

VIVEKANANDHA

**COLLEGE OF ARTS AND SCIENCES FOR WOMEN
ELAYAMPALAYAM, TIRUCHENGODE (Tk.), NAMAKKAL (Dt.).**

An ISO 9001: 2015 Certified Institution

(Affiliated to Periyar University, Approved by AICTE, recognized u/s 2 (f) & 12 (B) & Re-accredited
with 'A+' by NAAC)

Recognized under section 2(f) and 12(B) of UGC Act, 1956

An ISO 9001:2015 (Certificate Institution)



DEPARTMENT OF ZOOLOGY

M.Sc., ZOOLOGY

SYLLABUS AND REGULATIONS

Academic Year – 2024-25

**(FOR CANDIDATES ADMITTED FROM 2023-
2024 ONWARDS UNDER AUTONOMOUS CBCS
AND OBE PATTERN)**

**VIVEKANANDHA EDUCATIONAL
INSTITUTIONS**

Angammal Educational Trust
Elayampalayam, Tiruchengode (Tk.),
Namakkal (Dt.)

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**VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN
(AUTONOMOUS)
ELAYAMPALAYAM, TIRUCHENGODE - 637205**

**DEPARTMENT OF ZOOLOGY
OBE REGULATIONS AND SYLLABUS
(With effect from the academic year 2023-2024 onwards)**

PROGRAMME: M. Sc., ZOOLOGY

PROGRAMME CODE: PZO

I. VISION AND MISSION OF THE COLLEGE

VISION

- To evolve into a center of excellence in higher education through creative and innovative practices to social equity for women.

MISSION

- To provide sufficient learning infrastructure to the students to pursue their studies.
- To provide good opportunity for higher education and conducive environment to the students to acquire education.
- To provide quality academic programs training activities and research facilities.
- To facilitate industry-institute interaction.

II. VISION AND MISSION OF THE DEPARTMENT

DEPARTMENT OF ZOOLOGY

VISION

- Provide a sound education in basic science
- Transform society through the empowerment of women
- Provide inexpensive educational services to the weaker sections of society
- Inculcate respect for nature and concern for ethical values among students through good and scientific educational practices.
- Recognizing the essential roles of science and biology in the lives of citizens today and tomorrow, we emphasize biological literacy in our teaching and outreach programs.

MISSION

- To impart to the students the contemporary advancements in life sciences.
- To impart a global perspective and such skills among students that benefit humanity.
- To promote the discovery and broad communication of knowledge about the biology of animals including their taxonomy, evolution, physiology, cell, molecular and biochemical make up, interaction with their environments and its zoogeographical realms.
- To develop research aptitude and a scientific advancement.

- Reinvent ourselves in response to the changing demands of society with high moral values as a good citizen

III. PROGRAME EDUCATIONAL OBJECTIVES

1. M.Sc., Zoology is a two year post-graduate degree programme, which is focus on animals and its significance to the living and Non Living organisms. The M.Sc., Zoology is concealments the emerging areas in life sciences.
2. These include core courses like Structure and Functions of Invertebrates, Comparative Anatomy of Vertebrates, Cell and Molecular Biology, Genetics, Immunology, Evolution, Developmental Biology, Animal Physiology, Aquaculture, Ecology in M.Sc. programme.
3. Hands on practical training to the students is one of the outstanding features of the PG programme
4. The applied aspects of PG program is revealed that the regional, National needs and better performance in various competitive examinations.

IV. PROGRAMME SPECIFIC OUTCOMES:

PSO1 – Placement

To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.

PSO 2 - Entrepreneur

To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.

PSO3 – Research and Development

Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.

PSO4 – Contribution to Business World

To produce employable, ethical and innovative professionals to sustain in the dynamic business world.

PSO 5 – Contribution to the Society

To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

V. PROGRAMME OUTCOMES:

PO1: Problem Solving Skill

Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.

PO2: Decision Making Skill

Foster analytical and critical thinking abilities for data-based decision-making.

PO3: Ethical Value

Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.

PO4: Communication Skill

Ability to develop communication, managerial and interpersonal skills.

PO5: Individual and Team Leadership Skill

Capability to lead themselves and the team to achieve organizational goals.

PO6: Employability Skill

Inculcate contemporary business practices to enhance employability skills in the competitive environment.

PO7: Entrepreneurial Skill

Equip with skills and competencies to become an entrepreneur.

PO8: Contribution to Society

Succeed in career endeavors and contribute significantly to society.

PO 9 Multicultural competence

Possess knowledge of the values and beliefs of multiple cultures and a global perspective.

PO 10: Moral and ethical awareness/reasoning

Ability to embrace moral/ethical values in conducting one's life.

VI. SWAYAM COURSES

Students must select the subject related online SWAYAM COURSES offered by other institutions across the country. At least two courses must be successfully completed within two years of M.Sc. Programme to get the Degree. Registration for the Swayam Course will be guided by the Mentor available in the Department.

VII. ELIGIBILITY FOR ADMISSION

Candidates who have qualified B.Sc., Zoology / Animal Science / Any other Degree related to Zoology / Life Sciences approved by the Syndicate of Periyar University, Salem or any of the above degree of any other university accepted by the Syndicate of the Periyar University

VIII. DURATION OF THE COURSE

The duration of the M.Sc. Zoology Course shall be over a period of Two Years from the commencement of the course. A student shall obtain the M.Sc. Degree in Zoology if he/she has registered, undergone and secured the required minimum credits for all the Core and Elective courses and completed the Project Work / Dissertation within the stipulated time.

IX. ELIGIBILITY FOR EXAMINATION

A candidate will be permitted to appear for the end semester examination only on earning 75 % of attendance and only when his/her conduct has been satisfactory. It shall be open to grant exemption to a candidate for valid reasons subject to conditions prescribed.

X. PATTERN OF QUESTION PAPER

PART A : Choose the best answer (10 MCQ)	10 x 1 = 10 Marks
PART B : Answer all 5 Questions (Either or type)	5 x 7 = 35 Marks
PART C : Answer any 3 Questions (three out of five)	3 x 10 = 30 Marks

XI. INTERNAL ASSESSMENT STRUCTURE

The performance of the students will be assessed continuously and the

Internal Assessment Marks for theory will be as under:

Practical will be as under:

1. Average of two Tests - 10 Marks Marks	
2. Assignment - 5 Marks Marks	
3. Attendance - 5 Marks Marks	
4. Seminar - 5 Marks	
<u>= 25 Marks</u>	Total

1. Model Exam	-	25
2. Observation Note	-	10
3. Attendance	-	05
<hr/>		
Total		
= 40 Marks		

Passing minimum for Internal Assessment : 13 marks

Passing minimum of End Semester Examinations : 35 marks

Project and dissertation work will be as under

Internal mark 40 marks should be given in the following pattern by research guide and HOD

Format of Project	: 10 marks
Quality of Work	: 10 marks
<u>Mock Viva-Voce*</u>	<u>: 20 marks</u>

Total : 40 Marks

*(Evaluated by Research Guide and Internal Examiner)

XII. Attendance Breakup for theory and Practical (Semester Pattern Practical)

Range of Attendance (%)	Marks
76 % - 80 %	1
81 % - 85 %	2
86 % - 90 %	3
91 % - 95 %	4
96 % - 100 %	5

XIII. DISTRIBUTION OF MARKS

THEORY:

Internal Assessment - 25 marks

External Examination - 75 marks

PROJECT

PRACTICALS :

Internal Assessment - 40 marks

External Examination - 60 marks

1. Each student shall select a topic for his/her Project work in consultation with his/her guide and the Head of the department.
2. The Project report should be submitted to the Controller of Examinations (PG Courses) through the Head of the Department one week prior to the commencement of the terminal Examinations. If a candidate fails to submit the project report within the stipulated time, he/she may be permitted to submit the same one day prior to date of *viva voce* examinations with late fee prescribed by the Principal. If the candidate fails to submit the project report one day prior to the date of *viva voce* examination, he/she may be permitted to submit the Project report within a period of one month from the date of conduct of *viva voce*, with extension fee prescribed by the Principal. If the candidate fails to submit the project report even after that extension period, he/she will be treated with on par with failures and he/she has to do another project and to submit the report after six months by paying fee prescribed the Principal.
3. Each student shall submit 2 copies of his/her Project report for valuation.
4. The Project report shall contain a minimum of 25 pages excluding bibliography and appendices.
5. The Project report shall be valued for a total of 40 marks out of which the external examiner and the Guide share 20 marks each. The sum of marks awarded by both the examiners shall be considered to be the final mark. For a pass in the Project report, the student should secure a minimum of 18 marks. If a student fails to get the minimum pass mark in the Project report, he/she

shell be permitted to resubmit his / her Project report once again within a period of 6 months from the date of publication of the result.

6. For those candidates who have passed in the evaluation of Project report, there will be a *viva voce* examination on the above. The *vivo voce* carries a maximum of 20 marks and the guide and the external examiner will conduct it jointly. The student should secure a minimum of 10 marks for a pass in the *viva voce* examination, failing which he/she shall be required to reappear for the *viva voce* after a month from the date of *viva voce* already conducted but within a period of 3 months for which he/she will have to pay a fee as prescribed by the Principal.
7. For a pass in this paper as a whole, a student should secure a minimum of 50 percentage marks in internal mark, Project evaluation and *viva voce* put together.

XIV. COMMENCEMENT OF THESE REGULATIONS

The regulations are applicable for the students who are admitted during the academic year 2023 – 2024 and thereafter.

XV. ELIGIBILITY CONDITION FOR GETTING THE DEGREE

A candidate undergoing M.Sc., degree course in Zoology will be eligible for the award of M.Sc., degree in Zoology, if he/she completes the entire course and earns a total of 91 credits, (comprising Core and Elective credits).

XVI. CLASSIFICATION OF CANDIDATES

The successful candidates will be classified as per the details given in the following table:

RANGE OF MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90-100	9.0-10.0	O	OUTSTANDING
80-89	8.0-8.9	D+	EXCELLENT
75-79	7.5-7.9	D	DISTINCTION
70-74	7.0-7.4	A+	VERY GOOD
60-69	6.0-6.9	A	GOOD
50-59	5.0-5.9	B	AVERAGE
00-49	0.0-4.9	U	RE-APPEAR
ABSENT	0.0	AAA	ABSENT

CLASSIFICATION:

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5-10.0	O+	First Class- Exemplary
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class- Distinction
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-appear

C_i = Credits earned for course in any semester

G_i = Grade Point obtained for course in any semester

n refers to the semester in which such course were credited

For a Semester:

$$\text{GRADE POINT AVERAGE [GPA]} = \frac{\sum C_i G_i}{\sum C_i}$$

Sum of the multiplication of grade points by the credits of the course

$$\text{GPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the course}}{\text{Sum of the credits of the courses in a semester}}$$

Sum of the credits of the courses in a semester

For the entire programme:

$$\text{CUMULATIVE GRADE POINT AVERAGE (CGPA)} = \frac{\sum_n \sum_i C_{ni} G_{ni}}{\sum_n \sum_i C_{ni}}$$

Sum of the multiplication of grade points by the credits of the entire programme

$$\text{CGPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

Sum of the credits of the courses of the entire programme

XVII. TRANSITORY PROVISION:

Candidates who were admitted to the PG course of study before 2022-2023 shall be permitted to appear for the examinations under those regulations for a period of two years i.e., up to and inclusive of the examination of April/May 2023. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

XVIII. OTHER PROVISIONS

Students failing in any paper in any semester must reappear for the examination in that paper and it is necessary to repeat the course. A student who has already passed a paper will not be permitted to reappear for the purpose of improvement.

A student who fails to attend the examination can reappear in the subsequent Terminal Examinations. However, a student who cannot appear for the examination due to lack of attendance, can appear for the examination only after earning the required minimum attendance.

Repeat Examinations will be conducted for the final semester paper(s) within a month after the publication of final semester results. Hence, a student who fails in the final semester examinations can appear for the above paper only in the Repeat Examinations or in the subsequent year Even Semester Examination.

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DEPARTMENT OF ZOOLOGY
M.Sc., ZOOLOGY SYLLABUS
2023-2024 ONWARDS**

Sem	Subject Code	Core/ Elective	Title of the paper	HRS/ Week	Credit	Exam (Hours)	Int. Mark	Ext. Mark	Mark
I	23P1ZOC01	Core-I	Structure and Function of Invertebrates	6	4	3	25	75	100
	23P1ZOC02	Core-II	Comparative Anatomy of Vertebrates	6	4	3	25	75	100
	23P1ZOCP01	Lab Course -I	Lab Course I : Invertebrates & Vertebrates	6	3	4	40	60	100
	23P1ZODE01	Elective – I	Molecules and their interaction relevant to Biology	4	3	3	25	75	100
	23P1ZODE02	Elective – II	Biostatistics	4	3	3	25	75	100
	23P1ZOCP01	PCC I	Intellectual Property Rights	2	2	3	25	75	100
	23P1ZOAC01	AECC	Sericulture	2	2	3	25	75	100
Total				30	21		190	510	700
II	23P2ZOC03	Core- III	Cellular and Molecular Biology	6	5	3	25	75	100
	23P2ZOC04	Core-IV	Developmental Biology	6	5	3	25	75	100
	23P2ZOCP02	Lab Course -II	Lab Course II : Cell Biology and Developmental Biology	6	3	4	40	60	100
	23P2ZODE03	Elective – III	Economic Entomology	4	3	3	25	75	100
	23P2ZODE04	Elective – IV	Research Methodology	4	3	3	25	75	100
	23P2ZODE05	Elective V	Apiculture	4	3	3	25	75	100
	-	Internship		-	-				
Total				30	22		165	435	600
III	23P3ZOC05	Core-V	Molecular Genetics	5	5	3	25	75	100
	23P3ZOC06	Core-VI	Evolution	5	5	3	25	75	100
	23P3ZOC07	Core- VII	Animal Physiology	5	5	3	25	75	100
	23P3ZOCP03	Lab Course -III	Lab course III	5	3	4	40	60	100
	23P3ZODE06	Elective – VI	Stem cell biology	4	3	3	25	75	100
	23P3ZODE07	Elective – VII	Medical Laboratory Techniques	4	3	3	25	75	100
	23P3HR01	-	Human Rights	2	1				
	23P3ZOSI01	Internship		-	1				
Total				30	26		165	435	600
IV	23P4ZOC08	Core VIII	Immunology	6	5	3	25	75	100
	23P4ZOC09	Core IX	Ecology	6	5	3	25	75	100
	23P4ZOCP04	Lab Course - IV	Lab Course in Immunology	6	3	4	40	60	100
	23P4ZODE08	Elective VIII	Animal behavior	4	3	3	25	75	100
	23P4ZOED01	EDC	Aquaculture	4	3	3	25	75	100
	23P4ZOPR01	Project Viva		4	3		40	60	100
Total				30	22	-	180	420	600
Grand Total					91	-	700	2100	2500

Semester- I / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P1ZOC01	STRUCTURE AND FUNCTION OF INVERTEBRATES	Core	Y	-	-	-	4	6	25	75	100
Learning Objectives											
CO1	To understand the concept of classification and their characteristic features of major group of invertebrates.										
CO2	To realize the range of diversification of invertebrate animals.										
CO3	To enable to find out the ancestors or derivatives of any taxon.										
CO4	To know the functional morphology of system biology of invertebrates.										
UNIT	Details								No. of Hours	Course Objective s	
I	Taxonomy of invertebrates: Introduction and Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Types of Nomenclature; Taxonomic procedures; New trends in taxonomy								12	CO1	
II	Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata								12	CO2	
III	Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory pigments; Mechanism of respiration								12	CO3	
IV	Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malphigian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda); Trends in neural evolution								12	CO4	
V	Invertebrate larvae: Larval forms of free living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters								12	CO5	
Total									60		

Course Outcomes (STRUCTURE AND FUNCTION OF INVERTEBRATES)		
Course Outcomes	On completion of this course, students will;	
CO1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	PO1
CO2	Understand the evolutionary process. All are linked in a sequence of life patterns.	PO1, PO2
CO3	Apply this for pre-professional work in agriculture and conservation of life forms.	PO4, PO6
CO4	Analyze what lies beyond our present knowledge of life process.	PO4, PO5, PO6
CO5	Evaluate and to create the perfect phylogenetic relationship in classification.	PO3, PO8
TEXT BOOKS (Latest Editions)		
1.	Ekambaranatha Iyer, 2000. A Manual of Zoology, 10 th edition, Viswanathan, S., Printers & Publishers Pvt Ltd	
2.	Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12 th edn. S. Chand & Co.	
3.	Kotpal, R.L, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda.	
REFERENCES BOOKS (Latest editions, and the style as given below must be strictly adhered to)		
1.	Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.	
2.	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science	
3.	Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson	
4.	Hyman L.H, 1955. The invertebrates - Vol. I to Vol. VII – Mc Graw Hill Book Co.	
5.	Parker, J. and Haswell , 1978. A text book of Zoology Vol. I - Williams and Williams.	
Web Resources		
1.	https://www.nationalgeographic.com/animals/invertebrates/	
2.	https://bit.ly/3kABzKa 3. https://www.nio.org/ 4. https://greatbarrierreef.org/	

Semester- I / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P1ZOC02	COMPARATIVE ANATOMY OF VERTEBRATES	Core	Y	-	-	-	4	6	25	75	100
Learning Objectives											
CO1	Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.										
CO2	Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.										
CO3	Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals										
CO4	Imparting conceptual knowledge about the animal life in the air and their behaviours.										
CO5	Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.										
UNIT	Details									No. of Hours	Course Objectives
I	Origin of vertebrates: Concept of Protochordata; The nature of vertebrate morphology; Definition, scope and relation to other disciplines; Importance of the study of vertebrate morphology.									12	CO1, CO2
II	Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.									12	CO1, CO2, CO4, CO5
III	General plan of circulation in various groups; Blood; Evolution of heart; Evolution of aortic arches and portal systems. Respiratory system: Characters of respiratory tissue; Internal and external respiration; Comparative account of respiratory organs									12	CO1, CO2, CO3, CO5
IV	Skeletal system: Form, function, body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrate series.									12	CO4, CO5
V	Sense organs: Simple receptors; Organs of Olfaction and taste; Lateral line system; Electoreception. Nervous system: Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinal cord; Nerves-Cranial, Peripheral and Autonomous nervous systems.									12	CO4, CO5
	Total									60	
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.									PO1	
CO2	Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.									PO1, PO2	
CO3	Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals									PO3, PO4, PO5	
CO4	Imparting conceptual knowledge about the animal life in the air and their behaviours.									PO4, PO5, PO6	
CO5	Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.									PO1, PO2, PO3, PO8	
Text Books											

(Latest Editions)

1.	Ekambaranatha Ayyar, and T. N. Ananthakrishnan, 2000. A Manual of Zoology. Vol 1 (Invertebrata). Part II – Viswanathan Pvt. Ltd, 842pp
2.	Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12 th edn. S. Chand& Co.
3.	Kotpal R.L. 2019. Modern Text Book of Zoology, Invertebrates 9 th Ed., Rastogi Publications, Gangotri, Shivaji Road, Meerut, 1004 pp.
4.	Vasantharaj David, B. 2001. Elements of Economic Entomology, Popular Book Depot, Chennai. 400pp.
5.	Ruppert and Barnes, R.D. 2006. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition, Belmont, CA : Thomson-Brooks/Cole, 928pp.

REFERENCES BOOKS

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

1.	Barrington, E.J.W., 2012, Invertebrate structure and function. Boston – Houghton. Mifflin and ELBS, London.
2.	Bhamrah, H.S. and Kavitha Juneja, 2002. A text book of Invertebrates. Alilnol Publications Private Limited, 4374/4B. Ansari Road, Dayaganj, New Delhi.
3.	Hyman L.H, 1955. The invertebrates – Vol. I to Vol. VII – McGraw Hill Book Co.
4.	Kotpal, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, R.L- Rastogi Publication.
5.	Parker, J. and Haswell, 1978. A text book of Zoology Vol. I - Williams and Williams.
6.	Srivastava, M.D.L and Srivastava, 1969. A text book of Invertebrate Zoology, U.S- Central Book Depot, Allahabad.
7.	Verma, A. Invertebrates: Protozoa to Echinodermata. Narosa Publishing House Private Limited. 35-36 Greams Road, Thousand Lights, Chennai.

Web Resources

1.	https://www.nationalgeographic.com/animals/invertebrates/
2.	https://bit.ly/3kABzKa
3.	https://www.nio.org/
4.	https://bit.ly/3IJdUX0

Semester- I / Course Elective	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P1ZODE01	MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY	Elective	Y	-	-	-	3	4	25	75	100
Learning Objectives											
CO1	Students should know the fundamentals of biochemistry										
UNIT	Details									No. of Hours	Course Objectives
I	Basics of biophysical chemistry and biochemistry: Structure of atoms, molecules and chemical bonds - Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).									12	CO1, CO2
II	Molecular interactions and their properties: Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc. Stability of Proteins and nucleic acids.									12	CO1, CO2, CO4, CO5
III	Biomolecules: Composition, structure, function and metabolism of carbohydrates, lipids, proteins, nucleic acids and vitamins.									12	CO1, CO2, CO3, CO5
IV	Bioenergetics and enzymology: Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers - Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes									12	CO4, CO5
V	Structural conformation of proteins and nucleic acids: Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motifs and folds) - Conformation of nucleic acids (A-, B-, Z-DNA), t-RNA, micro-RNA).									12	CO4, CO5
Total									60		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Learn the structure, properties, metabolism and bioenergetics of biomolecules									PO1	
CO2	Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation									PO1, PO2	
CO3	Understand the fundamentals of biophysical chemistry and biochemistry, importance and applications of methods in conforming the structure of biopolymers									PO3, PO4, PO5	
CO4	Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids									PO4, PO5, PO6	
CO5	Familiarize the use of methods for the identification, characterization and conformation of biopolymer structures									PO1, PO2, PO3, PO8	
Text Books (Latest Editions)											
1.	Berg, J. M., J. L. Tymoczko and L. Stryer 2002. Biochemistry. 5th Ed., W.H. Freeman & Co., New York, pp-1050.										
2.	Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.										

3.	McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7th Edition). Oxford University Press, US, pp-793.
4.	Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.
5.	Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.

REFERENCES BOOKS

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

1.	Buchanan, B.B., W. Gruissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp
2.	Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), The McGraw
3.	Palmer, T. 2004. Enzymes. Affiliated East
4.	Voet D. and J.G. Voet. 2011. Biochemistry. (4th Edition). John Wiley & Sons (Asia) Pvt. Ltd., pp

Web Resources

1.	https://www.nationalgeographic.com/animals/invertebrates/
2.	https://bit.ly/3kABzKa
3.	https://www.nio.org/
4.	https://bit.ly/3IJdUX0

Semester- I / Core Elective II	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P1ZODE02	BIOSTATISTICS	Elective	Y	-	-	-	3	4	25	75	100
Learning Objectives											
CO1	Students should know basic concepts in Biostatistics.										
UNIT	Details									No. of Hours	Course Objectives
I	Definition, scope and application of statistics; Primary and secondary data: Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency, Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram, pie chart and line diagram.									9	CO1, CO2
II	Measures of central tendency: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error and coefficient of variation.									9	CO1, CO2, CO4, CO5
III	Probability: Theories and rules; Theorem of Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.									9	CO1, CO2, CO3, CO5
IV	Hypothesis testing: Student 't' test - paired sample and mean difference 't' tests. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Significance test for correlation coefficients. Regression analysis: Computation of biological data, calculation of regression co-efficient- Chi –Square test.									9	CO4, CO5
V	Analysis of variance: one way and two way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS) and MS Excel.									9	CO4, CO5
Total									45		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Clear understanding of design and application of biostatistics relevant to experimental and population studies.									PO1	
CO2	Acquired skills to perform various statistical analyses using modern statistical techniques and software.									PO1, PO2	
CO3	Knowledge on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate statistical design/ methods of analysis.									PO3, PO4, PO5	
Text Books (Latest Editions)											
1.	Arora, P. N. and P. K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp										
2.	Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp										
3.	Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp										
4.	Palanichamy, S. and Manoharan, M. 1990. Statistical Methods for Biologists, Palani Paramount										

	Publications, Tamil Nadu, pp
REFERENCES BOOKS	
(Latest editions, and the style as given below must be strictly adhered to)	
1.	Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp
2.	Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp
3.	Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp
4	Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp
5	Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp
6	Wayne W. Daniel. Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons Inc, USA, pp
7	Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp
8	Pagano, M. and K. Gauvreau. 2008. Principles of Biostatistics (Second Edition), Cengage Learning, New Delhi, pp
Web Resources	
1.	https://www.nationalgeographic.com/animals/invertebrates/
2.	https://bit.ly/3kABzKa
3.	https://www.nio.org/
4.	https://bit.ly/3lJdUX0

Semester- I / PCC I	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P1ZOPC 01	INTELLECTUAL PROPERTY RIGHTS	PCC	Y	-	-	-	2	2	25	75	100
Learning Objectives											
CO1	Students should gain basic knowledge intellectual property.										
UNIT	Details									No. of Hours	Course Objectives
I	Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad - Genesis and Development - the way from WTO to WIPO - TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations - Important examples of IPR.									4	CO1, CO2
II	Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad									4	CO1, CO2, CO4, CO5
III	International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.									4	CO1, CO2, CO3, CO5
IV	Digital Innovations and Developments as Knowledge Assets - IP Laws, Cyber Law and Digital Content Protection - Unfair Competition - Meaning and Relationship between Unfair Competition and IP Laws - Case Studies.									4	CO4, CO5
V	Infringement of IPRs, Enforcement Measures, Emerging issues - Case Studies.									4	CO4, CO5
Total									20		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Claim the rights for the protection of their invention done in their project work.									PO1	
CO2	Identify criterias' to fit one's own intellectual work in particular form of IPRs									PO1, PO2	
CO3	To get registration in our country and foreign countries of their invention, designs and thesis or theory written by students during their project.									PO3, PO4, PO5	
Text Books (Latest Editions)											
1.	Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.										
2.	Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.										
3.	Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.										
REFERENCES BOOKS (Latest editions, and the style as given below must be strictly adhered to)											
1.	V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012										
2.	S.V Satakar Intellectual property Rights and Copy Rights, Ess Publication, New Delhi, 2002.										

Web Resources	
1.	https://www.nationalgeographic.com/animals/invertebrates/
2.	https://bit.ly/3kABzKa
3.	https://www.nio.org/
4.	https://bit.ly/3IJdUX0

Semester- I / AECC	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks			
									CIA	External	Total	
23P1ZOAC01	SERICULTURE	AEC C	Y	-	-	-	2	2	25	75	100	
Learning Objectives												
CO1	Students should know basic concepts and techniques in Sericulture.											
UNIT	Details								No. of Hours	Course Objectives		
I	Introduction to textile fibers; types- natural and synthetic fibers; sources of silk fiber- Tasar, Muga, Anaphe, Gonometa, Fagara, spider and mussel; properties and importance of silk fiber. History, development, status, characteristics and advantages of sericulture in India.								9	CO1, CO2		
II	Host plants; Moriculture- distribution, morphology, propagation- seedling, cutting, grafting, layering and micropropagation methods, maintenance- irrigation, manuring and pruning, pests and diseases of mulberry.								9	CO1, CO2, CO4, CO5		
III	<i>Bombyx mori</i> - morphology, anatomy, life cycle, geographical locations, larval moults, voltinism, indigenous and commercial races. Diapause. Egg-storage and transportation.								9	CO1, CO2, CO3, CO5		
IV	Rearing houses and equipment. Rearing operations- disinfection, brushing, feeding and spacing. Moulting and spinning. Harvest. Rearing methods- chawki, lasso, showa, shelf-rearing, floor-rearing and shoot rearing. Diseases of <i>Bombyx mori</i> - protozoan, bacterial, viral and fungal. Pests of silkworm- Uzi fly, desmestids, mites, ants, nematodes, aves and mammals.								9	CO4, CO5		
V	Physical and commercial characteristics of cocoons. Cocoon harvesting and marketing. Cocoon sorting, stifling, deflossing, riddling, cooking, brushing, reeling and re-reeling. Weaving. By-products of sericulture industry.								9	CO4, CO5		
Total									45			
Course Outcomes												
Course Outcomes	On completion of this course, students will;											
CO1	To understand the various practices in sericulture. To know the needs for sericulture and the status of India in global market.								PO1			
CO2	Able to apply the techniques and practices needed for sericulture.								PO1, PO2			
CO3	To know the difficulties in sericulture and be able to propose plans against it.								PO3, PO4, PO5			
Text Books (Latest Editions)												
1.	. G. Ganga and J. Sulochana Chetty. 2019. An introduction to sericulture, 2 nd edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.											
2.	M. Johnson and M. Kesary. 2019. Sericulture, Saras publication, Tamilnadu											
3.	Singh, Amardev & Ravinder Kumar. 2013. Sericulture handbook Vol 1, Biotech.											
4.	M. Madan Mohan Rao. An Introduction to Sericulture, 2 nd edition, BS Publications.											
Web Resources												
1.	https://www.nationalgeographic.com/animals/invertebrates/											
2.	https://bit.ly/3kABzKa											
3.	https://www.nio.org/											
4.	https://bit.ly/3lJdUX0											

emester- I / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P1ZOCP01	INVERTEBRATES & VERTEBRATES	Core	Y	-	-	-	3	6	25	75	100

Learning Objectives

CO1	Understanding the different systems in invertebrates & vertebrates.
CO2	Learning about various animal species, their phylogenetic affinities and their adaptive features
CO3	Imparting conceptual knowledge about the salient features and functional anatomy.
CO4	Developing the skill in mounting techniques of the biological samples.
CO5	Gaining fundamental knowledge on the skeletal system

INVERTEBRATES

Dissection

- Earthworm : Nervous system
Pila : Digestive and nervous systems
Cockroach : Nervous system
Grasshopper : Digestive system and mouth parts
Prawn : Appendages, nervous and digestive systems

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

1. *Amoeba*
2. *Entamoeba histolytica*
3. *Paramecium*
4. *Hydra* with bud
5. Sporocyst – Liver fluke
6. *Cercaria* larva
7. *Tape worm (Scolex)*
8. *Ascaris* T. S.
9. Mysis of prawn

Spotters

1. Scorpion
2. *Penaeus indicus*
3. *Emerita (Hippra)*
4. *Perna viridis*

Mounting

- Earthworm : Body setae
Pila : Radula
Cockroach : Mouth parts
Honeybee : Mouth parts

CHORDATES

Study the nervous system of Indian dog shark - Dissection

1. Nervous system of *Scoliodon laticaudatus* – 5th or Trigeminal nerve
2. Nervous system of *Scoliodon laticaudatus* – 7th or Facial nerve

Nervous system of *Scoliodon laticaudatus* – 9th and 10th or Glossopharyngeal & Vagus nerve

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

1. *Amphioxus* sp. (Lancelet)

2. *Ascidia* sp. (sea squirt)
3. *Scoliodon laticaudatus* (Indian dog shark)
4. *Trygon* sp. (Sting ray)
5. *Torpedo* sp. (Electric ray)
6. *Arius maculatus* (Cat fish)
7. *Belone cancila* (Flute fish)
8. *Exocoetus poecilopterus* (Flying fish)
9. *Mugil cephalus* (Mullet)
10. *Tilapia mossambicus* (Tilapia)
11. *Rachycentron canadum* (Cobia)
12. *Tetrodon punctatus* (Puffer fish)
13. *Dendrophis* sp. (Tree snake)

Study of the different types of scales in fishes

1. Cycloid scale
2. Ctenoid scale
3. Placoid scale

Study of the frog skeleton system (Representative samples)

1. Entire skeleton
2. Skull
3. Hyoid apparatus
4. Pectoral girdle and sternum
5. Pelvic girdle
6. Fore limb
7. Hind limb

Mounting

1. Weberian ossicles of fish

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Understand the structure and functions of various systems in animals	PO1
CO2	Learn the adaptive features of different groups of animals	PO1, PO2
CO3	Learn the mounting techniques	PO3, PO4, PO5
CO4	Acquire strong knowledge on the animal skeletal system	PO4, PO5, PO6

**Text Books
(Latest Editions)**

1.	Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp
2.	Iuliiis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp
3.	Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp

Semester- II /	Course Name	Ca	teg	ory	L	T	P	S	Ur	edi	t	Ho	Marks
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Course Code										CIA	External	Total
23P2ZOC03	CELLULAR AND MOLECULAR BIOLOGY	Core	Y	-	-	-	4	6	25	75	100	

Learning Objectives

CO1	To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
CO2	To realize involvement of various cellular components in accomplishing cell division.
CO3	To enable a successful performance in cell biology component of CSIR-UGC NET.
CO4	To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.

UNIT	Details	No. of Hours	Course Objectives
I	General features of the cell: Basic structure of prokaryotic and eukaryotic cells - Protoplasm and deutoplasm - cell organelles; cell theory; Diversity of cell size and shapes.	12	CO1
II	Cellular organization: Membrane structure and functions - Structure of model membrane, lipid bilayer and membrane proteins diffusion, osmosis, ion channels, active transport, ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles and chloroplasts.	12	CO2
III	Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Molecular biology of cell: Structure of DNA and RNA; Process of DNA replication, transcription and translation in pro- and eukaryotic cells; Genetic maps.	12	CO3
IV	Cell communication and cell signaling: Membrane- associated receptors for peptide and steroid hormones - signaling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures.	12	CO4
V	Cancer cells: Characteristic features of normal and cancer cells; Carcinogens: types and cancer induction; Metastasis; Oncogenes and tumor suppressor genes, apoptosis; therapeutic interventions of uncontrolled cell growth.	12	CO5
Total		60	

Course Outcomes (CELLULAR AND MOLECULAR BIOLOGY)

Course Outcomes	On completion of this course, students will;	
CO1	Understand the general concepts of cell and molecular biology.	PO1
CO2	Visualize the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance of molecular and cellular structures influencing functional features.	PO1, PO2
CO3	Perceive the importance of physical and chemical signals at the molecular level resulting in modulation of response of cellular responses.	PO4, PO6
CO4	Updated the knowledge on the rapid advances in cell and molecular biology for a better understanding of onset of various diseases including cancer.	PO4, PO5, PO6
CO5	Understand the general concepts of cell and molecular biology.	PO3,

		PO8
TEXT BOOKS (Latest Editions)		
1.	Plopper, G., D. Sharp, and E. Sikorski. 2015. <i>Lewin's Cells</i> (Third Edition), Jones & Bartlett, New Delhi, pp	
2.	Plopper, G. 2013. <i>Principles of Cell Biology</i> , Jones & Bartlett, Maryland, pp	
REFERENCES BOOKS (Latest editions, and the style as given below must be strictly adhered to)		
1.	Karp, G. 2010. <i>Cell Biology</i> (Sixth Edition), John Wiley & Sons, Singapore, pp-765.	
2.	Lodish, H., C. A. Kaiser, A. Bretscher, <i>et al.</i> , 2013. <i>Molecular Cell Biology</i> (Seventh Edition), Macmillan, England, pp-1154	
3.	De Robertis, E.D.P. and E. M. F. De Robertis Jr, 1987. <i>Cell and Molecular Biology</i> . Info-Med, Hong Kong, pp-734	
4.	Abbas, A. K., A. H. Lichtman and S. Pillai, 2007, <i>Cell and Molecular Immunology</i> (Sixth Edition), Saunders, Philadelphia, pp-566	
5.	Loewy, A.G., P. Siekevitz and J. R. Menninger, <i>et al.</i> , 1991, <i>Cell Structure and Function</i>	
Web Resources		
1.	https://www.nationalgeographic.com/animals/invertebrates/	
2.	https://bit.ly/3kABzKa 3. https://www.nio.org/ 4. https://greatbarrierreef.org/	

Semester- II/ Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P2ZOC04	DEVELOPMENTAL BIOLOGY	Core	Y	-	-	-	4	6	25	75	100
Learning Objectives											
CO1	Understand the process of gametogenesis, cleavage and gastrulation, embryonic development, extra embryonic membrane and placenta in various animals and human.										
CO2	Learn the principles, methods and applications of cryo-preservation of gametes and embryo.										
UNIT	Details								No. of Hours	Course Objectives	
I	Pattern of animal development: Chief events in animal development; History of thoughts and conceptual developments. Gametogenesis: Origin of germ cells, spermatogenesis - Sperm morphology in relation to the type of fertilization, Oogenesis - Oogenesis in insects and amphibians; Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians								12	CO1	
II	Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitation in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg - Egg activation - Intracellular calcium release - Cortical reaction - Physiological polyspermy - Fusion of male and female pronuclei - Post fertilization metabolic activation - Parthenogenesis								12	CO2	
III	Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition - Determinate and regulatory embryos, Factors affecting gastrulation, mechanisms and types of gastrulation in respective animal embryos (Sea urchin, <i>Amphioxus</i> , Amphibians, Aves, Mammals); Fate maps - (Amphibian and Chick), Epigenesis and preformation – Formation of primary germ layers								12	CO3	
IV	Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation; Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Gene and development; Anterior- posterior axis in determination in drosophila, Maternal effect genes - <i>Bicoid</i> and <i>Nanos</i> proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes								12	CO4	
V	Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Formation of ectodermal cap and regeneration blastema – Types of regeneration in planaria, Regenerative ability in different animal groups, Factors stimulating regeneration – Biochemical changes associated with regeneration. Aging and senescences: Biology of senescences- cause of aging- mechanism involved in apoptosis.								12	CO5	

	Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Endocrine changes associated with normal pregnancy, Induced ovulation in humans – Cryopreservation of gametes/embryos - Ethical issues in cryopreservation		
	Total	60	
Course Outcomes (DEVELOPMENTAL BIOLOGY)			
Course Outcomes	On completion of this course, students will;		
CO1	Define the concepts of embryonic development		PO1
CO2	Observe various stages of cell divisions under microscope		PO1, PO2
CO3	Understand the formation of zygote		PO4, PO6
CO4	Differentiate the blastula and gastrula stages		PO4, PO5, PO6
CO5	Learn the distinguishing features of three different germ layers and formation of various tissues and organs		PO3, PO8
TEXT BOOKS (Latest Editions)			
1.	Balinsky, B. I. 1981. Introduction to Embryology (5 th Edition), CBS College Publishers, New York, pp-782.		
2.	Gilbert. S. F. 2006. Developmental Biology, 8 th Edition, INC Publishers, USA, pp-785.		
3.	Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.		
4.	Tyler, M.S. 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA, pp-208.		
5.	Subramoniam, T. 2011. Molecular Developmental Biology (2 nd Edition), Narosa Publishers, India, pp-364.		
REFERENCES BOOKS (Latest editions, and the style as given below must be strictly adhered to)			
1.	Wilt, F.H. and N.K. Wessel. 1967. Methods in Developmental Biology, Thomas Y Crowell, New York.		
2.	Slack J.M.W. 2012. Essential Developmental Biology (3 rd Edition), Wily-Blackwell Publications, USA, pp-496		
3.	Mari-Beffa, M. and J. Knight. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404		
Web Resources			
1.	https://www.nationalgeographic.com/animals/invertebrates/		
2.	https://bit.ly/3kABzKa 3. https://www.nio.org/ 4. https://greatbarrierreef.org/		

Semester- I / Core Lab Course II	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P2ZOCP02	Core Practical - II Cell Biology and	Core	Y	-	-	-	3	6	40	60	100

Developmental Biology		
Learning Objectives		
CO1	Practical course aims at demonstrating significant cellular and molecular biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology, genetics and developmental biology into practical understanding.	
<u>CELL AND MOLECULAR BIOLOGY</u>		
<ol style="list-style-type: none"> 1. Determination of cell size using micrometer 2. Mitosis in root meristematic cells of plants 3. Identification of various stages of meiosis in the testes of grasshopper 4. Detection of polytene chromosome in salivary gland cells of the larvae of the Chironomus 5. Detection of sex chromatin 6. Identification of blood cells in the haemolymph of the of the cockroach 7. Isolation of genomic DNA from eukaryotic tissue 8. Isolation of total RNA from bacterial cells/tissues 9. Agarose gel electrophoresis of DNA 10. SDS-Polyacrylamide gel electrophoresis 		
<u>DEVELOPMENTAL BIOLOGY</u>		
Gametogenesis - Observation of gametes from gonadal tissue sections		
i.	Oogenesis:	✓ Section through ovary of shrimp, fish, frog and mammals
ii	Spermatogenesis:	✓ Section through testis of shrimp, fish, calotes and mammals
Fertilization		
iii	Induced spawning in polychaete worm <i>Hydroids elegans</i>	
iv	<i>In vitro</i> fertilization and development in a polychaete worm <i>Hydroids elegans</i>	
v	Observation of egg developmental stages in <i>Emerita emeritus</i>	
Embryogenesis		
vi	Observation and whole mount preparation of the chick blastoderm - 18 hours of development	
vii	Chick embryonic stage - 24 hours of development	
viii	Chick embryonic stage - 48 hours of development	
ix	Chick embryonic stage - 72 hours of development	
x	Chick embryonic stage - 96 hours of development	
Histological observation: Section through various developmental stages in chick embryo		
Experimental Embryology		
Regeneration in Frog Tadpoles		
	xi	Blastema formation
	xii	Demonstration of regenerative process in tadpole
Metamorphosis		
	xiii	Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine
Cryopreservation		
	xiv	Demonstration of cryopreservation of gametes of fin fish/shell fish
Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Acquire knowledge to differentiate the cells of various living organisms and become aware of physiological processes of cells e.g. cell divisions, various stages of fertilization and embryo development.	PO1
CO2	Understand and observe as well as correctly identify different cell types,	PO1, PO2

	cellular structures using different microscopic techniques.	
CO3	Develop handling - skills through the wet-lab course.	PO3, PO4, PO5
CO4	Learn the method of culturing of <i>Drosophila</i> and identification of their wild and mutant strains	PO4, PO5, PO6
CO5	Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities	

Semester- II / Core Elective III	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P2ZODE03	ECONOMIC ENTOMOLOGY	Elective	Y	-	-	-	3	4	25	75	100

Learning Objectives

CO1	Students should acquire a fairly good understanding about the life of insects and their classification.										
UNIT	Details									No. of Hours	Course Objectives
I	Overview of insects and insect taxonomy: Insects and their biological success - Man and insects; Basic concepts in Insect Taxonomy and classification. Characteristic features insects orders: Orthoptera, Hemiptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera									9	CO1, CO2
II	Beneficial insects: Silkworms - types, life history of <i>Bombyx mori</i> , disease management and rearing methods - Types of honey bees, life history, social organization (colonies and caste system), honey bee care and management of bee hive - Lac insects-life history, lac cultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil-builders.									9	CO1, CO2, CO4, CO5
III	Destructive insects: Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Biology of the insect pests – Any two pests of paddy, cotton, sugarcane, vegetables, coconut and stored grains cereals.									9	CO1, CO2, CO3, CO5
IV	Pest management/Control strategies: Methods and principles of pest control - Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control - Development and uses of pest resistant plant varieties - Integrated pest management - Concepts and practice.									9	CO4, CO5
V	Vector biology: Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures									9	CO4, CO5
Total									60		

Course Outcomes

Course Outcomes	On completion of this course, students will;										
CO1	Understand taxonomy, classification and life of insects in the animal kingdom.									PO1	
CO2	Know the life cycle, rearing and management of diseases of beneficial insects.									PO1, PO2	
CO3	Know the type of harmful insects, life cycle, damage potential and management of pests including natural pest control										
CO4	Recognize insects which act as vectors causing diseases in animals and human.									PO3, PO4, PO5	

Text Books (Latest Editions)

1.	Ayyar, L.V. R. 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi, pp										
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2.	Vasantharaj David, B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp
3.	Ross. H.H. 1965. A Text Book of Entomology, John Wiley & Sons Inc., New York, pp
REFERENCES BOOKS	
(Latest editions, and the style as given below must be strictly adhered to)	
1.	Chapman, R.F., S.J. Simpson and A.E. Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
2.	Imms, A.D., O.W. Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2:
3.	Mani, M.S. 1982. General Entomology. Oxford & IBH Publishing Co., pp-912.
4.	Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746
Web Resources	
1.	https://www.nationalgeographic.com/animals/invertebrates/
2.	https://bit.ly/3kABzKa
3.	https://www.nio.org/
4.	https://bit.ly/3IJdUX0

Semester- II / Core Elective IV	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P2ZODE04	RESEARCH METHODOLOGY	Elective	Y	-	-	-	3	4	25	75	100
Learning Objectives											
CO1	Students understand the basic principle, methodology and applications of widely used instruments in biological sciences.										
UNIT	Details									No. of Hours	Course Objectives
I	Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry.									9	CO1, CO2
II	Histology, Histochemistry, Bioinformatics and Electron microscopy.									9	CO1, CO2, CO4, CO5
III	Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy.									9	CO1, CO2, CO3, CO5
IV	Centrifuges, Chromatography, Electrophoresis, ELISA and blotting.									9	CO4, CO5
V	Principles and Applications of tracer techniques in biology, Animal cell culture techniques.									9	CO4, CO5
Total									45		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Understand the implications of GLP									PO1	
CO2	Learn the working principles of different instruments									PO1, PO2	
CO3	Gain the knowledge on techniques of histology and histochemistry										
CO4	Acquire knowledge on the basic principle and application of various modules of light and electron microscopy									PO3, PO4, PO5	
Text Books (Latest Editions)											
1.	Pearse, A.G. 1968. Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J & A Churchill Ltd, pp-758.										
2.	Lillie, R.D. 1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.										
3.	Hoppert, M. 2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.										
REFERENCES BOOKS (Latest editions, and the style as given below must be strictly adhered to)											
1.	Chandler, D.E. and Roberson R.W. 2009. Bioimaging: Current Concepts in Light and Electron Microscopy, Jones and Bartlet Publishers, Sudbury, MA, USA, pp440.										
2.	Engelbert, B. 1960. Radioactive Isotopes in Biochemistry, Elsevier Applied Science, pp-376.										
3.	Srivastava, B. B. 2005. Fundamentals of Nuclear Physics, Rastogi Publications, pp-500.										
Web Resources											
1.	https://www.nationalgeographic.com/animals/invertebrates/										
2.	https://bit.ly/3kABzKa										
3.	https://www.nio.org/										

Semester- II / Course Code (AECC II)	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks			
									CIA	External	Total	
23P2ZOAC02	APICULTURE	AECC	Y	-	-	-	2	2	25	75	100	
Learning Objectives												
CO1	Students should know basic concepts in Apiculture.											
UNIT	Details									No. of Hours	Course Objectives	
I	Introduction to Apiculture. History, classification, types, life Cycle of different species of Honey Bees and their behavioural patterns. Social organization of bee colony									9	CO1, CO2	
II	Bee-keeping system, tools and equipments needed for bee keeping. Types of bee hives, structure and functional features. Criteria for site selection for apiculture and factors affecting them.									9	CO1, CO2, CO4, CO5	
III	Identification and characteristics and Preventive measures to be taken against of different bee enemies. Diseases affecting honey bees and their control measures. Colony collapse disorder and its management.									9	CO1, CO2, CO3, CO5	
IV	Bee products and byproducts of bee keeping - Honey, Royal jelly, Propolis, Pollen and Bee wax and Bee venom. Harvesting, Processing, Packaging and Marketing of bee products.									9	CO4, CO5	
V	Apiculture industry around the world and Role of Central Bee Research & Training institute in India. Apiculture as an Entrepreneurial venture.									9	CO4, CO5	
Total												
Course Outcomes												
Course Outcomes	On completion of this course, students will;											
CO1	Clear understanding of morphology, life cycle, characteristics of honey bees and bee keeping.									PO1		
CO2	Acquired skills to perform bee keeping from managing colonies of bees in order to harvest honey and other Bee related by-products in different setups and as an Entrepreneurial venture.									PO1, PO2		
CO3	Knowledge on the harvesting, preserving and processing of bee products and identification of the appropriate markets to sell the produce.									PO3, PO4, PO5		
Text Books (Latest Editions)												
1.	1. Singh, D., Singh, D. Pratap. 2006. A Handbook of Beekeeping. AGROBIOS (INDIA) 2. Sharma P.L. and Singh, S.H. Book of Bee keeping. 3. Cherian and Ramanathan, S. Bee keeping in south India. 4. Prospective in Indian Apiculture - R.C. Mishra.											
	Caron, D.W. 2013 (revised from 1999). Honey Bee Biology and Beekeeping. Wicwas Press. Cheshire, CT, 368 pp.											

	Hendriksma, H. P., A. L. Toth, and S. Shafir. 2019. Individual and Colony Level Foraging decisions of Bumble Bees and Honey Bees in Relation to Balancing of Nutrient Needs. <i>Frontiers in Ecology and Evolution</i> 7: 177.
Web Resources	
1.	https://www.nationalgeographic.com/animals/invertebrates/
2.	https://bit.ly/3kABzKa
3.	https://www.nio.org/
4.	https://bit.ly/3lJdUX0

Semester- III / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P3ZOC05	MOLECULAR GENETICS	Core	Y	-	-	-	4	4	25	75	100
Learning Objectives											
CO1	Understanding DNA as genetic material, fine structure of DNA & RNA molecules, as well as physico-chemical properties of macromolecules.										
CO2	Gain insight into sequential events occurs during protein synthesis.										
CO3	Learn the structure and function of chromosome and chromosomal basis of genetic disorders.										
CO4	To acquire knowledge about microbial genetics										
UNI T	Details								No. of Hours	Course Objectiv es	
I	Structure, properties and functions of genetic materials: DNA as the genetic Materials - Basic structure of DNA and RNA, alternate and unusual forms of DNA - Physical and Chemical properties of nucleic acid, base properties, denaturation and renaturation, T _m and cot values, hybridization.								12	CO1	
II	Genetic code - Methods of deciphering the genetic code and general features of the code word dictionary. Chromosomal genetics: Molecular structure of chromosomes - Variation in chromosome number and structure - Chromosome nomenclature - Chromosomal syndromes.								12	CO2	
III	Microbial Genetics: Genetics of Virus - Viral chromosome, Lytic cycle, Lysogenic cycle - Bacterial genetics -Bacterial genome - Gene transfer mechanisms in bacteria and virus - conjugation, transduction and transformation								12	CO3	
IV	Recombinant DNA technology: Recombinant DNA technology - Overview - Tools for Recombinant DNA Technology – Vectors - types - Techniques used in recombinant DNA technology - generation of DNA fragments - Restriction endonucleases, DNA modifying enzymes, Ligases								12	CO4	
V	Introduction of rDNA into host cell - calcium chloride mediated gene transfer - <i>Agrobacterium</i> mediated DNA transfer, electroporation, microinjection, liposome fusion, particle gun bombardment - Selection and screening of transformed cells - Expression of cloned gene; Application of rDNA technology in human welfare - Environment, Medicine and Agriculture								12	CO4	
Total								60			
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Explain the organization and functions of genetic material in the living system.									PO1	
CO2	Understand various sequential processes in protein synthesis									PO1, PO2	
CO3	Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.									PO4, PO6	

CO4	Able to distinguish lytic and lysogenic cycle and explain the mechanisms of genetic recombination of the microbes.	PO4, PO5, PO6
CO5	Understand the principle and application of rDNA technology for the welfare of human being.	PO3, PO8
TEXT BOOKS (Latest Editions)		
1.	Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley & Sons. INC. New York, pp-740.	
2.	Brooker, R. J. 2014. Genetics: Analysis and Principles. 5th Edition, McGraw Hill Publsiher, pp-880.	
3.	Russell, P.J. 2005. Genetics: A Molecular Approach (2nd Edition). Pearson/Benjamin Cummings, San Francisco, pp-850.	
REFERENCES BOOKS (Latest editions, and the style as given below must be strictly adhered to)		
1.	Griffiths, A. J. F., H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart. 2012. An Introduction to Genetic Analysis. 11th Edition, W. H. Greeman. New York.	
2.	Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics, John Wiley Publications, pp-784.	
3.	Watson, J. D., T. A. Baker, S. P. Bell, Alexander Gann, Michael Levine, Richard Losick. 2003. Molecular Biology of the Gene, (5 th Edition). Cold Spring Harbor Laboratory Press, pp-912	
4.	Klug, W. S. and M. R. Cummings, C. A. Spencer. 2005. Concepts of Genetics, Benjamin - Cummings Publishing Company	
5.	Harti, D. L. 2002. Essential Genetics, A Genomic Perspective, Jones & Bartlet	
Web Resources		
1.	https://onlinecourses.swayam2.ac.in/cec21_bt02/preview	
2.	https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/the-genetic-code	

Semester- III / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P3ZOC06	EVOLUTION	Core	Y	-	-	-	4	4	25	75	100
Learning Objectives											
CO1	To critically analyze the concepts of evolution in order to										
CO2	Understand the factors responsible for origin and generation of diversity among living beings and										
CO3	To develop strategies for sustenance of life on this planet										
CO4	To critically analyze the concepts of evolution in order to										
UNIT	Details									No. of Hours	Course Objectives
I	Emergence of evolutionary thoughts: Lamarck and Darwin – concepts of variation, adaptation, struggle, fitness and natural selection – Mendelism - Spontaneity of mutations - The evolutionary synthesis									12	CO1, CO2
II	Origin of cells and unicellular evolution: Origin of basic biological molecules - Abiotic synthesis of organic monomers and polymers - Concept of Oparin and Haldane - Experiment of Miller (1953) - The first cell - Evolution of prokaryotes - Origin of eukaryotic cells - Evolution of unicellular eukaryotes - Anaerobic metabolism, photosynthesis and aerobic metabolism									12	CO1, CO2, CO4, CO5
III	Paleontology and evolutionary history: The evolutionary time scale - Eras, periods and epoch - Major events in the evolutionary time scale - Origins of unicellular and multi cellular organisms - Stages in primitive evolution including <i>Homo sapiens</i>									12	CO1, CO2, CO3, CO5
IV	Molecular evolution: Molecular divergence - Molecular tools in phylogeny, classification and identification - Protein and nucleotide sequence analysis - Origin of new genes and proteins - Gene duplication and divergence									12	CO4, CO5
V	The mechanisms: Population genetics - Populations, Gene pool, Gene frequency - Hardy-Weinberg Law - concepts and rate of change in gene frequency through natural selection, migration and random genetic drift- Adaptive radiation - Isolating mechanisms – Speciation - Allopatricity and Sympatricity - Convergent evolution - Sexual selection - Co-evolution - Altruism and evolution									12	CO4, CO5
Total									60		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	To understand the concept of evolution. It provides a comprehensive account of evidences to support concept of evolution and different theories for exploring the mechanism of evolution.									PO1	
CO2	Study the origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.									PO1, PO2	
CO3	Understand the major events in the evolutionary time scale; Origins of unicellular and multi-cellular organisms.									PO3, PO4, PO5	
CO4	Comprehend the origin of new genes and proteins; Gene duplication and divergence.									PO4, PO5, PO6	
CO5	Appreciate the concepts and rate of change in gene frequency through natural selection, migration and random genetic drift									PO1, PO2, PO3, PO8	

**Text Books
(Latest Editions)**

1.	Bergstrom, C. T. and L. A. Dugatkin. 2012. Evolution, Second MEDIA Edition. W.W. Norton & Company, International Student Edition, pp-756.
2.	Jobling, M., E. Hollox, M. Hurles, T. Kivisild and C. T. Tyler Smith. 2014. Human Evolutionary Genetics. Second Edition. Garland Sciences, London, pp-650.
3.	Veer Bala Rostogi, 2018. Organic Evolution (Evolutionary Biology), Thirteenth Edition Vinoth Kumar Jain, Scientific International (Pvt.) Ltd, New Delhi, pp-590.

**REFERENCES BOOKS
(Latest editions, and the style as given below must be strictly adhered to)**

1.	Strickberger. M. W. 2000. Evolution. Third Edition, Jones Bartlett Publishers, pp-722.
2.	Hall B. K. and B. Hallgrimsson. 2014. Strickberger's Evolution. Fifth Edition, Bartlett Learning, An Ascend Learning Company, pp-642.
3.	Barton, N.H., D. Briggs, J.A. Eisen David, D.B. Goldstein and N.H. Patel. 2007. Evolution. Cold Spring Harbor Laboratory Press, pp-833.

Web Resources

1.	https://www.flipkart.com/books/evolution~contributor/pr?sid=bks
2.	http://www.evolution-textbook.org/
3.	https://onlinelibrary.wiley.com/journal/15585646
4.	http://darwin-online.org.uk/

Semester- III / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P3ZOC07	ANIMAL PHYSIOLOGY	Core	Y	-	-	-	4	4	25	75	100
Learning Objectives											
CO1	Students acquire the basic knowledge on physiology of different organs in animals and human.										
CO2	Understand the functions of different systems such as digestion, excretion, blood circulatory system, respiration and nervous system of animal relating them to structure and functions of various organs.										
UNIT	Details									No. of Hours	Course Objectives
I	Blood and circulation: Components of Blood, haemopoiesis, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, haemostasis. Cardiovascular system : Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above									12	CO1, CO2
II	Respiratory system: Comparison of respiration in different species, anatomical considerations, exchange of gases, transport of gases, waste elimination, neural and chemical regulation of respiration									12	CO1, CO2, CO4, CO5
III	Nervous system: Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Sense organs: Vision, hearing and tactile response									12	CO1, CO2, CO3, CO5
IV	Digestive system: Digestion, absorption, energy balance, BMR. Excretory system: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance									12	CO4, CO5
V	Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation. Thermoregulation: Comfort zone, body temperature-physical, chemical, neural regulation, acclimatization: Stress and adaptation									12	CO4, CO5
Total									60		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Understand the functions of different systems of animals									PO1	
CO2	Learn the comparative anatomy of heart structure and functions									PO1, PO2	
CO3	Know the transport and exchange of gases, neural and chemical regulation of respiration									PO3, PO4, PO5	
CO4	Acquire knowledge on the organization and structure of central and peripheral nervous systems									PO4, PO5, PO6	
Text Books (Latest Editions)											
1.	Prosser C. L. 1991, Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley-Liss Publishers, pp-592										
2.	Hoar, S.W. 1983, General and Comparative Physiology, Prentice Hall Publication, pp-928.										

3.	Randall, D., W. Burggren, K. French and R. Eckert. 2001, <i>Animal Physiology Mechanisms and Adaptations</i> , New York : W.H. Freeman and Co., pp-
4.	Nelson K. S. 1997. <i>Animal Physiology: Adaptation and Environment</i> , Cambridge University Press, pp-617.
5.	Dantzler, W.H. 1997. <i>Comparative Physiology (Handbook of Physiology)</i> , Volumes I and II. Edited by William H. Dantzler. pp - 1824 Published for the American Physiological Society by Oxford University Press Inc., New York. Oxford University Press Canada, Toronto.
REFERENCES BOOKS	
(Latest editions, and the style as given below must be strictly adhered to)	
1.	Shepherd, G. M. 1994. <i>Neurobiology</i> , OUP USA Publsiher, pp-774.
2.	Hainsworth , F.R. 1981. <i>Animal Physilogy: Adaptation in function</i> , Addison Wesley Longman Publishers, pp-669.
3.	Mcfarland, D. 1999. <i>Animal Behaviour: Psychobiology, Ethology and Evolution</i> , Longman Publisher, pp-592.
4.	Gorden, M.S. <i>et al.</i> , 1977. <i>Animal Physiology: Principles and Adaptation</i> , New York, Third Edition.
5.	Ahearn, G.A. <i>et al.</i> , 1988. <i>Advances in Comparative and Environmental Physiology – 2</i> , Springer Publishers, pp-252.
Web Resources	
1.	https://swayam.gov.in/nd1_noc20_bt42/preview
2.	https://www.classcentral.com/course/swayam-animal-physiology-12894
3.	https://swayam.gov.in/nd1_noc20_hs33/preview

Semester- III / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P3ZOCP03	GENETICS, EVOLUTION & ANIMAL PHYSIOLOGY	Core	Y	-	-	-	4	4	25	75	100

Learning Objectives

CO1	To understand the genes and alleles.
CO2	To know the physiological phenomenon in animal.
CO3	To study the evolutionary significance of animals.

GENETICS

1. Localization of Barr Bodies in Buccal smear.
2. Culture of Drosophila for observation of mutant and normal wings and eyes.
3. Pedigree analysis.
4. Multiple alleles – Human blood grouping.

ANIMAL PHYSIOLOGY

1. Survey of digestive enzymes in cockroach.
2. Determination of salt loss and gain in fish.
3. Determination Urea, Uric acid, Ammonia and Creatinine in urine samples.
4. Quantitative estimation of Protein, Carbohydrates and Lipids.

EVOLUTION

1. Study of fossils and living fossils.
2. Study of connecting links
3. Study of vestigial organs.

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Understand the genes and their inheritance	PO1
CO2	Learn the physiological changes and biochemical changes in animal.	PO1, PO2
CO3	Know about various evidence of evolution.	PO3, PO4, PO5
Text Books (Latest Editions)		
1.	Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp	
2.	Iulii G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp	
3.	Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp	

Semester- III / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P3ZODE06	STEM CELL BIOLOGY	Elective	Y	-	-	-	4	4	25	75	100
Learning Objectives											
1	Students should know understand the basics of stem cells										
UNIT	Details									No. of Hours	Course Objectives
I	Introduction to stem cell biology: Stem cell definition, origin and hierarchy, stem cell properties, Identification and Characterization, potency and differentiation, niche of stem cell, overview of different stem cell types (embryonic stem cells, adult stem cells and induced pluripotent stem cells).									12	CO1, CO2
II	Embryonic stem (ES) cell: Characterization and properties of ES cells , pluripotency and self-renewal of ES cells; molecular mechanisms regulating pluripotency and maintenance of the stem state, progressive differentiation of ES cells into ectoderm lineage organs (skin, brain and nerve), mesoderm lineage organs (heart, kidney, muscle, bone and blood), and endoderm lineage organs (lung, liver, stomach, pancreas and intestine).									12	CO1, CO2, CO4, CO5
III	Adult stem cells: Mesenchymal stem cells (MSCs) - sources, properties (plasticity, homing and engraftment), potency and characterization; Haematopoietic stem cells (HSCs) - sources, properties, potency and characterization; steps involved in production of induced pluripotent stem cells (iPSCs); role of Yamanaka factor in iPSCs.									12	CO1, CO2, CO3, CO5
IV	Stem cell and aging: aging theory; cell cycle; telomere and telomerase; senescence of stem cell; role of stem cell in aging; tissue repair and regeneration of adult stem cell.									12	CO4, CO5
V	Current stem cell therapies: Advantages and disadvantages of ES cells and adult stem cells (MSCs and HSCs) therapy; Ethical concern on stem cell therapy; current stem cell therapy for various diseases; clinical outcome of stem cell therapy; state of clinical trials in adult stem cells for various diseases.									12	CO4, CO5
Total									60		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Understand the basic knowledge of stem cells and their origin									PO1	

CO2	Differentiating the embryonic and adult stem cells	PO1, PO2
CO3	Understand and apply the current stem cell therapies for their research	PO3, PO4, PO5
Text Books (Latest Editions)		
1.	Kiessling, A.A. 2006. Human Embryonic Stem Cells (Second Ed.), Jones & Barlett Publishers.	
2.	Lanza, R. and A. Atala. 2005. Essentials of Stem Cell Biology. Academic Press, pp-712.	
3.	Turksen, K. 2004. Adult Stem Cells. Humana Press, Inc, pp-429.	
4.	Lanza, R. <i>et al.</i> 2004. Handbook of Stem Cells: Embryonic/Adult and Fetal Stem Cells (Vol. 1 & 2). Academic Press, pp-1626.	
5.	Institute of Medicine, 2002. Stem cells and the future of regenerative medicine. National Academy Press, pp-112.	
6.	Quesenberry, P.J., G.S. Stein, B. Forget and S. Weissman. 2001. Stem Cell Biology and Gene Therapy, Wiley Publishers, pp-584.	
7.	Sell, S. and Totowa, N.J. 2004. Stem Cells Handbook, Humana Press, pp-534	
8.	Battler, A., and Leo, J. 2007. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Springer Publication, pp-422.	

Semester- III / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
223P3ZODE07	MEDICAL LABORATORY TECHNIQUES	Elective	Y	-	-	-	4	4	25	75	100
Learning Objectives											
CO1	Students should understand the different protocols and procedures to collect clinical samples.										
UNIT	Details									No. of Hours	Course Objectives
I	Laboratory safety - toxic chemicals and biohazards waste- biosafety level- good laboratory practice - hygiene and health issue - physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.									9	CO1, CO2
II	Composition of blood and their function- collection of blood & lab procedure- haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count WBC- blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.									9	CO1, CO2, CO4, CO5
III	Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome-Computer tomography (CT scan) - Magnetic Resonance imaging - flowcytometry - treadmill test - PET.									9	CO1, CO2, CO3, CO5
IV	Cardiovascular system- Blood pressure - Pulse - regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) - significance - ultra sonography- Electroencephalography (EEG).									9	CO4, CO5
V	Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining - staining methods - vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.									9	CO4, CO5
Total									45		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.									PO1	
CO2	Explain the characteristics of clinical samples and demonstrate skill in handling clinical equipment.									PO1, PO2	
CO3	Evaluate the hematological and histological parameters of biological samples.									PO3, PO4, PO5	
Text Books											

(Latest Editions)	
1.	Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai
2.	Guyton and Hall, 2000. Text Book of medical Physiology, 10 th edition, Elseiner, New Delhi.
3.	Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol,I,II,III. Tata MC GrawHill, New Delhi.
4.	Sood, R, 2009. Medical Laboratory technology, Methods and interpretation.
REFERENCES BOOKS	
(Latest editions, and the style as given below must be strictly adhered to)	
1.	Manoharan,A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeypee brothers, New Delhi.
2.	Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia.Published by Tata McGraw-Hill Education Pvt. Ltd.,
3.	Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

Semester-IV / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P4ZOC08	IMMUNOLOGY	Core	Y	-	-	-	4	4	25	75	100
Learning Objectives											
1	To impart conceptual understanding of functional organization of immune system and its responsiveness in health and disease.										
2	To enable a successful performance in Immunology component of CSIR-UGC NET.										
UNIT	Details									No. of Hours	Course Objectives
I	Introduction to Immunology: Scope of immunology, Concepts of external and internal defense systems; External (first line / innate) defense system: Internal (second line / acquired) immune system: Types of immunity: innate and acquired – types. Cellular and humoral immune components- distribution, salient functions-primary and secondary immune responses									12	CO1, CO2
II	Immune tissues & organs: types, anatomical location, structure and development; lymphocyte traffic during development; functional features. Antigens: Definition, characteristic features and classification; Antigenicity versus immunogenicity; Adjuvants: definition, types and applications.									12	CO1, CO2, CO4, CO5
III	Major effectors components of cellular immune system: Lymphocytes - types, morphology. B and T cell receptors, B and T cell epitopes, Toll-like receptors; Antigen presenting cells: antigen processing and presentation, MHC molecules and their immunologic significance.									12	CO1, CO2, CO3, CO5
IV	Major effectors components of humoral immune system: Antibodies - Primary structure, classification, variants and functions. Antigen-antibody interactions; Monoclonal antibodies: definition, production and applications; Antibody engineering and its applications. Complement system - Components, activation pathways, and immune functions. Cytokines - Definition and salient functional features; Interleukins: definition, types (lymphokines and monokines), and functions. Interferons - Origin, types and functions.									12	CO4, CO5
V	Immune responses and Diseases: Hypersensitivity: definition, Types and immune manifestations; Auto-immune diseases: onset, spectrum of diseases, and major immune responses; Immunodeficiency diseases: types including SCID and consequences; Viral (AIDS), bacterial (tuberculosis) and parasitic (malaria) diseases: etiology, host immune responses and evasion by pathogens; Vaccines: types, preparations, efficacies and recent developments									12	CO4, CO5
Total									60		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Various basic concepts in immunology and organization of immune systems.									PO1	
CO2	Mechanisms of immune response in health and their defects in various diseases.									PO1, PO2	
CO3	The application of immunological principles in biomedical sciences including blood transfusion, tissue grafting and organ transplantation.									PO3, PO4, PO5	
CO4	Vaccinology and its importance in disease management										

**Text Books
(Latest Editions)**

1.	Kuby, J. 1997. Immunology. W. H. Freeman & Co., New York, pp-670.
2.	Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7 th edition), Mosby / Elsevier, Philadelphia, pp-472
3.	Abbas, A. K and A. H. Lichtman. 2007. Cellular and Molecular Immunology (6 th edition), W. B. Saunders, Philadelphia, pp-564
4.	Coica, R. Sunshine, G. 2015. Immunology (Seventh Edition), Wiley Blackwell, UK, pp-406.

**REFERENCES BOOKS
(Latest editions, and the style as given below must be strictly adhered to)**

1.	Weir, D. M and J. Stewart. 1997. Immunology, Churchill Livingstone, London, pp-362
2.	Janeway, C. A and P. Travers. 1997. Immunology, Garland Publ. Inc., London, pp-904
3.	Peakman, M and D. Vergani. 1997. Basic and Clinical Immunology, Churchill Livingstone, London, pp-366
4.	Hood, L. Weissman, I. Wood, W. Wilson, J. 1984. Immunology (Second Edition), the Benjamin/Cummings, California, pp-558.

Semester-IV / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P4ZOC09	ECOLOGY	Core	Y	-	-	-	4	4	25	75	100
Learning Objectives											
1	Knowing the ecology and climatic changes at world level and its impact on natural resources.										
2	Understanding the contributing factors for pollution in the environment and the ways in controlling and restoring to natural conditions										
UNIT	Details									No. of Hours	Course Objectives
I	The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.									12	CO1, CO2
II	Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (<i>r</i> and <i>K</i> selection); concept of metapopulation-demes and dispersal, interdemec extinctions, age structured populations -action taken to control population explosion.									12	CO1, CO2, CO4, CO5
III	Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax									12	CO1, CO2, CO3, CO5
IV	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, eustarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.									12	CO4, CO5
V	Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches - Waste management. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).									12	CO4, CO5
Total									60		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Learn about the ecosystem, biotic communities and utilizing the energy processing									PO1	
CO2	Study the various community and population and population control									PO1, PO2	
CO3	Understand the fundamentals of climatic conditions and its impact on environment									PO3, PO4, PO5	
CO4	Realizing the nature of pollution and the ways for its control/reduction									PO1, PO2	
CO5	Impact of environmental studies on solid waste management									PO3, PO4, PO5	
Text Books											

(Latest Editions)

1.	Sharma, P.D. 2009. Ecology and Environment, Rastogi Publication, India, pp-616.
2.	Calabrese, E.J. 1978. Pollutants and High-Risk Groups, John Wiley, pp-286.
3.	Raven, P.H. and L.R. Berg, G.B. Johnson, 1993. Environment, Saunders College Publishing, pp-579.
4.	Cunningham, W. P. and B. W. Saigo, 1999. Environmental Science, McGraw Hill Boston, 5th Edition.
5.	Odum, E.P. 1893. Basic Ecology, Saunders & Co., Philadelphia, pp-383.

Semester-IV / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P4ZOCPO4	LAB COURSE IN IMMUNOLOGY & ECOLOGY	Core	Y	-	-	-	4	4	25	75	100
Learning Objectives											
1	To provide hands-on training to perform specific lab courses in immunology and research methodology.										
2	To enable clear understanding of the methodology through wet – lab courses.										
IMMUNOLOGY											
<ol style="list-style-type: none"> Histological study of primary and secondary lymphoid organs. Agglutination reaction: Qualitative analysis of antigen-antibody reaction using human blood group system Separation of lymphocytes from peripheral blood and identification of T and B cells. Identification of differential leucocytes count. ELISA – Demonstration. 											
ECOLOGY											
<ol style="list-style-type: none"> Determination of pH in water samples using pH paper and pH meter. Qualitative and quantitative analysis of zooplankton and mounting of any two types of species. Estimation of biological oxygen demand in water samples. Estimation of iron in water samples. Estimation of phosphates in water samples. 											
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Acquire ability to perform/ demonstrate various basic concepts in immunology as well as applications of research methods for quantitative/ qualitative analysis of biochemical components.									PO1	
CO2	Can estimate physiochemical properties of environmental samples,									PO3	

Semester- IV / Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P4ZODE08	AQUACULTURE	Elective	Y	-	-	-	4	4	25	75	100
Learning Objectives											
O1	Students should know basic concepts in Aquaculture.										
UNIT	Details									No. of Hours	Course Objectives
I	Importance of aquaculture- Present status, prospects and scope in India. Freshwater aquaculture- Brackishwater aquaculture- Mariculture - Metahaline culture in India. Types of fish culture -Types of fish ponds for culture practice. Topography, site selection - water quality - soil condition and quality – structure and construction design and layout - inlet and outlet. Water quality management for aquaculture. Control of parasites, predators and weeds in culture ponds. Fish farm implements - Secchi disc - aerator - pH meter - tools for hypophysation - feeding trays – Fishing gears used in aqua farming.									9	CO1, CO2
II	Procurement of seed from natural resources- collection methods and segregation. Hatchery technology for major carps and freshwater prawn. Artificial seed production – Breeding under control conditions, induced breeding technique, larval rearing, packing and transportation Commercial substitute for pituitary extracts. Classification of fish feed- Artificial feeds Types, Feed - formulation - feeding methods. Live feed- Microalgae, Rotifer, Artemia and their culture.									9	CO1, CO2, CO4, CO5
III	Shrimp hatchery technology - Hatchery design, brood stock management, spawning, larval rearing, Shrimp developmental stages, algal culture, packing and transportation. Shrimp culture technology - extensive culture methods semi- intensive - intensive culture methods - Biofloc technology - Culture operations (water quality, feed and health management) - harvesting, preservation and marketing. Brackish water fish culture. Edible and Pearl oyster culture - pearl production. Crab culture. Economic importance of Lobster, Sea urchin and Sea cucumber - their by-products. Types of Seaweeds - species and methods of culture – by-products									9	CO1, CO2, CO3, CO5
IV	Fish and Shrimp diseases and health management – infectious diseases - Bacterial, Fungal, Viral, Protozoan; Non-infectious - environmental and nutritional diseases. Diseases diagnosis, prevention and control measures.									9	CO4, CO5
V	Types of ornamental fishes (freshwater and marine), their breeding behavior and biology. Oviparous, Ovo-viviparous and Viviparous fishes. Setting and maintenance of freshwater Aquarium tanks. Central aquaculture research organizations- CMFRI, CIBA, CIFT, CIFA, CIFE, MPEDA and its activities.									9	CO4, CO5
Total									50		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	To develop knowledge on the fish farm and their maintenance. Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques									PO1	
CO2	To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval culture									PO1, PO2	
CO3	Identifies the different fishes diseases, diagnosis and their management										

	strategies. Understands Ornamental fishes and central aquaculture organizations	
Text Books (Latest Editions)		
1.	Pillay, T. V. R. (1990). Aquaculture: Principles and Practices. Blackwell Scientific Publications Ltd.	
2.	Yadav, B. N. (1997). Fish and fisheries. Daya Publishing house, New Delhi.	
3.	Sinha, V.R. P. and Srinivastava, H. C. (1991). Aquaculture Productivity. Oxford and IBH Publications CO., Ltd., New Delhi.	
4.	Santhanam, R. (1990). Fisheries Science. Daya Publishing House.	

Semester-IV/ Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
23P4ZODE09	ANIMAL BEHAVIOR	Elective	Y	-	-	-	4	4	25	75	100
Learning Objectives											
1	Students should understand basic concepts in Animal behaviour.										
UNIT	Details								No. of Hours	Course Objectives	
I	Genetic material, Genes and chromosomes, Genetic variation, Single and Polygenic inheritance of behaviour, Heritability of behaviour, Natural selection and behaviour, Frequency distribution of phenotypes, Darwinian fitness, Evolution of adaptive strategies.								9	CO1, CO2	
II	Sexual selection, Altruism, Sexual strategy and social organisation, Animal perception, Neural control of behaviour, Sensory processes and perception, Visual adaptations to unfavourable environments.								9	CO1, CO2, CO4, CO5	
III	Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning.								9	CO1, CO2, CO3, CO5	
IV	Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of honey bees, Evolutionary optimality, Mechanism of Decision making. The mentality of Animals: Languages and mental representation, non-verbal communication in human, mental images, Intelligence, tool use and culture, Animal awareness and Emotion.								9	CO4, CO5	
V	Organization of circadian system in multicellular animals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo-transduction; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases - Chronopharmacology, chronomedicine, chronotherapy.								9	CO4, CO5	
Total									45		
Course Outcomes											
Course Outcomes	On completion of this course, students will;										
CO1	Recall and record genetic basis and evolutionary history of behaviour.								PO1		
CO2	Analyse and identify innate, learned and cognitive behaviour and differentiate between various mating systems.								PO1, PO2		
CO3	Classify movement and migration behaviours and explain environmental influence upon behaviour.										
Text Books (Latest Editions)											

1.	David McFarland, 1985. Animal Behaviour, Longman Scientific & Technical, UK. 576pp.
2.	Harjindra Singh, 1990. A Text Book of Animal Behaviour, Anomol Publication, 293pp.
3.	Hoshang S. Gundevia and Hare Govind Singh, 1996. Animal Behaviour, S. Chand & Co, 280pp.
4.	Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp.
5.	Vinod Kumar, 2002. Biological Rhythms. Narosa Publishing House, Delhi
REFERENCES BOOKS	
(Latest editions, and the style as given below must be strictly adhered to)	
1.	Michael D. Breed and Janice Moore, 2012. Animal Behaviour, Academic Press, USA, 359pp.
2.	Aubrey Manning and Martin Stamp Dawkins, 2012. An Introduction to Animal Behaviour, 6th Edition, Cambridge University Press, UK. 458pp.
3.	Davis E. Davis, 1970. Integral Animal Behaviour, Mac Millan Company, London, 118pp.
4.	Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (ed). 2004. Chronobiology Biological time Keeping, Sinauer Associates Inc, Publishers, Sunderland, MA.