Fundamentals of Ecology (Saunders, 1971) 2) Odum : Basic Ecology (Saunders, 1985) 3) A.K.De: Environmental Chemistry 4) B.K.Sharma: Environment Chemistry 5) R.K.Sharma: Environmental Chemistry 6) Turk and Turk : Environmntal Science (4rth ed. Saunders, 1993) 7) Primark : A Primer of Conservation Biology (2nd ed. Sinauer Associates) 8) Calabrese : Pollutants and High-Risk Groups (John Wiley,1978) 9) Raven, Berg, Johnson : Environment (Saunders College Publishing, 1993) 10) P.D.Sharma : Ecology and Environment (Rastogi Publication, 7th ed. 2000)(55) 11) Cunningham and Saigo : Environmental Science (McGraw Hill Boston, 5th ed., 1999) 12) Kormondy: Concepts of Ecology 13) Ricklefs and Miller : Ecology (Freeman and Company, New York, 4th ed., 2000) 14) A.K.Verma: A handbook of Zoology 	

Programme/Class:	Year: Second	Semester: Third
Subject: Zoology		
Course code: 0827804	Course Title: Animal biotechnology	
Course Outcomes- The course has been designed so as to enable the students to understand the principles and practices of biotechnology. It will also provide broad training in technical skills in methods of biotechnology. It will help in producing responsible biotechnologists that can work within the interdisciplinary framework of biotechnology and other related biological fields.		
Credits: 4	Elective	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	Introduction Concept and scope of biotechnology, Tools and techniques in biotechnology. Cell culture media (natural and defined), Preparation and sterilization, Primary cell culture, Cell lines, Pluripotent stem cells, Cryopreservation of cultures.	
II	Molecular Techniques in Gene manipulation Introduction to the concept of Recombinant DNA Technology, Cloning vectors, Restriction and modifying enzymes, Transformation techniques (microbial, plants and animals), Construction and screening of DNA libraries, Molecular analysis of DNA, RNA and Proteins. Microarray, chromosome walking, Cre lox system, CRISPR-CAS technology.	
III	Transgenic Animal Technology Production of transgenic animals-nuclear transplantation, Retroviral method, DNA microinjection method, Applications of transgenic mice, sheep, goat, pig, birds and fish, Dolly and Polly, Scientific significance, Therapeutic applications, Human cloning, Ethical issues of transgenic animals.	
IV	Applications of Biotechnology Molecular diagnosis of genetic diseases (Cystic fibrosis, Huntington's disease, Sickle cell anemia), RFLP, RAPD and DNA fingerprinting, Vaccines and therapeutic agents, Recombinant DNA in medicines (recombinant insulin and human growth hormone), Gene therapy, Heterologous protein production, Bioremediation.	
V	Industrial Biotechnology: Industrial-Scale Fermentation, bioreactors and its types, Bioreactors for Cell Culture, Enzymes in detergents and leather industries, Intellectual property rights, Biosafety levels and guidelines.	

Recommended Books :

1. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
2. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
3. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.
4. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M., (1983) Recombinant DNA. II Edition. Freeman and Co., N.Y., USA.
5. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
6. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California, USA.
7. Primrose and R.M. Twyman, Principles of gene manipulation and genomics.

Programme/Class:	Year: Second	Semester: Third
Subject: Zoology		
Course code: 0927805	Course Title: Animal Behaviour	
Course outcome: Behaviour is the link between the organisms and environment and between the nervous system and the ecosystem. Behaviour is that part of an organism by which it interacts with its environment. The students will acquire the knowledge of key concepts and principles and themes in animal behaviour and will acquire the credentials for employment in fields related to it.		
Credits: 4	Elective	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	Introduction to ethology, evolutionary approach to Animal behaviour, Complex behaviour: Instinct and learning, Innate releasing mechanisms (IRMs): key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM. Fixed action pattern & its characteristics Mimicry, mimetic releaser and code breakers	
II	Mechanism of behaviour: Neural control of behaviour, sensory processes and perception. Mechanism of orientation: primary and secondary orientation; kinesis and taxis. Learning and cognition: habituation, classical conditioning, operant conditioning, latent learning, social learning, Homeostasis and behaviour: motivational system and their physiological basis, Hormonal regulation of behaviours, animal communication(Bird Song), habitat selection and optimality in foraging	
III	Parental care and mating systems: parental manipulation, evolutionarily stable strategy, cost benefit analysis of parental care. Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice), infanticide, sperm competition, mate guarding, consequences of mate choice for female fitness, monogamous verses polygamous sexual conflict.	
IV	Altruism, reciprocal altruism, group selection, kin selection and inclusive fitness. An over view of Sociality in animal systems. Social organization in insects, Cooperation and conflict in animals.	
V	Clocks, Rhythms & Calendar, types: Ultradian, circadian and circannual rhythms, Rhythms characteristics, organisation of circadian system in multi cellular organisms, anatomy of circadian clock, migration, orientation & navigation of birds.	

Recommended Books:

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1. An Introduction to Animal Behaviour (6th Edition). Aubrey Manning and Marian Stamp Dawkins, Cambridge University Press.
2. Animal Behaviour (11th Edition). Dustin R. Rubenstein and John Alcock, Sinauer Associate Inc., USA, 2018.
3. Neuroscience of Emotion: A New Synthesis. Ralph Adolphs and David J. Anderson, Princeton University Press, 2018.
4. Animal Behaviour: Psychobiology, Ethology and Evolution David McFarland.
5. *Animal Behaviour* (Ethology) by Agrawal V.K, S. Chand publication.
6. Animal Behaviour: Psychobiology, Ethology and Evolution

- **Virtual Dissection**
- **Major Dissection-**
 - Cranial Nerves of Scoliodon and Frog, Efferent and afferent Blood vessel of Scoliodon
- **Minor Dissection** – Wheel organ and oral hood of Amphioxus, Afferent blood vessel, ampulla of
 - lorenzini, Internal ear, hyoid apparatus, columella auris (Frog)
 - Museum specimens and slides of various chordate classes
- **Comparative osteology-** Amphibia, reptiles, Aves and mammals (Articulated & Disarticulated)
 - bones Skull, vertebrae, limbs and Girdles)
- **Mounting** – amphioxus whole mount, oral hood, vestibule, Ciona, Scales of Fish, feathers of birds, smooth and skeletal muscle.
- **Histological Techniques** –
 - Fixation, Dehydration, clearing, Embedding ,microtomy, staining.
 - Embryology- Preparation of chick embryo- (primitive streak and different embryonic stages slides)
 - Frog- Preparation and slides Blastula, Gastrula,
- **Ecology-** pH, TDS, EC, Hardness, DO, soil Moisture, Detection of soil, Aquatic Fauna, pelagic,
 - Benthic, Population dynamics, community, Ecological energetics
- **Pollution-** AIR pollution, water pollution, Periodic monitoring of surrounding and its data analysis
 - Field visit to Sewage treatment plant, National Parks, Biosphere reserves, Zoo, Botanical gardens and prepare reports.
- Behaviour- Fixed action pattern, Taxes (Chemo, thigmo, thermos, photo)
- Social behaviour- Honey Bee, Ants and Termites
- Territorial Behaviour- Primates
- Demonstration of Photoperiodic clock.
- Recording of body temp. (15/30 days periodic)
- Demonstration of assay on circadian rhythm using animal model system.
- Field visit

Marks Distribution

• Major Dissection	:	10
• Minor Dissection	:	05
• Mounting	:	05
• Microtomy	:	10 (4+3+3) (section cutting,, stretching and staining)
• Spotting	:	1x10 (4+4+2) Slides, specimens, Bones
• Embryology	:	$(2\frac{1}{2} \times 2) = 5 \times 2$
• Ecology	:	5x2=10
• Behaviour/Biotechnology	:	5x2=10
• Collection / Field report	:	10
• Viva	:	10
• Record	:	10

ELECTIVE COURSES: ANY ONE OF THE FOUR

Programme/Class:	Year: Second	Semester: FOURTH GROUP-A PARASITOLOGY
Subject: Zoology ElectiveXIIIA		
Course code: 1027801	Course Title: Biology Of Parasite-I	
Course outcome: The course will give ample space to understand the various types of interactions of parasites with their hosts and their life cycle especially of protozoan and helminths. As prevention and treatment of various infectious diseases require a clear understanding of the molecular relation between parasites and their hosts ,so detailed description of host parasite relation is incorporated in the course material.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Animal Associations & Categories: Introduction. Basic Principles & Concepts. Symbiosis. Parasitism. Commensalisms. Types of Parasites. b) Parasitic Adaptation: Evolution of Parasitism. Fate of Parasite. Adaptation to Parasitism.	
II	a) Host Parasite Relationship: Host specificity (I Ectoparasite: i. Larval stages parasitic & adult free living. ii. Adult parasitic & larval stages free living. iii. Both larva & adult parasitic). b) (II Endoparasite: i. Larval stages parasitic & adult free living: ii. Adult parasitic & larval stages free living). Action of Parasite upon their Hosts c) (Effects of parasites upon Invertebrates. Effects of parasites upon Vertebrates).	
III	a) Parasitic Protozoa: Introduction, General Classification, Trypanosoma gambiense. Leishmania donovani.	
IV	a) Trematoda: Introduction, General Classification, Types of Trematodes, Larval forms. b) Trematoda: Paragonimus westeramani c) Trematoda: Blood flukes (Schistosoma haematobium, S. mansoni & S.japonicum)	
V	a) Cestoda: Introduction, General Classification. b) Cestoda: Larval forms. c) Cestoda: Echinococcus granulosus, Hymenolepis nana & H. diminuta	

Recommended Books :

1. Biochemical Adaptation in Parasites by C Bryant & C Behm. Publisher: Chapman & Hall, NY
2. Biology of Echinococcus and Hydatid Disease by RCA Thompson. Publisher : George Allen & Unwin, London
3. Biology of Eucestoda by C Armes & PW Pappas. Publisher : Academic Press London
4. General Parasitology by TC Cheng. Publisher Orlando : Academic Press
5. Handbook of Medical Protozoology by CA Hoare. Publisher : Bailliere, Tyndall & Cox, London
6. Perspective in Trypanosomiasis Research by JR Barker. Publisher: John Wiley, UK
7. Systema Helminthum I: Digenetic Trematodes by S Yamaguti. Publisher : Interscience Publishing Co., NY
8. Systema Helminthum II: The Cestodes of Vertebrates by S Yamaguti. Publisher : Interscience Publishing Co., NY
9. Systema Helminthum IV: Monogenea & Aspidogastrea by S Yamaguti. Publisher : Interscience Publishing Co., NY
10. The Biology of Trematoda by DA Erasmus. Publisher : Edward-Arnold, London 11. The Biology of Trypanosoma & Leishmania by DH Moleneux & RW Ashford. Publisher : Taylor & Francis,

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code: 1027802	Course Title: Biology Of Parasite-II	
Course outcome: The course will offer an overview of the biological and epidemiological bases of important parasites, their ecology, life history, biochemistry and pathology. The main emphasis will be on the nematode parasites and important arthropodan pests.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) General Organization, Classification & General Pattern of life cycle of Nematodes (animals, plant parasitic & Entomopathogenic), Parasitic Adaptation. b) Introductory Nematology: Introduction, General Morphology, Economic importance, Types of Plant nematodes, Host Range, Biology	
II	a) Family-Strongyloidae: Strongyloides stercorales b) Family-Ancylostomatidae: Ancylostoma duodenale; c) Family - Filaridae: Wuchereria bancrofti.	
III	a) Techniques in Nematology: Methods of sampling (soil & plant samples), Methods of extracting nematodes from soil & plant samples, Methods of processing nematodes for observation. b) Plant Nematode Relationship: Host parasite relationship. Mechanism involved in injury & histopathology of infected tissue. Interaction with other microorganism. c) Brief Structure. Life Cycle. Epidemiology. Pathogenecity and Control of Root knot & Cyst Nematodes.	
IV	a) Acanthocephala - General Organization and Classification	
V	a) Medically Important Insects: Arthropods and vectors of human diseases (mosquitoes. lice. flies and ticks); Mode of transmission of pathogens by vectors. Chemical, biological and environmental control of anthropoid vectors. b) Insects carrying Vesication. Urtrication and Venomenization	

Recommended Books:

1. Handbook of Parasitology by AK Awasthi and BD Patnaik. Publisher : Dominant Publishers & Distributors India
2. Veterinary Parasitology by MA Taylor and R. L. Coop & RL Wall. Publisher : John Wiley & Sons, USA
3. Modern Parasitology: A Textbook of Parasitology by FEG Cox. Publisher : John Wiley & Sons, USA
4. Arthropod Borne Diseases by Carlos Brisola Marcondes (ed.). Publisher : Springer 5. Tylenchida: Parasites of Plants and Insects by Mohammad Rafiq Siddiqi. Publisher : CABI Publishing, UK
5. Imm's General Textbook of Entomology by OW Richard & RG Davies. Publisher : Chapman & Hall, London
6. An Ecological Approach to Acanthocephalan Physiology by DWT Crompton. Publisher : Cambridge University Press
7. Nematode Parasites of Domestic Animals and man by Norman D Levine. Publisher : Burgess Publishing Co., London
8. Plant Nematology: , 2nd Edition by Roland N Perry, Maurice Moens. Publisher: CABI
9. Entomopathogenic Nematology by Randy Gaugler. Publisher: CABI

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code: 1027803	Course Title: Physiology And Biochemistry Of Parasites	
Course outcome: The course material will provide a deep insight into the various physiological and biochemical aspects of parasites and will help them to pursue research in parasitology.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Nutrition -Uptake and digestion in protozoa. trematoda, cestoda and nematode Metabolism- Carbohydrate, metabolism and energy. b) Parasitic reproduction - Asexual, sexual, reproduction. synchronization of parasite with host reproduction. in vitro cultivation of parasites. c) Nucleic acids in parasites - Composition. synthesis and catabolism.	
II	a) Parasitic reproduction -Asexual. sexual. reproduction. synchronization of parasite with host reproduction. in vitro cultivation of parasites. b) Egg shell -Formation in helminthes. chemistry of egg shell formation. role of mehli's glands	
III	a) Excretion - Nitrogen excretion and water and ionic regulation in parasites	
IV	a) Parasite transmission -Mechanim of host selection. penetration and circadian rhythm. b) Ecology of parasitism -How parasite find their host. host selection and its consequences. negative interaction. problems of escape and dispersal. problem of mate finding, niche biology, population dynamics c) Growth and establishment of parasite - Hatching, establishment, site selection, migration.	
V	a) Nervous system and sense organs - Morphology of nervous system and sense organs. nervous transmission and neurosecretion and behavioral coordination	

Recommended Books:

1. Advances in Parasitology by B Dawes. Publisher: Academic Press, NY
2. Biochemical Parasitology by G Cooms & M North. Publisher : Taylor & Francis, London
3. Biochemistry and Molecular Biology of Parasite by JJ Marr & M Muller. Publisher: Academic Press, NY
4. Biochemistry of Parasites by Th Von Brand. Publisher : Academic Press NY 5. Chemical Physiology of Endoparasitic Animals by Th Von Brand. Publisher : Academic press, NY
5. Digestive System Physiology by PA Sanford. Publisher : Edward-Arnold, London
6. Physiology of Gastrointestinal Tract by LR Jonston. Publisher : Raven Press NY
7. Physiology of Parasite by Leslie H. Chappell. Publisher: Springer US
8. The Physiology & Biochemistry of Cestodes by JD Smyth & DP McManus. Publisher : Cambridge University Press.
9. The Physiology of Trematodes by JD Smyth & DW Halton. Publisher: Cambridge University Press.

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code: 1027804	Course Title: Immunoparasitology	
Course outcome: The science of immunology will give an opportunity to understand important concepts of immunology along with their applications in various biological fields. The process of immunisations or vaccinations has emerged as very strong line of treatment next to chemotherapy against many viral and communicable diseases .So ample space is given related to vaccines and vaccinations .		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Introduction: Early theories of immunity, historical prospective, recognition, kinds of immunity, normal immune response. b) An overview of immune system: Innate immunity, acquired immunity (Humoral & cell mediated immunity) c) Cells of immune system: Lymphoid cells (T-lymphocytes, B-lymphocytes), null cells, mononuclear cells, granulocytic cells. mast cells, basophils, dendritic cells, MHC molecules and compliments.	
II	a) Immune system: Lymphoid organs of the body, thymus, bone marrow, lymph nodes spleen, GALT. MALT. CALT b) Immunoglobulin: Basic structure of immunoglobulin, fine structure of IgG, IgM. IgA, IgE, monoclonal antibodies, parasite antigen. c) Antigen antibody interactions: Strength of antigen-antibody interactions, cross reactivity. precipitation reaction, agglutination reaction.	
III	a) Immunobiology of Protozoans: Malaria (Host response against Plasmodium infection, design of malaria vaccine). African sleeping sickness.	
IV	a) Immunobiology of trematodes: General considerations, immunological problems of trematode infection. immunological response against trematode infection. Schistosomiasis, fascioliasis. immunodiagnosis of trematodes.	
V	a) Immunobiology of cestodes: General consideration, immunity to adult cestodes. immunity to travel cestodes, imuno-diagnosis. b) Vaccines: Passive immunization active immunization, designing of vaccines for active immunization, whole organism vaccines, recombinant vector vaccines. DNA vaccines, synthetic vaccines.	

Recommended Books:

1. Fundamental of Immunology by William E. Paul. Publisher: Lippincott Williams & Wilkins
2. How helminthes alter immunity to infection by William Horsnell. Publisher: Springer
3. How the Immune System Works 4th Edition by L Sompayrac. Publisher : Willey Blackwell.
4. Immunoparasitology by Phillip Scott. Publisher: Blackwell Munksgaard
5. Immunity to Parasites: How Animal Controls Infections by D Wakelin Publisher : Edward Arnold, London
6. Immunoparasitology by André R.G. Capron. Publisher: Saunders, Philadelphia
7. In vitro cultivation of Parasitic Helminths by JD Smyth. Publisher : CRC Press, Boca Raton, USA
8. Introductory Immunology by Jeffrey K. Actor. Publisher: Academic Press
9. Malaria Immunology by P Perlmann & M Troye-Blomberg. Publisher: Karger
10. Parasite Antigens in Protection, Diagnosis and Escape by R.M.E. Parkhouse. Publisher: Springer Science & Business Media

GROUP A: PARASITOLOGY H-862 P

Course XIII A: Biology of Parasites – I (Protozoa, Trematoda and Cestoda)- H-4062

Course XIV A: Biology of Parasite – II (Nematoda and Arthropoda)- H-4063 Course

XV A: Physiology and Biochemistry of Parasites- H-4064

Course XVI A: Immunoparasitology- H-4065

Practical based on above

Practical class/field visit record file evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners.

1. Biology of Parasites – I (Protozoa, Trematoda and Cestoda)
2. Biology of Parasite – II (Nematoda and Arthropoda)
3. Physiology and Biochemistry of Parasites
4. Immunoparasitology
5. Field visit report and collection etc.

Marks Distribution

Duration: 5 hrs

M.M.: 100 Marks

- | | |
|---|-----------------|
| 1. Host examination (01) | 15 Marks |
| 2. Lymphoid organs of host (01) | 10 Marks |
| 3. Mounting(01) | 05 Marks |
| 4. Numerical exercise on Population Dynamics (01) | 05 Marks |
| 5. Spotting (1-10) | 20 Marks |
| Specimens: (04) | |
| Prepared Slides: (02) | |
| 6. Microtomy- Histological study | 10 Marks |
| a. Sectioning and stretching of tissues (02) | 5 Marks |
| b. Staining of pre-stretched tissue (02) | 5 Marks |
| 7. Field Visit/Collection/Ornamental fish management | 15 Marks |
| a. Visit report of laboratory /institute | 5 Marks |
| b. Collection & preservation of parasites | 5 Marks |
| c. Parasitology museum/laboratory setting and maintenance | 5 Marks |
| 8. Viva-voce | 10 Marks |
| 9. Practical Class Record | 10 Marks |

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology	Elective	
Course code:1027805	Course Title:Group-B Fish and Fisheries General Fish Biology	
Course outcome: Fishes form almost half the total number of vertebrates .The general objective of the course is to acknowledge the students with the great diversity of fish fauna in their body, forms, cales, fins, along with their classification schemes and migratory patterns. The students will learn the zoogeographical distribution of much diverse fish fauna along with different methods of identification of local fishes. They will also able to understand the various biological aspects of fish fauna.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Classification of fishes - Special emphasis on Berg's and Nelson scheme. b) Origin, diversity and distribution - Evolution of major groups of fishes, evolutionary strategies and morphological innovations, biogeographical distribution, Local fish fauna, fish identification, fish barcoding	
II	a) Fish morphology -Types of fish scales and fins, body forms and shapes, origin of paired and unpaired fins. Modifications and functions of fins b) Integument and exoskeleton - Fish scales and types.	
III	a) Locomotion in fishes – Locomotor` muscles. red and white muscle types. organization of myonemes, types of swimming and hydromechanics of propulsion. significance of swimbladder in swimming b) Migration in fishes - Types of migration, courses of migration. Homing, territorial recognition and schooling	
IV	a) Biological significance of endoskeleton and musculature -Vertebral column, types of jaw suspension in fishes, structure arrangement and homology of Weberian ossicles, lateral musculature and respiratory musculature b) Coloration in fishes - Chromatophores, types of chromatophores, morphological. physiological and biological significance of coloration in fishes.	
V	a) Adaptations in fishes -Deep sea adaptations, cave adaptations. hill stream fishes, freezing avoidance, symbiosis and parasitism. b) Fish venoms - Poisonous fishes. venom apparatus, pharmacology & toxicology of fish venoms	
	Recommended Books : 1. Leo.S.Berg Classification of fishes (fossilized & Recent) 2. C.B.LShrivastava, Fish Biology. 3. K.S.Mishra: An aid to classification of Fishes. 4. B.Qurashi: Identification of fishes. 5. A.J.K.Mainan: Identification of fishes.	

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code: 1027806	Course Title: Morphology and Physiology of fishes	
Course outcome: The students will be able to understand the various physiological aspects of fish viz. nutrition, blood vascular system, excretion and osmoregulation, respiration and reproduction. The in-depth knowledge of physiology equips the students for the propagation of fish with a better understanding. The students will also able to understand the breeding and reproductive behavior of major Indian Carps and in due course of time it will help them in selection of the proper fish.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	<p>a) Digestive System-Food, feeding habits, alimentary canal (modifications in relation to food and feeding habits in fishes), physiology of digestion</p> <p>b) Blood Vascular system- Heart and aortic arches, Blood, tissue fluids and blood forming organs, Hemodynamics and cardiac output.</p>	
II	<p>a) Respiratory System-Structure and function of gills, Mechanism of respiration(Counter current principle and water flow across the gills) , fish blood as gas carrier, water and ion transport across the gill</p> <p>b) Air breathing in fishes - Causes. Physiological adaptations in air breathing fishes, accessory respiratory organs, morphology & function of pseudobranch</p>	
III	<p>a) Excretion and osmoregulation- Structure and function of the kidney, osmoregulatory and excretory organs. excretory products, endocrine control of excretion and osmoregulation</p> <p>b) Nervous system & sense organs – Brain and Spinal cord. Cranial and spinal nerves autonomic nervous system, supporting tissues of CNS and sense organs in fishes</p> <p>c) Reproduction & development - Types of reproduction. Reproductive system , reproductive cycles, breeding season and spawning of Indian fish fauna, parental care and development</p>	
IV	<p>a) Endocrine glands in fishes - Pituitary. thyroid, gonads, adrenal. Corpuscles of stannous, pancreas, ultimobranchial gland</p> <p>b) Immune system- cells and tissues of the fish immune system,</p>	
V	<p>a) Electric organs in fishes-Types of electric fishes, origin, structure and function of electric organs. location of electric organs, evolution of electro-receptors and electric organs</p> <p>b) Luminescent organs in fishes-Location, structure and control of luminescent organs, physiological and biological significance of luminescence.</p>	

Recommended Books

1. Anthony P. Farrell, E.D. Stevens, J.J. Cech & J.G. Richards (Eds): Encyclopedia of Fish Physiology. 2011. Academic Press, UK.
2. W.S. Hoar and D.J. Randall (Series Eds): Fish Physiology. (Series) Academic Press, UK.
3. Evans, D. H. and Claiborne, J. D., Taylor and Francis Group: The Physiology of Fishes. 2013. CRC Press, UK.

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code:1027807	Course Title: FISH CULTURE	
<p>Course outcome: This paper will acquaint the students of fisheries with the various culture practices being practiced in different parts of the country along with the in-depth knowledge of various types of invaluable fisheries in India. The in-depth knowledge of physiology equips the students for the propagation of fish with a better understanding. The students will also be able to understand the breeding and reproductive behavior of major Indian Carps and in due course of time it will help them in selection of the proper fish.</p>		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Introduction & history of fishery science- Inland, marine. capture and culture fisheries. Indian fisheries. World fisheries. b) Cultivation of fish - Fresh water fish culture in India, culture of Indian major carps (Rohu Catla & Mrigal) exotic carps (Common carp. Grass carp. Silver carp). Composite fish Culture.. Aquaponics and fish farming	
II	a) Riverine fisheries -important river systems and their hydrological conditions, flora and fauna with special reference to fisheries b) Reservoir fisheries - Ecology of lakes and reservoirs, Dams and their effect on fish migration and remedial measures to be taken.	
III	a) Cold water and Lacustrine fisheries- ecology of hill streams, biology of important cold water fishes of India, origin of lakes and lake morphology, fisheries profile and potential of major Indian lakes. b) Marine Capture and crustacean fisheries -Common marine capture fisheries, Prawn fisheries, lobster and crab fisheries. Their present status and potential in India.	
IV	a) Ecology and Productivity -of a fresh water, pond lake and river, Distribution patterns of planktonic organisms, Adaptations of planktonic organisms to different aquatic habitats. Benthos. macrovegetation, nutrient cycle and productivity. Predator and weed fishes b) Light conditions, factors affecting light penetration, color, transparency and turbidity and its causes. Thermal stratification.	
V	a) Environment & Fish - impact of pollution on fish, ecosystem analysis- bio-indicators, biomonitoring, fish health, Effect of exotic fish on local fish fauna, b) Fishing methods - crafts, gears and nets used in India for fishing. Recent advances in fishing methods-electrical fishing, light fishing, fish finders (echosounder and sonar, remote sensing) and their uses.	
<p>Recommended Books :</p> <ol style="list-style-type: none"> 1. Francis day Vol I & II Fishes of India. 2. Gopalji Shrivastava: Indian of fishes of U.P. & Bihar. 3. W.D. Russell: Aquatic Productivity. 4. Handbook of Fisheries and Aquaculture. 2013. Indian council of Agricultural Research, ICAR, DIPA, New Delhi, India 		

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code: 1027808	Course Title: Applied Fisheries	
Course outcome: The course encompasses a wide variety of topics to enable the students to choose fisheries as their lucrative carrer. The main emphasis is on the aquaculture engineering practices and application of biotechnology in the field of aquaculture.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	<ul style="list-style-type: none"> a) Pisciculture-Objectives in south East Asia, India. b) Fish Breeding -Induced Breeding and recent advances in it. c) Aquaculture engineering-Construction and lay out of different types of hatcheries, ponds. Pond management 	
II	<ul style="list-style-type: none"> a) Fish Pathology-Symptoms. Etiology. Prophylaxis and Treatment of common diseases of cultivable fishes and their control. c) Fish Processing Technology- Methods of Preservation of fish and prawn (chilling, freezing. quick freezing, salting, drying. freeze-drying, smoking, canning), Rigor mortis in fish, fish spoilage - bacterial & chemical. d) Quality Assurance: Value Added Products (Fish Fingers, Fish Flakes. Soup. Powder). Byproducts (Fish Meal. Fish Oil, Surgical Sutures). 	
III	<ul style="list-style-type: none"> a) Length weight relationship and condition factor b) Significance of Age and growth studies; methods of age determination; methods of determining fish growth c) Characteristics of fish eggs, collection of fish eggs from natural resources 	
IV	<ul style="list-style-type: none"> a) Fish Genetics & Biotechnology :Genetic Improvement (Inbreeding & Cross Breeding). Chromosome Manipulation, Transgenic fish, Cryopreservation of fish gamets and embryo. b) Fish Nutrition & Feed Technology :Feed formulation strategies & Methods. Types of feed & their ingredients. Formulation of feed for larvae. fry, fingerlings. adults & brood stock, feeding techniques, role of probiotics in nutrition. c) Ornamental Fishes : Types of ornamental fishes, Aquarium development and its maintenance. 	

V	<p>a) Fish Transport & Marketing - Handling & Transportation of Fresh Water Fish, Wholesale and Retail markets. Fishery cooperatives.</p> <p>b) Fishery Education & Management - Objectives & function of various fishery institutes. Application of bioinformatics in fisheries Fisheries legislation for resource management and fish biodiversity conservation. EEZ, Indian Antarctic expedition and relevance to fishing. Sustainable aquaculture.</p>
<p>Recommended Books :</p> <ol style="list-style-type: none"> 1. A.J.K.Mainan : Identification of fishes 2. Arugun and Natarajan: Fresh water aquaculture 3. Arugun and Natrajan:Santanu- Coastal Aquaculture 4. B. Quarshi: Identification of fishes 5. C.B.L.Shrivastava:A text book of Fishery science and Indian fisheries 6. Francis Day Vol I&II Fishes of India 7. Gopalji Shrivastava: Identification of fishes 8. H.D.Kumar: Sustainability &Management of aquaculture & fisheries 9. H.R.Singh: Advance in fish Biodiversity 10. J.F.Nrman: An History of fishes 11. K.F.Lagler: Ictyology 12. K.S.Mishra: An aid to classification of fishes 13. Leo.S. Berg:Classification of fishes(fossilized and recent) 14. N.R. Rao: An introduction of fishes 15. R.L. Rath: Fresh water aquaculture 16. R.Sanatham: A manual of fresh water aquaculture 17. S.S.Khanna: An introduction to fishes 18. V.G.Jhingram: Fish and fisheries of India 19. W.D.Rusell: Aquatic productivity 20. The perfect aquarium: Complete guide to setting up and maintaining an aquarium 	

GROUP B: FISH & FISHERIES H-862 P Practical based on above

I. General Fish Biology

- a) Collection and identification of local fish fauna
- b) Osteology of a fresh water teleost
- c) Mounting of different types of Scales, Scale showing Lateral Line, chromatophores
- d) Museum specimens & prepared slides of fishes having special characters, economically important food fishes, aquarium Fishes and larvivores Fishes etc.
- e) Study of adaptive radiation in fishes of common/different habitat
- f) Visit to fish biology laboratory/institute
- g) Visit to fresh water/marine fish farm

II. Morphology and Physiology of fishes

- a) **Major Dissection:** Cranial Nerves of Wallago, Labeo and Mystus
- b) **Minor Dissection**
 - i. Biometry and General anatomy of any local food fish
 - ii. Accessory respiratory Organs of Clarias or Heteropneustes
 - iii. Weberian ossicle of Wallago, Labeo, Mystus
 - iv. Preparation and observation of fish Blood film for different blood constituents
 - v. Calculation of Gonado-somatic index and Gastro-somatic index
 - vi. Study of feeding habits of fishes of gut for food content
 - vii. Estimation of Muscle Protein, Serum Protein / glucose / Lipids vii. Estimation of hemoglobin in fish blood / Counting of erythrocytes/ RBC in fish blood
 - viii. Differential count of corpuscles
 - ix. Location of electric and luminescent organs in fishes
 - x. Location of endocrine glands in fishes
 - xi. Identification of stages of life cycle of fishes

III. Fish Culture

Analysis of Different parameters of soil and water and equipment used for analysis; Identification of planktons in different samples of water; Experimental culture of Phyto - and zooplanktons; Different crafts and gears and nets used in capture fisheries; Sampling equipment of water, plankton and benthic organisms

IV. Applied Fisheries

Aquarium fabrication, setting and maintenance of ornamental fishes , different diet formulations; Determination of fish fecundity, ova diameter and maturity stages of fishes; Study of length –weight relationship and condition factor of fish; Screening of gut and other organs for protozoan and helminth parasites; Determination of age with the help of scales Survey of fish resources at coastal regions/fresh water system/fish market/fish landing centers/hatcheries/fish farms/culture ponds

Practical class/field visit record file evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners.

1. General Fish Biology
2. Morphology and Physiology of fishes
3. Fish Culture and Limnology
4. Applied Fisheries
5. Field visit report and collection etc.

Marks Distribution Duration: 5 hrs M.M.: 100 Marks

1. Major Dissection (01)	10 Marks
2. Minor Dissection (01)	05 Marks
3. Mounting (01)	05 Marks
4. Water/Soil analysis (01)	05 Marks
5. Spotting (1-10)	20 Marks
Specimens: (04)	
Prepared slides(3)	
Bones (2)	
Fishing Nets and Gears: Through models (01)	
6. Identification of Local Ichthyofauna (02)	5 Marks
(1 Cyprinid & 1 Silurid)	
7. Fish Physiology/ Biochemistry (01)	05 Marks
8. Microtomy- Histological study of tissues	10 Marks
Intestine/ Liver/ Kidney/ Gills etc.	
a. Sectioning and stretching of tissues (02)	5 Marks
b. Staining of pre-stretched tissue (02)	5 Marks
9. Field Visit/Collection/Ornamental fish management	15 Marks
a. Visit report of effluent treatment plant/aquafarm/hatchery/ laboratory /institute (01)	5 Marks
b. Collection and submission of local fish fauna (specimens/amateur photographs & videos etc.)/endoskeleton of fish/scientific news reports/ Microtomy slides (stained/stretched) and blocks (Raw/trimmed) etc.	
	5 Marks
c. Aquarium fabrication, setting and maintenance	
	5 Marks
10. Viva-voce	10 Marks
11. Practical Class Record	10 Marks

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code:1027809	Course Title: Group-D Cytology And Cytogenetics Chromosomes & Genomic Organization	
Course outcome: Cytogenetics is one of the fastest growing fields in life sciences. The course will provide the ample opportunity to students for deep understanding of their genomic environment.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) Chromosomes (Ultrastructure: Nucleosome and solenoid model, nuclear scaffold) b) Molecular structure of telomeres (structure. synthesis and significance of telomere length); Kinetochore and centromere (yeast centromere, alpha-satellite DNA, other centromere sequences). c) Reassociation kinetics and "Cot" curves (chemical complexity and kinetic complexity); Sat-DNA (including in-situ hybridization) d) Molecular structure of euchromatin and heterochromatin. e) Molecular structure of an eukaryotic gene.	
II	a) Concept of totipotency vis-a-genome constancy. b) Amphibians: Serial nuclear transplants c) Developmental-significance of fluctuations in genomic DNA content (rDNA amplification)	
III	a) Chromosomal organization of genes and non-coding DNA b) Mobile DNA c) Morphological and functional elements of eukaryotic chromosomes	
IV	a) Genetic regulation of cell division in eukaryotes b) Molecular basis of cellular check points c) Molecular basis of neoplasia (cancer). Oncogenes and tumour suppressor genes. d) Conversion of proto-oncogenes into oncogenes	
V	Cytogenetics of Sex determination and sex differentiation a) Genic balance theory of sex determination (Drosophila. Lumantria and Caenorhakdnis elegans). X/A ratio, multiple numerator elements, sex linked master control genes and autosomal regulatory genes. b) Sex determination and sex differentiation in mammals (including human) c) Dosage compensation in organisms with heterogametic males d) Genetic imprinting	

Recommended Books :

1. Molecular Cell Biology, Lodish et al. Scientific American Books
2. Cell and Molecular biology De Robertis and De Robertis: Saunders College Publ
3. Molecular Biology of cell Alberts et al.: Garland Publishing, USA
4. Genetics, Strickberger : Macmillan
5. The Science of Genetics, Atherly et al.:Saunders College Publ. NY
6. Principles of Genetics, Snustad, D.P. and M. Simmons: John Wiley & Sons, NY
7. Genetics, Brooker, R.J.:Benjamin/Cummings USA
8. Genetics, Gupta P.K.: Rastogi Publ., Meerut
9. Genetics, Farnsworth: Harper & Row
10. Principles of Genetics, Gardner, E.J., M.J., Simmons & D.P. Snustad John Willey and Sons. Inc. NY

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code:1027810	Course Title: Genomic Analysis, Immunogenetics	
Course outcome: Students will gain knowledge in latest molecular cytogenetics techniques ,molecular mapping of genome along with critical aspects of genetic counselling. That will boost their chance in getting employment in genetic research labs.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	Genome analysis <ol style="list-style-type: none"> C-value paradox, detailed account of various models of prokaryotic genomes. Viral genome and eukaryotic genomes. Organization of genes in organelle genomes. Molecular analysis of genomic DNA in yeast or any other eukaryote. Transposable elements in prokaryotes and eukaryotes. Role of transposable elements in genetic regulation. Genome analysis- Microbial genomes. Drosophila. yeast. 	
II	Molecular cytogenetic techniques <ol style="list-style-type: none"> Automated Karyotyping Chromosome banding and chromosome painting Construction of a restriction map Restriction fragment length polymorphism (RFLPs) 	
III	Molecular mapping of genomes <ol style="list-style-type: none"> Choice of mapping population: Simple sequence repeat loci Southern and fluorescence in situ hybridization for genome analysis Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis. Molecular markers linked to disease genes. e. Applications of RFLP in forensics, disease diagnosis, genetic counseling. Germplasm maintenance and taxonomy. 	
IV	Immunogenetics <ol style="list-style-type: none"> Immunoglobulin gene structure Multigene organization of Ig genes Mechanisms of DNA rearrangements and generation of antibody diversity DNA rearrangements and expression of T-cell receptors. 	
V	Human genetics <ol style="list-style-type: none"> Genetic screening, prenatal diagnosis and genetic counseling Prenatal screening methods: foetal screening: newborn screening: carrier screening; pre-implantation screening History and methods of genetic counseling; need to seek genetic counseling, ethical and legal aspects 	

Recommended Books:

1. Molecular Cell Biology. J. Daenell, H. Lodish and D. Baltimore, Scientific American Book, Inc., USA
2. Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson, Garland Publishing, Inc., New York.
3. Genes, VI. Lewin, B.Oxford University Press, Oxford, New York, Tokyo. 4. Biotechnology, BD Singh
4. Biotechnology, PK Gupta
5. Recombinant DNA technology, Watson

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code: 1027811	:Human & Microbial Cytogenetics And Molecular Biology	
Course outcome: Microbes are the relative very simple system for studying genetic phenomenon and thus are very useful to other higher organisms. Microbial genetics is an important tool for understanding molecular techniques that are used to modify genes and proteins, also it provides a platform for fundamental research in diverse areas of biotechnology.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	Chromosome a) Molecular anatomy of eukaryotic chromosomes b) Metaphase chromosome. centromere, kinetochore, telomere and its maintenance c) Heterochromatin and Euchromatin d) Giant Chromosome: Polytene & Lamp brush Chromosome. Somatic cell genetics e) Heterokaryon-selecting hybrids and chromosome segregation	
II	Human cytogenetics a) Techniques in human chromosome analysis-molecular cytogenetics approach b) Numerical and structural abnormalities of human chromosome - syndromes c) Human genetics d) Cytogenetics implications and consequences of structural changes and numerical alterations of chromosomes	
III	Microbial Genetics a) Bacterial transformation, transduction, conjugation. bacterial chromosome b) Bacteriophage: Types. Structure and morphology of T4phage. morphogenesis c) Cytogenetic effects of ionizing and non-ionizing radiation d) Genetics of cell cycle and cyclin independent kinases	
IV	Molecular Biology a) DNA synthesis b) DNA replication in prokaryotic and eukaryotic cell c) Genetic code d) DNA damage and repair	

V	<p>Transcription and Translations</p> <ul style="list-style-type: none"> a) Transcription in prokaryotic and eukaryotic cell b) RNA & DNA polymorphisms c) C. Regulation of gene expression in prokaryotes and eukaryotes d) The translation machinery in prokaryotes and eukaryotes e) Post transcriptional modification in polypeptide 	
<p>Recommended Books:</p> <ol style="list-style-type: none"> 1. Cell and molecular biology: Albert 2. Cell and molecular biology: Gerald Karp 3. Cell and molecular biology: PK Gupta 4. Cell Biology – Townsend 5. Cell physiology- Grise 6. Genes VIII: Benjamin Levi's 7. Microbiology : Prescott 8. Molecular cell biology: H. Lodish, J. Daenell, and D. Baltimore 9. Principles of Microbiology: Ronald M. Atlas and Lawrence Parks 		

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code:1027812	Course Title: Advanced Cell Biology	
Course outcome: The students will be enable to understand how cell biology mechanics play an important role in cell signalling pathways. Cytology and biotechnical techniques are also included that will help them in their future research.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	Cell Biology a) Circadian rhythms in cells. i.e. from human supra chiasmatic nucleus and peripheral oscillators and cyanobacteria. b) Membrane transport, cell to cell communication and its importance c) Transmembrane proteins and receptors d) Signal transduction pathways e) Cell adhesion and cell functions, Caindependent cell-cell adhesion.Cadherins, etc.	
II	Cytogenetics and genome of pro and eukaryotes a) Hierarchy in organization of cells b) Prokaryotic and eukaryotic genome c) Regulation of gene expression	
III	Modern cytogenetics and instrumentation a) Flow cytometry b) Ageing in cells c) Necrosis and apoptosis (Programmed cell death)	
IV	Cytology of Extremophiles a) Tag polymerase production by Thermus aquaticus b) Cytology of flora and fauna of thermophilic areas like hot sulphur springs and novel genes carrying forms living in cold deserts	
V	Cytology and biotechnological techniques a) Cloning b) DNA sequencing c) FISH. GISH d) RFLP in forensics, disease diagnosis	
Recommended Books :		
1. Cell and Molecular biology De Robertis and De Robertis: Saunders College Publ 2. Cell and molecular biology, Karp Gerald 3. Cell and molecular biology, Thorpe 4. Molecular Cell Biology, Lodish et al. : Scientific American Books 5. Principles of biochemistry, Lehninger 6. The Cell, Alberts et al.: Garland Publishing, USA		

GROUP D: CYTOLOGY and CYTOGENETICS H-862 P Practical based on above Marks

Distribution Duration: 5 hrs M.M.: 100 Marks

- | | |
|--|----------|
| 1. Enumeration of the number of RBC/WBC by Hemocytometer | 10 Marks |
| Estimation of % hemoglobin by Haemometer | |
| 2. Numerical Problems from Genetics and Biostatistics (01+01) | 10 Marks |
| 3. Exercise from Bioinformatics (01) | 05 Marks |
| 4. Biochemical tests for proteins, Carbohydrates, Lipids and Enzymes | 10 Marks |
| 5. ECG, Electrophoresis of proteins, chromatography | 05 Marks |
| 6. Spotting (1-10) | 20 Marks |
| 7. Equipment and Apparatus: (04) | |
| 8. Molecular models | |
| 9. Field Visit/Collection/Laboratory management etc. | 15 Marks |
| a. Visit report of field/laboratory /institute (01) | 5 Marks |
| b. Collection of local fauna (Specimens, photographs, videos etc.)/ | 5 Marks |
| c. Laboratory setting and maintenance | 5 Marks |
| 10. Viva | 10 Marks |
| 11. Practical Class Record | 10 Marks |

Practical class/field visit record file evidences of the following to be maintained by the students and submitted at the time of practical examination for evaluation by the examiners-
1. Advanced cell biology 2. Chromosome and genomic organization 3. Genomic analysis and immunogenetics 4. Human and Microbial cytogenetics and molecular biology 5. Field visit report and collection etc.

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code: 1027813	Course Title: Morphology & Taxonomy Of Insects	
<p>Course outcome: Insect diversity society and evolution attempts to introduce students to the various orders and some of the most important families of insects so that they can distinguish between harmful and beneficial insects, which form the basis of entomology. The course emphasizes on understanding the morphological fundamentals of insects in order to understand their diversity. This is followed by understanding the unique morphological characters of the insects orders. Insect morphology has been included in the syllabus for the purpose of identification of insects particularly with species with parasitic and predatory behaviour. Students would also be introduced to the classification and evolution of these 29 orders. Understanding insect societies would empower the student to appreciate their societal implications. Besides many social insects are good candidate biocontrol agents.</p>		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a) General Principles of insect taxonomy. b) General characters, classification (up to families) & affinities of different order of Apterygota and Pterygota (Exopterygota & Endopterygota)	
II	a) Origin, evolution and distribution of insects in time and space b) Ecological dynamics, effect of biotic and abiotic factors on abundance and diversity of insects, dispersal and migration in insects c) Phylogenetic analysis; Universal tree of life; fossil history of insects	
III	Collection and preservation of insects Methods of insect collection, different methods of insect rearing. methods of insect preservation & maintenance of insect museum	
IV	Insect Integument - Structure & function of insect integument, cuticular outgrowths, colorations and modifications of integument, moulting	
V	Segmentation & body regions – a) Head- Origin, structure and modification; types of mouthparts and antennae, cranial structure: tentorium and neck sclerites, compound eye b) Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation; Legs: structure and modifications, Abdomen- segmentation and appendages	

Recommended Books:

1. Blackwelder RE. 1967. Taxonomy - A Text and Reference Book. John Wiley & Sons, New York.
2. Chapman RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.
3. David BV & Ananthkrishnan TN. 2004. General and Applied Entomology. Tata-McGraw Hill, New Delhi.
4. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
5. Kapoor VC. 1983. Theory and Practice in Animal Taxonomy. Oxford & IBH, New Delhi.
6. Mayr E. 1971. Principles of Systematic Zoology. Tata McGraw-Hill, New Delhi.
7. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10h Ed. Chapman & Hall, London.
8. Ross HH. 1974. Biological Systematics. Addison Wesley Publ. Co.
9. Snodgrass RE. 1993. Principles of Insect Morphology. Cornell Univ. Press, Ithaca.
10. Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects.

Programme/Class:		Year: Second	Semester: Fourth
Subject: Zoology			
Course code: 1027814		Course Title: Anatomy & Physiology	
Course outcome: Insect Physiology is the study of the properties, processes, and functions of insect systems. The students will become familiar with the various physiological systems operating in insects and will develop a sense of how physiology can be an important aspect in major research topics in entomology. As a component of this course we study some major biochemical molecules and their physiological actions to examine and understand the structure–function correlates within the various physiological systems functioning in insects.			
Credits: 4		Core:	
Max. Marks: (25+75)		Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):			
Unit	Topics:		
I	a) Physiology of various systems (Digestive system, respiratory system. Excretory system, circulatory system, nervous system & Sense organs)		
II	a) Musculature, adaptations in insects , wing coupling apparatus and mechanism of flight b) Effector organs (Sound producing organs & light producing organs)		
III	a) The endocrine system - Organization, structure of glands and their hormones, endocrine functions (In metamorphosis, reproduction. metabolism & osmoregulation) b) Pheromones and their glands		
IV	a) Reproductive system- Male and female reproductive organs and their endocrine control. b) Genitalia and their modifications, vitellogenesis and hermaphroditism,		
V	a) Gametogenesis, insemination, fertilization. Early embryonic and post embryonic development. b) Sex determination; dosage compensation; genetic control programs		
			Totals No. of Lectures (60)

Recommended Books:

1. Chapman RF. 1998. Insects: Structure and Function. ELBS Ed., London
2. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi
3. Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York
4. Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Assoc. for Advancement of Entomology, Trivandrum, Kerala.
5. Patnaik BD. 2002. Physiology of Insects. Dominant, New Delhi
6. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10 th Ed. Vol. 1. Structure, Physiology and Development. Chapman & Hall, New York
7. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10h Ed. Chapman & Hall, London
8. Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur
9. Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects
10. Wigglesworth VB. 1984. Insect Physiology. 8th Ed. Chapman & Hall, New York

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code:1027815	Course Title: Applied Entomology I	
Course outcome: The course indicates the biodiversity of insects in different ecosystems and various type of behaviour of insects. Insects are important for the survival of different biota on the earth. Various type of insects plant interaction will be discussed with the students.		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	a).Insect Population, Population change and factors affecting insect population. Symbiosis in relation to parasitism, commensalism and mutualism. Social adaptations in insects. Locust Phase theory- Monitoring and control measure	
II	a) Insect - plant Interaction-Theory of co-evolution. Phytophagous insects and host plant selection. Tritrophic interactions. Allelochemicals mediated interactions. Chemically mediated interactions. b) Defense mechanisms of plants against insects. Responses of insects to chemical defense. Establishment and adaptation of insect population on a plant. Insects as vectors of plant diseases.	
III	a.Systematic position, identification, distribution, host range, bionomics, nature and extent of damage, seasonal abundance and management of insect b.Pests of stored grains & forests; Pests in polyhouses and protected cultivation.	
IV	a) Types of pests ; causes that make the insect as a pest. Pest out break and global factors causing pest outbreak. b) Natural control of insect pest with reference to climatic features, natural barriers & enemies and insect diseases, Gut analyses of predators.	
V	a) History, principles and scope of chemical control; Insecticides/ Pesticides- Nature, chemistry, mode of action and their application. Insect resistance against pesticides. Biocontrol mechanism for pest control. b)Insect pheromones and their role in pest control; entomophagous aspects of Bt Cotton and Bt Brinjal	

Recommended Books:

1. Burges HD & Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London
2. Butani DK & Jotwani MG. 1984. Insects and Vegetables. Periodical Expert Book Agency, New Delhi
3. Chapman JL & Reiss MJ. 2006. Ecology: Principles & Applications. iCambridge. Ed. Cambridge Univ. Press,
4. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York
5. Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi
6. Huffaker CB & Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London
7. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York
8. Price PW. 1997. Insect Ecology. 3rd Ed. John Wiley, New York
9. Speight MR, Hunta MD & Watt AD. 2006. Ecology of Insects: Concepts and Application. Elsevier Science Publ., The Netherlands
10. Driesch & Bellows TS. Jr. 1996. Biological Control. Chapman & Hall, New York

Programme/Class:	Year: Second	Semester: Fourth
Subject: Zoology		
Course code:1027816	Course Title: Applied Entomology II	
<p>Course outcome: The course describes the interaction of nature, plants and insects in order to understand the gravity of pest problem on standing crops and harvested yields and highlights various control methods to ensure crop protection by controlling insect pests of important crops. The course describes adverse effects of pesticides and management of crop pests by an Integrated Pest Management (IPM) approach. Enough space is given to various beneficial insect keeping in view the economical necessity of the county.</p> <p>The course offers information on transmission of diseases, methods of surveillance for diseases, effective Integrated Management of Vector control and other methods of prevention of arthropod borne diseases.</p>		
Credits: 4	Core:	
Max. Marks: (25+75)	Min. Passing Marks: 40	
Total No. of Lecture-Tutorials-Practical (in hours per week):		
Unit	Topics:	Totals No. of Lectures (60)
I	<p>a) Distinguishing features of lac-insect, silk worm and honey bees- their biology, management, principles, products, agricultural and industrial importance. Genetically modified disease resistant lac-insect, silk worm and honey bees. Regulatory laws related to release of genetically modified insects into the environment</p> <p>b. Insects as pollinator and bioindicators, Biological control of weeds using insects</p>	
II	Insect pests of crops - pests of cereals (wheat, paddy, maize), fruits (mango, guava, litchi, papaya), and vegetables (brinjal, mustard, tomato, lady's finger, spinach), pests of stored grains, pests of forest.	
III	<p>Insects injurious to man and livestock -a.Life cycle, pathogenicity and control measures of insects injurious to human beings-mosquitoes, sand flies, lice, house flies etc.</p> <p>b. Life cycle, pathogenicity and control measures of insects injurious to Livestock- Black flies, Horse flies, louse flies, Horse botflies etc.</p>	
IV	<p>Insect control measures-Natural control, applied control, integrated pest management history, IPM programmes. Application of IPM to farmers' real-time situations (IPM modules of important crops), Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation</p> <p>b.Decision making areas, cost-benefit ratio, ecological sound approaches for the insect pest control different phases of pest control.</p>	
V	<p>Different types of insecticides- a) Classification of pesticides based on chemical structure, mode of entry, action, toxicity and structure activity relationship</p> <p>b.Mode of action of different types of insecticides</p> <p>c.Systematic insecticides, phytotoxicity, compatibility, antagonism and synergism</p>	

Recommended Books:

1. Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural entomology. Kalyani Publ., New Delhi
2. Flint MC & Bosch RV. 1981. Introduction to Integrated Pest Management. 1st Ed., Springer, New York
3. Horowitz AR & Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi
4. Ignacimuthu SS & Jayaraj S. 2007. Biotechnology and Insect Pest management. Elite Publ., New Delhi
5. Metcalf RL & Luckman WH. 1982. Introduction of Insect Pest management. John Wiley & Sons, New York
6. Norris RF, Caswell-Chen EP & Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi
7. Oakeshott J & Whitten MA. 1994. Molecular Approaches to Fundamental and Applied Entomology. Springer Verlag
8. Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi

I. General Insect Biology

- Insect collection and preservation for systematic studies
- Identification of different insects up to orders
- Identification of insects up to families of economically important insect orders

II. Anatomy & Physiology of Insects

- Major Dissection:
 - Nervous system of Honey bee, Wasp, Grasshopper and Beetle
 - Nervous system and alimentary canal of cockroach

III. Applied Entomology I

- Collection and identification of insects up to species: Mosquitoes, honeybees, stored grain beetles, aquatic insects, important crop and household pests

IV. Applied Entomology II

- Life cycle studies of crop pests
- Equipment and accessories for rearing of lac-insect, honey bee and silk worm

Marks Distribution

Duration: 4 hrs.

M.M.: 100 Marks

- | | |
|--|-----------------|
| 1. Major Dissection: (01) | 10 Marks |
| 2. Minor Dissection: (01) | 05 Marks |
| Sting apparatus of honey bee/ wasp. | |
| Salivary glands and mouth parts of cockroach. | |
| 3. Mounting: (01) | 05 Marks |
| Different types of mouth parts, wings, antennae and legs of insects. | |
| Malpighian tubules and Hepatic caeca from alimentary canal of cockroach. | |
| Spiracles and trachea of cockroach. | |
| 4. Spotting: (1-10) | 20 Marks |
| Museum specimens of insects with special features (04) | |
| Permanent slides of whole mounts, mouth parts, wings, antennae and legs (02) | |
| Histological slides (02) | |
| Insect collection nets & traps through models (02) | |
| 5. Taxonomic Identification: (02) | 10 Marks |
| 6. Written exercises based on theory courses | 05 Marks |
| 7. Microtomy: Histological study of tissues- Alimentary Canal, Malpighian tubules etc. | 10 Marks |
| Sectioning and stretching of tissues (Ribbon) (02) | 05 Marks |
| Staining of pre-stretched tissue (Ribbon) (02) | 05 Marks |
| 8. Field Visit/Collection/Museum & laboratory management | 15 Marks |
| 9. a. Field visit report of Insectary/Lac culture, Apiculture, Sericulture Farm/ Laboratory/ Institute (01) | 05 Marks |
| b. Collection & preservation of local insect fauna/ Microtomy blocks & slides | 05 Marks |
| c. Maintenance of museum & laboratory | 05 Marks |
| 10. Viva-voce | 10 Marks |
| 11. Practical Class records | 10 Marks |

Health and Food Nutrition

Unit. I-

- a) Basic Overview :- Definition and basic Concepts regarding Health,
- b) Epidemiology of important Diseases

Unit. II-

- a) Diseases Types : Communicable (Air borne and water borne) and Non Communicable, lifestyle diseases (hypertension, diabetes and obesity), Bacterial and viral diseases.
- b) Social health problems, smoking, alcoholism, drug dependence and AIDS.

Unit. III-

- Clinical Analysis
- Test and Assays for identification of various important diseases.

Unit. IV-

- a) Food, Nutrition, Nutrients(Micro and Macro Nutrients in diet)
- b) Diseases caused by deficiency of nutrients (vitamins deficiency, protein deficiency)

Unit. V-

- a) Food sanitation and concept of Hygiene, Natural toxicants in food, Adulteration and Food contamination.
- b) Methods of food preservation.

Recommended books-

- A textbook of clinical nutrition- Luxita Sharma
- Principles of human nutrition- Whitman H. Jordan
- Food processing and preservation- G Subbulakshmi, Shobha A Udipi, Padmini s Ghugre
- Textbook of health and hygiene- J. Saxena

MINOR ELECTIVE

Credit-4

Course code-0927850

ENVIRONMENT AND BIODIVERSITY CONSERVATION

Unit. I- Concept of Environment

1. Biosphere
2. Fundamentals features (Abiotic and biotic component)
3. Habitat Ecology

Unit. II-

1. Population, Community, Species interactions
2. Ecosystem and Energy flow

Unit. III- Biodiversity

1. Threats to biodiversity
2. Conservation strategies
3. Legislative methods of biodiversity conservation.

Unit. IV- Wildlife and its conservation

1. National Parks and sanctuaries
2. Biosphere reserves and Hotspots
3. Causes of wildlife depletion and preventive strategies

Unit. V- Toxicology

1. Bioassay and chronic toxicity
2. Features of surrounding medium to the chemical exposures
3. Different routes of exposure to toxicants

Unit. VI- Xenobiotic

1. Concepts of bio-concentration, Bioaccumulation and bio-magnification,
2. Process of bioaccumulation in the biological system.

Recommended Books-

Ecology and environment-P.D.Sharma
Fundamentals of ecology-Eugene Odum
Elements of ecology-T.M.Smith
Environmental science and conservation-J.S. SINGH

Syllabus of Pre-Ph.D. Course Work

PAPER-I

Credit-6

Course code-1127877

RESEARCH METHODOLOGY

This course is common for doctoral research students of all the subjects in science faculty.

UNIT –I

Basic principles of research, objectives of research, significance of research, types of research : basic and applied, Research process, selection and necessity of defining the research topic and problem, techniques involved in defining a problem, assessment of current status of topic chosen, literature survey and reference collection, formulation of Hypothesis, basic concepts concerning testing of hypothesis, research designs and important concepts relating to research design, different research designs (Research design in case of exploratory research studies, descriptive and diagnostic research studies and in case of hypothesis-testing research studies).

UNIT-II

The source of ethical issues in science especially in life sciences, ethical issues in science research and reporting, code of ethics, fabrication of data, the problem of plagiarism, animals, use of animals animal ethics and related laws and norms(for Zoology) Bio safety regulations in biological research .

UNIT –III

Types and sources of data, collection methods of primary and secondary data, analysis for specific type of data, tabulation and graphical representation, central tendency, dispersion, skewness, correlation, regression, Chi-square test, t and f tests, ANOVA-one-way and Two-way, important.

UNIT-IV

Meaning and techniques of interpretation, Significance of Report writing, different steps in writing Report and research papers,layout of the Research Report, types of reports, oral and written presentation of research (abstract/synopsis)mechanics of writing a Research Report, precautions for writing research reports, conclusions, Impact factor and citation index.

UNIT-V

ComputerandInternet:Networking,differentLANandWANconnections,connectiontoanetwork,webBrowsers ,InternetSecurity,WebSearchEngine,MSword,HandlingGraphics, Tables and Charts, converting a word document into various formats like-Text, rich Text, Word perfect, HTML, PDF etc. MS Power Point: creating slide show with animations, creating a blank presentation, auto layout, power point screen, screen layout and views, insert a new slide, applying design template, changing slide layout, reordering and hiding slides, slide show and editing custom slide.

Data analysis and display: facilities in MS Excel for data analysis and display, other data display software's, case study: origin, software for scientific and statistical analysis: case studies: SPSS database: creating a database

- Research Methodology methods and techniques by C.R.Kothari, second revised edition
- Research Methodology a step by step for beginners by Ranjit Kumar
- Research methodology resources. <http://edutechwiki.unige.ch/en/Research-methodology-resources>
- David B. Resnik, 1998, The ethics of Science: An introduction. Routledge publisher, USA
- Tripathi A.N., 2008, Human values. New age publishers, New Delhi
- Statistical Methods SPGupta
- Research Design,Qualitative,Quantitative and mixed methods approaches by W.C reswell, third edition
- Information Communication Technology by Tim Shortis
- Handbook of Communication and Social Interaction Skills by John O Green, Brant Raney Burles n

PAPER-II

Credit-6

Course code -1127878

ADVANCED ZOOLOGY

UNIT-I Immunology

- (a) Cells and molecules involved in immunity and immunogenicity, immune system: lymphoid organs (thymus, bone marrow, lymph node spleen); MHcomplex(HLAclass-I,HLAclass-II, HLAclass-III molecules)
- (b) Mechanism and Genetic basis of immune response and generation of antibody diversity, humoral and cell mediated immunity, Hypersensitivity-Autoimmunity-Immunodeficiency.

UNIT-II Genetic Engineering

- (a) Principles and methods of genetic engineering: application in health, agriculture and industry, primary culture; cell lines and cloning, in vitro fertilization and embryo transfer in human and Livestock, transfection methods and transgenic animals.
- (b) Recombinant DNA technology in Prokaryotes and Eukaryotes. Microarrays/ DNA CHIPS (Characteristic features, types and application of microarrays)

UNIT-III Molecular Biology

- (a) Vectors and advances in gene therapy; safety assurances; methods of DNA analysis; diagnosing infectious diseases, identifying genetic disease.
- (b) DNA fingerprinting, genetic identification, use of technology in anthropological studies.

UNIT-IV Environmental Pollution

- (a) Types of environmental health hazards, acute and chronic toxicity; Bioassay LC 50 and LD 50 values
- (b) Environmental pollution and its impact on animals- Biomagnification, biodegradation and bioremediation. Environmental impact assessment

UNIT-V Biosafety

- (a) Introduction and history, Guidelines for Bio-safety, Biosafety levels, animals in containment, Laboratory facilities and safety equipments
- (b) Functioning of Institutional Bio-safety committee, Institutional Animal Ethics Committee, and Institutional Ethical Committee, CPCSEA guidelines for Animal experimentation, DBT guidelines for Bio-safety practices.

Recommended Books -

- Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed.), Benjamin/Cumin, 1993
- Sambrook et al. Molecular cloning Vols I, II, III. CSHL (2001)1.
- Alberts et al: Molecular Biology of the Cell(4th Ed.),Garland,2002
- Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
- Cooper: Cell. A Molecular approach: ASM Press (2000)Essentials of Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing
- Kuby Immunology by Glodsy, Kindt and Osborne
- Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing
- Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing
- Odum : Basic Ecology (Saunders, 1985)
- Kormondy: Concepts of Ecology
- Ricklefs and Miller : Ecology (Freeman and Company, New York,4th ed., 2000)
- Biological Safety, Principles and Practices, 4th edition, (Fleming and Hunt)
- Laboratory Biosafety Manual, 3rd ed. (WHO)

Paper III

Credits : 6

Course code : 1127879

Biotechniques and Research Publication Ethics

Unit- I

- (a) **Microscopy**-Light microscopy, Phase contrast microscopy, Polarization microscopy, Fluorescence microscopy, Electron microscopy, Confocal microscopy, Camera Lucida
- (b) **Histological Techniques**-Fixation, dehydration, clearing, Embedding, Microtomy. Classification of stains and their mechanism of staining, cyto chemical staining

Unit-II

- (a) **Spectroscopy**-Instrumentation, applications of spectrophotometry, atomic absorption spectrophotometry, microspectro fluorimetry, Infrared resonance spectrophotometry, Matrix assisted laser desorption ionization (MALDI), NMR spectroscopy,
- (b) **Immunodiagnostic methods**- Antigen antibody reaction, Immuno precipitation, Radio immuno Assay(RIA), Enzyme Immunoassay, competitive ELISA, Indirect ELISA, Sandwich ELISA, applications of ELISA.

Unit-III

- (a) **Chromatography**- Paper chromatography, High performance liquid chromatography (HPLC), Gas liquid chromatography, Chromatofocusing
- (b) **Centrifugation, Electrophoresis and PCR**- Types and application of analytical centrifugation, electrophoresis of proteins, enzymes, nucleic acids, Southern, Northern & Western blotting, standard PCR technique and its application.

Unit –IV

- (a) **Ethics** -Definition, nature and scope, concept, branches. Intellectual property rights.
- (b) **Scientific conduct**-Ethics with respect to science and research, scientific misconduct, falsification, fabrication and plagiarism (FFP). Duplicate and overlapping publications, Salami slicing. Selective reporting and misrepresentation of data.

Unit-V

- (a) **Publication ethics-** Definition, introduction and importance. Best practices/ standards, setting initiatives and guidelines, COPE, WAME etc. Violation of publication ethics, authorship and contributorship. Use of plagiarism software like Turnitin, Urkund (Ouriginal) and other open source software tools.
- (b) **Database and research metrics-** Indexing databases, citation databases, web of science, Scopus etc.
Impact factor of journal as per Journal citation Report, SNIP, SJR, IPP, Cite score. h-index, g-index, i10 index.

Recommended Books -

Holme and Peck: Analytical Biochemistry (3rd Ed.), Tata McGraw Hill, 1998
Plumer: An Introduction to Practical Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990
R.C.Dubey and D.K.Maheshwari: A text book of Microbiology
S.V.S. Rana :Biotechniques Theory and Practice
Bird,A.(2006).*PhilosophyofScience*.Routledge.
P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978- 9387480865.
Resnik,D. B.(2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
Beall, J.(2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. <https://doi.org/10.1038/489179a>
Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482 17. [http:// www.insaindia.rcs.in/pdf/EthicsBook.pdf](http://www.insaindia.rcs.in/pdf/EthicsBook.pdf)
