



SYLLABUS

Core, Complementary
& Open Courses

UG PROGRAMME IN ZOOLOGY

Under Choice Based Credit Semester

**FAROOK
COLLEGE**
(AUTONOMOUS)

CERTIFICATE

I hereby certify that the documents attached are the bonafide copies of the syllabus of Core Courses offered to B.Sc. Zoology programme and Complementary & Open Courses offered by the Department of Zoology to be effective from 2022 admission onwards.

Principal

Date:
Place: Farook College

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MEMBERS OF BOARD OF STUDIES

CHAIRMAN:

1. **Dr. Abdul Hameed. S.V (Chairman) Ph: 9645681816**
e-mail: svabdulhameed@gmail.com
Associate Professor & Head
Department of Zoology, Farook College, Calicut – 673 632

MEMBERS

1. **Ms. Shabana. T. P**
Ph: 9446800648
Associate Professor,
Department of Zoology, Farook College
2. **Dr. Rashiba A.P.**
Ph: 9895285242
Assistant Professor
Department of Zoology, Farook College
3. **Dr. Abdul Gafoor P.**
Ph: 9447635613
Assistant Professor
Department of Zoology, Farook College
4. **Dr. Sobha T.R.**
Ph: 9048871751
Assistant Professor
Department of Zoology, Farook College
5. **Dr. Kishore Kumar K.**
Ph: 9895339755
Assistant Professor & Head
Department of Botany, Farook College
6. **Dr. Adnaan Farook V.**
Ph: 9497892541
Assistant Professor
Department of Botany, Farook College
7. **Dr. T.V.Sajeev**
Ph: 9447125458
Principal Scientist,
KFRI, Peechi, Thrissur
8. **Dr. P.P. Rajan**
Ph: 9947311980
HoD of Botany
Zamorin's Guruvayurappan College, Kozhikode
9. **Dr. M. Nasser,**
Ph: 8547560471
Pro- Vice Chancellor (Professor, Dept of Zoology), University of Calicut
10. **Dr. M. Sabu**
Ph: 9447636333
Emiretus Scientist
MBGIPS, Kozhikode
11. **Dr. P.A. Azeez**
Ph: 8903213942
Former Director

SACON, Coimbatore, Bharathiar University, Coimbatore

SPECIAL INVITEE

- 1. Dr. Santhosh J. Eapen**
Ph: 9447072747
Head, Division of Crop Protection
IISR, Chelavoor, Kozhikode
- 2. Dr. H. Habeebrehman**
Ph: 9495400181
Assistant Professor,
Department of Zoology, Farook College
- 3. Naseeha C.P.**
Ph: 924993 8304
Assistant Professor
Department of Botany, Farook College

PROGRAMME SPECIFIC OUTCOMES (PSO)

Upon completion of BSc Zoology programme, the students will be able to:

- PSO 01** Understand the fundamental concepts, foundations, theories and ideas in zoology and their importance.
- PSO 02** Understand the biological diversity and grades of complexity of various animal forms through their systematic classification and process of organic evolution.
- PSO 03** Understand the roles of plants, animals and microbes in the sustainability of the environment and their interaction among themselves and deterioration of the environment due to anthropogenic activities.
- PSO 04** Apply theoretical knowledge, critical thinking and analytical skills to study human interactions in the ecosystem
- PSO 05** Apply a range of research methods, both quantitative and qualitative, to collect and analyze data relevant to environmental research questions, drawing appropriate conclusions and making evidence-based recommendations and communicate research findings effectively, both orally and in writing, to a variety of audiences
- PSO 06** Analyze the concepts and principles of biochemistry, immunology, physiology, ethology, endocrinology, developmental biology, cell biology, genetics, molecular biology and microbiology and develop technical skills in biotechnology, bioinformatics and biostatistics.
- PSO 07** Execute or experiment various laboratory procedures as per standard protocols in the areas of animal diversity, systematics, cell biology, genetics, biochemistry, molecular biology, microbiology, physiology, immunology, developmental biology, environmental biology,

ethology, evolution and science methodology.

- PSO 08** Analyze the characteristics, nomenclature and classification of human chromosomes; construction of pedigrees of Sex-linked and Autosomal dominant and recessive gene mutation disorders, multifactorial inheritance, basic genetics of reproduction and development major genetic services and genetic counseling
- PSO 09** Evaluate the critical aspects and theories of sociology of development, media and society, environment and society and sociology of health and illness.
- PSO 10** Evaluate the key concepts, theories, methods and types underpinning social research methods, and their applicability to different research contexts.
- PSO 11** Create a comprehensive research design that includes clear research questions, appropriate sampling methods, and ethical considerations and an awareness of the ethical considerations and potential implications of social research, including issues related to confidentiality, informed consent, and the potential impact of research on participants.

SCHEME OF THE PROGRAMME

Credit and Mark Distribution in Each Semester Total Credits: 140

Semester	Course	Credit	Internal Mark	External Mark	Total Mark
I	Common course: English	3	15	60	75
	Common course: English	3	15	60	75
	Common course: Prose & Drama	4	20	80	100
	Core Course 1: Animal diversity: non-chordata part I	2	15	60	75
	Complementary course: General Chemistry	2	15	60	75
	Complementary course Angiosperm Anatomy and Microtechnique	2	15	60	75
	Audit Course: Environment studies	4	20	80	100
	Total		20		
II	Common course: Writing for the Academic & Professional Success	4	20	80	100
	Common course: Zeitgeist-Reading on Contemporary Culture	4	20	80	100
	Common course: Grammar and Translation	4	20	80	100

	Core Course 2: Animal diversity: non-chordata part – 11	2	15	60	75
	Complementary course: Physical chemistry	2	15	60	75
	Complementary course: Cryptogams, Gymnosperm & Plant Pathology	2	15	60	75
	Audit Course: Disaster Management	4	20	80	100
		22			625
III	Common course: English	4	20	80	100
	Common course: Poetry in Hindi	4	20	80	100
	Core Course 3: Animal diversity: chordata part 1	3	15	60	75
	Complementary course: Organic Chemistry	2	15	60	75
	Complementary course: Morphology, systematic Botany, EcoBotany, Plant Breeding & Horticulture	2	15	60	75
	Audit Course: Human Rights	4	15	60	75
	Total	19			
IV	Common course: Spectrum: Literature Contemporary issues	4	20	80	100
	Common course: Novel and Short stories	4	20	80	100
	Core Course 4: Animal diversity: chordata part 11	3	15	60	75
	Core Course 5: Animal Diversity Practical -1	4	20	80	100
	Complementary course: Physical & Applied Chemistry	2	15	60	75
	Complementary course (Practical): Physical & Applied Chemistry	4	20	80	100
	Complementary course: Plant Physiology, Ecology & Genetics	2	15	60	75
	Complementary Practical	4	20	80	100

	Audit Course: Gender Studies	4	20	80	100
	Total	31			825
V	Core Course 6: Cell biology and genetics	4	20	80	100
	Core Course 7: Biotechnology microbiology and immunology	4	20	80	100
	Core Course 8: Biochemistry and molecular biology	4	20	80	100
	Core Course 9: Methodology in science, Biostatistics, and Bioinformatics.	4	20	80	100
	Open course	3	15	60	75
	Total	19			475
VI	Core Course 10: Physiology and endocrinology	3	15	60	75
	Core Course 11: Reproductive and developmental biology	3	15	60	75
	Core Course 12: Environmental and conservation biology	3	15	60	75
	Core Course 13: Ethology, Evolution and zoogeography	3	15	60	75
	Elective Course: Human genetics	2	15	60	75
	Elective Course: Aquaculture, Animal Husbandry, and Poultry science				
	Elective Course Applied Entomology				
	Practical Core: Practical II	4	20	80	100
	Practical Core: Practical III	4	20	80	100
	Project Work	3	15	60	75
Total	25			650	
English	22			550	
W12Additional Language	16			400	

Complementary Course: Chemistry				12				400	
Complementary Course: Botany				12				400	
Core Course: Zoology				52				1375	
Open Course				3				75	
Project				3				75	
<i>Audit Course</i>				<i>16</i>				400	
<i>Extra Credit Activities</i>				<i>4</i>				100	
Total				140					
Semester	Common Course		Core Course	Complementary Course		Open Course	Project	Audit Course	Total
	English	Additional language		Chemistry	Botany				

1	3+3	4	2	2	2			4	20
2	4+4	4	2	2	2			4	22
3	4	4	3	2	2			4	19
4	4	4	3+4*	2+4*	2+4*			4	31
5			4+4+4+4			3			19
6	-	-	3+3+3+3+2+4+4				3		25
Total	22	16	52	12	12	3	3	16	136
Extra Credit Activities									4
Grand Total = (120 + 16 Audit Courses + 4 Extra Credit Activities)									140

Credit Distribution

CORE COURSE STRUCTURE

Total Credits: 52 (Internal: 20%; External: 80%)

Semester	Code No	Course Title	Hrs/ Week	Credit	Marks
I	BZL1B01	Core Course I: Animal diversity: non- chordata part1		2	75
II	BZL2B02	Core Course II: Animal diversity: non- chordata part – 11		2	75
III	BZL3B03	Core Course III: Animal diversity: chordata part1		3	75
IV	BEC4B04	Core Course IV: Animal diversity: chordata part 11		3	75
	BZL4B05P	Core Course V: Animal Diversity Practical -1		4	
V	BZL5B06	Core Course VI: Cell biology and genetics		4	100
	BZL5B07	Core Course VII: Biotechnology microbiology and immunology		4	100
	BZL5B08	Core course VIII: Biochemistry and molecular biology		4	100
	BZL5B09	Core Course IX: Methodology in science, Biostatistics, and Bioinformatics.		4	100

VI	BZL6B10T	Core Course X: Physiology and endocrinology		3	75
	BZL6B11T	Core Course XI: Reproductive and developmental biology		3	75
	BZL6B12T	Core Course XII: Environmental and conservation biology		3	75
	BZL6B13T	Core Course XIII: Ethology, Evolution and zoogeography		3	75
	BZL6B15P	Practical II		4	
	BZL6B16P	Practical III		4	
	BZL6B16P	Project work and field study		3	75
				55	1075

ELECTIVE COURSE STRUCTURE

Semester	Code No	Course Title	Hrs/ Week	Credit	Marks
VI	BZL6E01	Elective Course I: Human genetics	3	3	75
	BZL6E02	Elective Course II: Aquaculture, Animal Husbandry, and Poultry science			
	BZL6E03	Elective Course III: Applied Entomology			

OPEN COURSE STRUCTURE

Semester	Code No	Course Title	Hrs/ Week	Credit	Marks
V	BZL5D01	Open Course I: Reproductive health and sex education		3	75
	BZL5D02	Open Course II: Nutrition, Health and Hygiene			

	BZL5D03	Open Course III: Applied zoology (any one)			
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COMPLEMENTARY COURSE STRUCTURE

Total Credits: 24 (Internal: 20%; External: 80%)

Semester	Code No	Course Title	Hrs/Week	Total Hrs	Credit	Marks
I	BCH1C01	Complementary Course I: General Chemistry			2	
	BBT1C01	COMPLEMENTARY COURSE II: Angiosperm Anatomy and Micro technique			2	
II	BCH2C02	COMPLEMENTARY COURSE III: Physical chemistry			2	
	BBT2C02	COMPLEMENTARY COURSE IV: Cryptogams, Gymnosperm & Plant Pathology			2	
III	BCH3C03	COMPLEMENTARY COURSE V: Organic Chemistry			2	
	BBT3C03	COMPLEMENTARY COURSE VI: Morphology, systematic Botany, EcoBotany, Plant Breeding & Horticulture			2	
IV	BCH4C04	COMPLEMENTARY COURSE – VII: Physical & Applied Chemistry			2	
	BCH4C05(P)	COMPLEMENTARY COURSE (Practicals): Physical & Applied Chemistry			4	
	BBT4C04	COMPLEMENTARY COURSE VIII: Plant Physiology, Ecology & Genetics			2	
	BBT4C05P	COMPLEMENTARY COURSE (Practicals): Plant Physiology, Ecology & Genetics			4	
Total					24	

CORE COURSE SYLLABUS

SEMESTER 1

COURSE CODE: BZL1B01
CORE COURSE I: ANIMAL DIVERSITY: NON-CHORDATA PART- I

Credit	Hours/week	Marks		
		Internal	External	Total
2	2	15	60	75

Course Outcome	Expected Course Outcome	Learning Domains	PSO No
		Upon completion of this course, students will be able to;	
CO1	Describe the principles of classification and nomenclature	understand	2
CO2	Explain the five-kingdom classification of living organisms	Apply	3
CO3	Understand the concepts of classification of animals	Evaluate	5
CO4	Explain the classification with examples and characteristic features of kingdom Protista and describe the morphology and structural organization of <i>Paramecium</i>	Analyse	2
CO5	Describe the characteristic features of subkingdom Mesozoa	Apply	8
CO6	Explain the classification of phylum Porifera and elucidate the salient features of each class	Create	4
CO7	Describe the characteristic features of phylum Cnidaria and Ctenophora, illustrate the classification of phylum Cnidaria down to classes and explain the structural organization of <i>Obelia</i>	Create	2
CO8	Enlist the salient features of phylum Platyhelminthes and illustrate its classification down to classes	Understand	10
CO9	Explain the characteristic features and classification of super-phylum Aschelminthes and phylum Nematoda	Analyse	9
CO10	Elucidate the characters of Pseudocoelomate minor phyla Rotifera and Gastrotricha	Understand	2

COURSE CONTENT	
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Module 1. CONCEPTS OF CLASSIFICATION OF ORGANISMS	5 Hours										
Principles of classification and nomenclature											
Systematics: natural and classical. Nomenclature: Binomial and Trinomial nomenclature; International rules of Zoological nomenclature (brief account); Mention modern trends in systematics: Chemotaxonomy, Serotaxonomy, Cytotaxonomy, Evolutionary taxonomy, Numerical taxonomy (Phenetics), Cladistics (Phylogenetics), Molecular systematics, DNA barcoding											
Module 2. Five kingdom classification of living organisms	1 Hours										
Mention Cavalier-smith's eight kingdom classification also.											
Module 3. Concepts of classification of animals	4 Hours										
Classification based on number of cells, tissue or organ system level of organization, development of germ layers, development of symmetry, development of coelom, segmentation, homology and analogy of organs and their origin, development of mouth and digestive tract (brief account).											
Module 4 CLASSIFICATION OF KINGDOM PROTISTA	6 Hours										
Characteristic features and classification of Kingdom Protista down to phyla. [Salient features of the major groups of protists given below with notes on the examples cited]											
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Phylum: Rhizopoda</td> <td style="width: 50%;">e.g. <i>Entamoeba</i></td> </tr> <tr> <td>Phylum: Dinoflagellata</td> <td>e.g. <i>Noctiluca</i></td> </tr> <tr> <td>Phylum: Parabasilia</td> <td>e.g. <i>Trichonympha</i></td> </tr> <tr> <td>Phylum: Apicomplexa [=Sporozoa]</td> <td>e.g. <i>Plasmodium</i></td> </tr> <tr> <td>Phylum: Ciliophora</td> <td>e.g. <i>Vorticella</i>.</td> </tr> </table>		Phylum: Rhizopoda	e.g. <i>Entamoeba</i>	Phylum: Dinoflagellata	e.g. <i>Noctiluca</i>	Phylum: Parabasilia	e.g. <i>Trichonympha</i>	Phylum: Apicomplexa [=Sporozoa]	e.g. <i>Plasmodium</i>	Phylum: Ciliophora	e.g. <i>Vorticella</i> .
Phylum: Rhizopoda	e.g. <i>Entamoeba</i>										
Phylum: Dinoflagellata	e.g. <i>Noctiluca</i>										
Phylum: Parabasilia	e.g. <i>Trichonympha</i>										
Phylum: Apicomplexa [=Sporozoa]	e.g. <i>Plasmodium</i>										
Phylum: Ciliophora	e.g. <i>Vorticella</i> .										
Type <i>Paramecium</i> Morphology and structural organization [as revealed by compound microscopy]; locomotion, nutrition, excretion, osmoregulation and reproduction; conjugation in detail.											
Module 5. Subkingdom: MESOZOA	1 Hour										
A brief account of Dicyemid (=Rhombozoans) mesozoans [e.g. <i>Dicyema</i>] and Orthonectid mesozoans [e.g. <i>Rhopalura</i>]											
Module 6 Subkingdom: PARAZOA Phylum: PORIFERA	3 Hours										
Classification down to classes and salient features of each class.											
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Class Calcarea (=Calcispongiae)</td> <td style="width: 50%;">e.g. <i>Leucosolenia</i></td> </tr> <tr> <td>Class Demospongiae</td> <td>e.g. <i>Spongilla</i></td> </tr> <tr> <td>Class Hexactinellida (=Hyalospongiae)</td> <td>e.g. <i>Euplectella</i></td> </tr> </table>		Class Calcarea (=Calcispongiae)	e.g. <i>Leucosolenia</i>	Class Demospongiae	e.g. <i>Spongilla</i>	Class Hexactinellida (=Hyalospongiae)	e.g. <i>Euplectella</i>				
Class Calcarea (=Calcispongiae)	e.g. <i>Leucosolenia</i>										
Class Demospongiae	e.g. <i>Spongilla</i>										
Class Hexactinellida (=Hyalospongiae)	e.g. <i>Euplectella</i>										
Give an account of canal system (Asconoid, Syconoid, Leuconoid and Rhagonoid); Mention amphiblastula, parenchymula and sponge gemmule.											
Module 7 Sub kingdom: METAZOA Phylum CNIDARIA [=COELENTERATA]	8 Hours										

Classification of the phylum down to classes and salient features of each class. <i>Class Hydrozoa e.g. Halistemma, Physalia</i> <i>Class Scyphozoa e.g. Rhizostoma</i> <i>Class Anthozoa e.g. Adamsia, Zoanthus, and Madrepora</i> Type <i>Obelia</i> : Morphology and life cycle. Polymorphism in cnidarians with special reference to siphonophores. Phylum CTENOPHORA [ACNIDARIA] Unique features as exemplified by <i>Pleurobrachia</i> ; mention cidioid larva.	
Module 8 ACOELOMATA Phylum platyhelminthes	3 Hours
Classification down to classes and salient features of the following classes. <i>Class Turbellaria e.g. Bipalium</i> <i>Class Trematoda e.g. Fasciola</i> <i>Class Cestoda e.g. Taenia</i> Type <i>Dugesia</i> (Planaria): Structural organization, Digestive system, locomotion and reproduction.	
Module 9 PSEUDOCOELOMATA	3 Hours
Super Phylum: aschelminthes Classification down to phyla; highlight the heterogeneous nature of animals of this group. Phylum: NEMATODA Characteristic features of <i>Ascaris</i> . Examples: <i>Ancylostoma, Enterobius, Wuchereria</i>	
Module 10 PSEUDOCOELOMATE MINOR PHYLA	2 Hours
Salient features of the following pseudocoelomate minor phyla: Phylum Gastrotricha <i>e.g. Chaetonotus</i> Phylum Rotifera <i>e.g. Brachionus</i>	

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled Presentations

Presentation of students Seminar Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (15 Marks)				
a.	Classroom participation (20%):	3 Mark		
b.	Test papers I (40%):	6 Mark		
c.	Assignment (20%):	3 Mark		
d.	Seminar/ Viva (20%):	3 Mark		
External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21				
PATTERN OF QUESTION PAPER				
Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	20
Paragraph	7	Up to 7	5	30
Essay	2	1	10	10
Total				60

MODULE WISE MARK DISTRIBUTION	
Module	Mark
Module 1	7
Module 2	2
Module 3	9
Module 4	17
Module 5	2
Module 6	7
Module 7	19
Module 8	7
Module 9	7
Module 10	2

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SEMESTER

COURSE CODE: BZL2B02				
CORE COURSE II: ANIMAL DIVERSITY: NON-CHORDATA PART- II				
Credit	Hours/week	Marks		
		Internal	External	Total
2	4	15	60	75

Course Outcomes	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	Explain the classification with examples and characteristic features of phylum Annelida and describe the morphology and structural organization of <i>Neanthes</i>	understand	2
CO2	Describe the distribution, peculiarities and affinities of phylum Onychophora	Evaluate	5

CO3	Explain the classification of phylum Arthropoda; elucidate the salient features of each class and describe the morphology and structural organization of <i>Penaeus</i>	Understand	7
CO4	Describe the characteristic features of phylum Mollusca, illustrate its classification down to classes and explain the structural organization of <i>Pila globosa</i>	Apply	1,2
CO5	Explain the salient features of phylum Echinodermata and illustrate its classification down to classes	Analyse	10
CO6	Understand the salient features and affinities of phylum Hemichordata	Understand	4
CO7	Elucidate the characters of coelomate minor phyla Phoronida, Ectoprocta and Echiura	Analyse	6

COURSE CONTENT							
Module I	7 Hours						
<p>Phylum ANNELIDA Classification down to subclasses; salient features of the following classes and subclasses:</p> <ol style="list-style-type: none"> 1. Class Polychaeta e.g. Arenicola 2. Class Clitellata <ul style="list-style-type: none"> • Subclass Oligochaeta e.g. Megascolex • Subclass Hirudinea e.g. Hirudinaria, Haemadyspa. <p>Type: Neanthes [Nereis] [Morphology, body wall, digestive system, respiratory system, circulatory system, excretory system, sense organs and reproductive system. Mention Heteronereis stage and Trochophore larva.]</p>							
Module II	2 Hours						
<p>Phylum ONYCHOPHORA Peripatus [distribution, peculiarities and affinities].</p>							
Module III	11 Hours						
<p>Phylum ARTHROPODA Classification down to classes (mention the five subphyla and 16 arthropod classes); salient features of the following classes:</p> <table border="1" style="width: 100%;"> <tr> <td>1. Class Trilobita (brief account only)</td> <td></td> </tr> <tr> <td>2. Class Merostomata</td> <td>e.g. <i>Limulus</i></td> </tr> <tr> <td>3. Class Arachnida</td> <td>e.g. <i>Heterometrus</i> (<i>Palamnaeus</i>), <i>Heteropoda</i></td> </tr> </table>		1. Class Trilobita (brief account only)		2. Class Merostomata	e.g. <i>Limulus</i>	3. Class Arachnida	e.g. <i>Heterometrus</i> (<i>Palamnaeus</i>), <i>Heteropoda</i>
1. Class Trilobita (brief account only)							
2. Class Merostomata	e.g. <i>Limulus</i>						
3. Class Arachnida	e.g. <i>Heterometrus</i> (<i>Palamnaeus</i>), <i>Heteropoda</i>						

	(Huntsman spider, Order <i>Araneae</i>). Mention ticks and mites (Subclass <i>Acari</i>).
4. Class Chilopoda	e.g. <i>Scolopendra</i> , <i>Scutigera</i>
5. Class Diplopoda	e.g. <i>Spirostreptus</i> , <i>Julus</i>
6. Class Crustacea	e.g. <i>Sacculina</i> , <i>Eupagurus</i>
7. Class Insecta	e.g. <i>Lepisma</i> , <i>Mantis</i> , <i>Tabanus</i> , <i>Troides minos</i> (Southern Birdwing butterfly), <i>Papilio buddha</i> (Malabar Banded Peacock), <i>Apis</i> .

Type: *Penaeus indicus* [Prawn]

[Morphology, digestive system, respiratory system, blood vascular system, excretory system, nervous system, sense organs (statocyst, compound eye in detail), reproductive system and development]

[Details of larval stages not expected].

1. Class Aplacophora	e.g. <i>Chaetoderma</i>
2. Class Polyplacophora (=Amphineura)	e.g. <i>Chiton</i>
3. Class Monoplacophora	e.g. <i>Neopilina</i>
4. Class Gastropoda	e.g. <i>Turbinella</i>
5. Class Bivalvia (=Pelecypoda)	e.g. <i>Perna</i>
6. Class Scaphopoda	e.g. <i>Dentalium</i>
7. Class Cephalopoda (=Siphonopoda)	e.g. <i>Sepia</i>

Module IV	8 Hours
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Phylum MOLLUSCA

Classification down to classes; Mention Nudibranchs and Nautilus. Salient features of the following classes:

Type: *Pila globosa* [Apple Snail]

[Morphology, digestive system, respiratory system, blood vascular system, excretory system, nervous system, sense organs (osphradium in detail) and reproductive system].

Module V	4 Hours
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Phylum ECHINODERMATA

Classification down to classes [of extant forms only]; salient features of the following classes and brief account of examples:

1. Class Crinoidea e.g. Antedon
2. Class Asteroidea e.g. Astropecten
3. Class Ophiuroidea e.g. Ophiothrix
4. Class Holothuroidea e.g. Holothuria
5. Class Echinoidea e.g. Echinus

Structural peculiarities of Asterias (starfish); water vascular system in detail.

Module VI	1 Hour
Phylum HEMICHORDATA <i>Balanoglossus</i> : Salient features and affinities.	
Module VII	3 Hours
COELOMATE MINOR PHYLA Salient features of the following coelomate minor phyla; mention examples specified [structure and life history not required). <ol style="list-style-type: none"> 1. Phylum Phoronida e.g. <i>Phoronis</i> 2. Phylum Ectoprocta/Bryozoa e.g. <i>Bugula</i> 3. Phylum Echiura e.g. <i>Bonellia</i> 	

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled Presentations

Presentation of students Seminar Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (15 Marks)				
a. Classroom participation (20%):	3 Mark			
b. Test papers I (40%):	6 Mark			
c. Assignment (20%):	3 Mark			
d. Seminar/ Viva (20%):	3 Mark			
External Assessment (60 Marks) Duration 2. Hours, No of Questions: 21				
Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	20
Paragraph	7	Up to 7	5	30
Essay	2	1	10	10
Total				60

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	14
Module II	2
Module III	28
Module IV	19
Module V	7
Module VI	2
Module VII	7

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SEMESTER 3

COURSE CODE: BZL3B03

CORE COURSE III: ANIMAL DIVERSITY: CHORDATA PART- I

Credit	Hours/week	Marks		
		Internal	External	Total
2	4	15	60	75

Course Outcomes	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	Explain the characteristics of chordates and outline classification of the phylum Chordata	Understand	3

CO2	Describe the salient features and affinities of subphylum Urochordata and its classification down to classes; elucidate the morphology and structural organization of <i>Ascidia</i>	Evaluate	7
CO3	Explain the salient features and affinities of subphylum Cephalochordata with reference to <i>Branchiostoma</i>	Analyse	9
CO4	Describe the salient features of subphylum Vertebrata, illustrate its classification down to classes and elucidate the characteristics of division Agnatha	Understand	7
CO5	Enumerate the salient features of superclass Pisces and illustrate its classification down to orders and the morphology and structural organization of <i>Mugil cephalus</i>	Apply	2
CO6	Describe the salient features and affinities of class Amphibia and its classification up to orders; explain the morphology and organ systems of <i>Hoplobatrachus tigerinus</i>	Evaluate	4
CO7	Elucidate the characteristic features of the class Reptilia and its classification down to orders; describe the morphology and organ systems of <i>Calotes versicolor</i>	Create	8

COURSE CONTENT	
Module I	2 Hours
<p>Introduction</p> <p>Chordate characters (fundamental, general and advanced); chordates versus non-chordates; diversity of chordates; outline classification down to classes; salient features of each subphylum.</p> <p>[Type studies with special emphasis on morphology and various functional systems such as integumentary, digestive, respiratory, circulatory, excretory, nervous and reproductive systems. Also mention the evolutionary significance]</p>	
Module II	5 Hours
<p>Subphylum UROCHORDATA [Tunicata]</p> <p>Classification of the subphylum down to classes. Affinities of urochordates with cephalochordates and vertebrates.</p> <p>Class Ascidiacea e.g. Herdmania</p> <p>Class Larvacea e.g. Oikopleura</p> <p>Class Thaliacea e.g. Doliolum</p> <p>Type: Ascidia [Morphology and retrogressive metamorphosis]; add a note on neoteny and paedogenesis.</p>	

Module III	5 Hours
<p>Subphylum UROCHORDATA [Tunicata] Classification of the subphylum down to classes. Affinities of urochordates with cephalochordates and vertebrates.</p> <p>Class Ascidiacea e.g. Herdmania Class Larvacea e.g. Oikopleura Class Thaliacea e.g. Doliolum</p> <p>Type: Ascidia [Morphology and retrogressive metamorphosis]; add a note on neoteny and paedogenesis.</p>	
Module IV	3 Hours
<p>Subphylum VERTEBRATA Salient features of subphylum vertebrata and its outline classification down to classes.</p> <p>Division 1. AGNATHA</p> <p>Characters, classification down to classes and examples: Myxine; Petromyzon [mention Ammocoetes larva]</p> <p>Division 2. GNATHOSTOMATA</p>	
Module V	12 Hours
<p>Superclass PISCES Classification of Pisces down to orders; salient features of the following extant groups:</p> <p>Class Chondrichthyes [Cartilaginous fishes] Subclass Selachii e.g. Scoliodon, Trygon Subclass Holocephali e.g. Chimaera Class Osteichthyes [Bony fishes]</p> <p>Sub class Sarcopterygii 1. Order Crossopterygii [Coelacanth] e.g. Latimeria 2. Order Dipnoi [Lung fishes] e.g. Neoceratodus, Protopterus, Lepidosiren (Add a note on the distribution of lung fishes).</p> <p>Sub class Actinopterygii 1. Superorder Chondrostei e.g. Acipenser 2. Superorder Holostei e.g. Amia, Lepidosteus 3. Superorder Teleostei [Spiny-rayed fishes] e.g. Sardinella, Rastrelliger</p> <p>Type: Mugil cephalus (Grey Mullet) [Morphology, body wall, digestive system, respiratory system, circulatory system, excretory system, sense organs (structure of brain, neuromast organ in detail) and reproductive system]. Sub-terranean fishes from Kerala: Aenigmachanna Gollum (Gollum Snakehead), Kryptoglanis shajii, Horaglanis krishnai (Blind Catfish) & Monopterus digressus (Blind cave eel). Mention recent addition to ornamental fish trade - Sahyadria denisonii (Miss Kerala).</p> <p>Super class TETRAPODA</p>	
Module VI	13 Hours

Class AMPHIBIA

Classification of Amphibia down to orders with examples [of extant forms only].

Subclass Stegocephalia (extinct)

Subclass Lissamphibia

1. Order Apoda (=Gymnophiona) e.g. Ichthyophis, Uraeotyphus
2. Order Caudata (=Urodela) e.g. Necturus, Ambystoma, mention Axolotl larva.
3. Order Anura (=Salientia) e.g. Duttaphrynus, Rhacophorus

Type: Hoplobatrachus tigerinus (Indian Bullfrog)

[Morphology, body wall, skeletal system(exclude skull bones), digestive system, respiratory system, circulatory system, excretory system, sense organs, structure of brain and reproductive system].

Mention about the diversity of bush frogs, dancing frogs and night frogs in the Western Ghats and the discovery of Nasikabatrachus sahyadrensis (Purple frog).

Module VII**15 Hours****Class REPTILIA**

Classification of class Reptilia down to orders and salient features of the following orders (only extant forms):

Subclass I - Anapsida

Order Cotylosauria [stem reptiles] e.g. Hylonomus

1. Order Chelonia [common turtles, tortoises etc.] e.g. Melanochelys, Chelone
2. SubclassII - **Diapsida**

1. Order Rhynchocephalia e.g. Sphenodon
2. Order Squamata
 - Suborder Lacertilia (Lizards) e.g. Chamaeleo, Hemidactylus
 - Suborder Ophidia (Snakes)

Brief account on common venomous and non-venomous snakes of Kerala: a) Python molurus b) Ptyas mucosus c) Gongylophis (= EryX) conicus d) Indotyphlops braminus e) Bungarus caeruleus f) Naja naja g) Daboia russellii h) Ophiophagus hannah

Identification key for venomous and non-venomous snakes.

3. Order Crocodylia e.g. Crocodylus, Gavialis

[Mention the extinct subclasses **Euryapsida**, **Parapsida**, **Synapsida**(Mammal- like reptiles) and mention the origin of mammals from synapsids].

Type: Calotes versicolor (Garden Lizard).

[Morphology, body wall, skeletal system (exclude skull bones), digestive system, respiratory system, circulatory system, excretory system, sense organs, structure of brain and reproductive system].

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled Presentations

Presentation of students Seminar Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

- a. Classroom participation (20%): 3 Mark
- b. Test papers I (40%): 6 Mark
- c. Assignment (20%): 3 Mark
- d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	20
Paragraph	7	Up to 7	5	30
Essay	2	1	10	10
Total				60

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	2
Module II	7
Module III	2
Module IV	2
Module V	16
Module VI	24
Module VII	26

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SEMESTER 4

COURSE CODE –BZL4B04				
CORE COURSE IV: ANIMAL DIVERSITY: CHORDATA PART- II				
Credit	Hours/week	Marks		
		Internal	External	Total
2	4	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No.
	CO1		

	salient features of each order with suitable examples		
CO2	Describe the external characters and functional systems of <i>Columba livia</i>	Apply	4
CO3	Enumerate the salient features and classification of class Mammalia down to orders with suitable examples	Evaluate	8
CO4	Elucidate the external characters and functional systems of <i>Oryctolagus cuniculus</i>	Analyse	2
CO5	Describe the classification of class Aves down to orders, salient features of each order with suitable examples	Understand	2

COURSE CONTENT	
Module 1	11 Hours
<p>Classification of Aves Classification of class Aves down to the orders specified; mention at least one example for each order.</p> <p>Subclass Archaeornithes [2 hrs]</p> <p>1. Order Archaeopterygiformes e.g. <i>Archaeopteryx lithographica</i> - a brief account of its discovery and evolutionary significance.</p> <p>Subclass Neornithes [2 hrs]</p> <p>Super order Palaeognathae[Ratitae]</p> <p>2. Order Casuariiformes e.g. <i>Casuarius</i> (Cassowary)</p> <p>3. Order Dinornithiformes [=Apterygiformes] e.g. <i>Apteryx</i> (Kiwi)</p> <p>4. Order Rheiforme e.g. <i>Rhea</i></p> <p>5. Order Struthioniformes e.g. <i>Struthio</i> (Ostrich)</p> <p>Super order Neognathae[Carinatae] [7 hrs]</p> <p>6. Order Galliformes [pheasants, quail, turkeys, grouse] e.g. <i>Pavo cristatus</i>.</p> <p>7. Order Anseriformes [screamers, water fowls] e.g. <i>Anas poecilorhyncha</i></p> <p>8. Order Passeriformes [perching birds] e.g. <i>Passer domesticus</i></p> <p>9. Order Piciformes [woodpeckers, barbets, honeyguides] e.g. <i>Dinopium</i></p> <p>10. Order Coraciiformes [kingfishers & allies] e.g. <i>Alcedo atthis</i></p> <p>11. Order Apodiformes [swifts, humming birds] e.g. <i>Apus nipalensis</i></p> <p>12. Order Strigiformes [owls] e.g. <i>Bubo</i></p> <p>13. Order Cuculiformes [cuckoos, roadrunners, turacos] e.g. <i>Eudynamys</i></p> <p>14. Order Psittaciformes [parrots, lories, cockatoos] e.g. <i>Psittacula krameri</i></p> <p>15. Order Gruiformes [cranes, rails, coots, bustards] e.g. <i>Ardeotis nigriceps</i></p> <p>16. Order Charadriiformes [plovers, gulls, terns, auks, sand pipers] e.g. <i>Tringa</i></p> <p>17. Order Columbiformes [pigeons, doves, dodos, sand grouse] e.g. <i>Columba</i></p> <p>18. Order Falconiformes [diurnal birds of prey - falcons, hawks] e.g. <i>Milvus</i>.</p> <p>19. Order Ciconiiformes [herons, storks, ibis, spoon bills] e.g. <i>Ardeola grayii</i>.</p> <p>20. Order Pelecaniformes [pelicans, cormorants] e.g. <i>Pelecanus</i>.</p> <p>21. Order Sphenisciformes [Impennae] e.g. <i>Aptenodytes</i> (penguin)</p> <p>22. Order Phoenicopteriformes (flamingos) e.g. <i>Phoenicopterus</i></p> <p>Recent Extinctions: Passenger Pigeon [<i>Ectopistes migratorius</i>], Dodo [<i>Raphus cucullatus</i>], Pink-headed Duck [<i>Rhodonessa caryophyllacea</i>], Elephant Bird [<i>Aepyornis</i>].</p> <p>Rediscovery of Jerdon's Courser [<i>Cursorius bitorquatus</i>]& Forest Owlet [<i>Athene blewitti</i>].</p>	

Module 2	16 Hours
<p>Type: Columba livia (Rock Pigeon)</p> <p>[External characters, integumentary system (structure of feather in detail - exclude development of feather), skeletal system (skull excluded), digestive system, respiratory system, circulatory system, excretory system, sense organs and reproductive system].</p>	
Module 3	11 Hours
<p>Classification of Mammalia [2hr] Classification of class Mammalia down to the orders cited with examples specified.</p> <p>Subclass Prototheria [2hr] Infraclass Ornithodelphia [egg-laying mammals] 1. Order Monotremata e.g. <i>Ornithorhynchus</i> [Platypus], <i>Tachyglossus</i> [= <i>Echidna</i>]</p> <p>Subclass Theria Infraclass Metatheria [marsupials] 2. Order Marsupialia e.g. <i>Didelphis</i> [Opossum], <i>Macropus</i> [Kangaroo]</p> <p>Infraclass Eutheria [true placental mammals] [7hrs]</p> <ol style="list-style-type: none"> 3. Order Edentata e.g. <i>Bradypus</i> (Sloth), <i>Dasybus</i> (Armadillo) <i>Myrmecophaga</i> (Spiny ant-eater) 4. Order Pholidota e.g. <i>Manis</i> (Pangolin/ Scaly ant-eater) 5. Order Lagomorpha [rabbits and hares] e.g. <i>Lepus nigricollis</i> (Indian Hare) 6. Order Rodentia e.g. <i>Funambulus</i>, <i>Ratufa</i> (Giant squirrel) 7. Order Soricimorpha [shrews, moles] e.g. <i>Suncus murinus</i>, <i>Crocidura</i> 8. Order Erinaceomorpha e.g. <i>Paraechinus micropus</i> (Indian Hedgehog) 9. Order Chrysochloridea e.g. Golden mole of South Africa 10. Order Dermoptera [colugos] e.g. <i>Cynocephalus volans</i> (flying lemur) 11. Order Chiroptera e.g. <i>Pteropus</i>, <i>Pipistrellus</i>, <i>Kerivoula picta</i> (Painted bat) 12. Order Primates e.g. <i>Loris</i>, <i>Macaca</i>, <i>Gorilla</i>, <i>Pongo</i>, <i>Hylobates</i>, <i>Homo</i> 13. Order Carnivora e.g. <i>Phoca</i> (Seal), <i>Odobenus</i> (Walrus), <i>Panthera sp.</i>, <i>Viverricula indica</i> (Civet), <i>Lutrogale</i> (Otter), <i>Cuon Alpinus</i> (Wild dog) 14. Cetacea e.g. <i>Physeter</i> (Sperm whale), <i>Delphinus</i> (Dolphins), <i>Phocaena</i> (Porpoise), <i>Balaenoptera</i> (Baleen whale) 15. Order Artiodactyla e.g. <i>Sus scrofa cristatus</i> (Wild Boar), <i>Bos gaurus</i> (Gaur), <i>Giraffa</i> (Giraffe), <i>Hemitragus</i> [Tahr], <i>Rusa</i> (= <i>Cervus</i>) <i>Unicolor</i> (Sambar deer), <i>Axis axis</i> (Spotted deer), <i>Moschiola</i> (Mouse deer), <i>Antilope cervicapra</i> (Blackbuck). 16. Order Perissodactyla e.g. <i>Equus caballus</i> (Horse), <i>Rhinoceros</i> 17. Order Sirenia e.g. <i>Trichechus</i> (Manatee), <i>Dugong</i>. 18. Order Proboscidea e.g. <i>Elephas maximus indicus</i> [Indian elephant], <i>Elephas maximus borneensis</i> [Borneo pigmy elephant], <i>Loxodonta Africana</i> [African savanna elephant] and <i>Loxodonta cyclotis</i> [African forest elephant]. 19. Order Hyracoidea e.g. <i>Hyrax</i> (Coney) 20. Order Tubulidentata e.g. <i>Aardvark</i> 	

Module 4	16 Hours
Type: Oryctolagus cuniculus (European Rabbit) [External features, integumentary system, skeletal system (dentition in detail - skull excluded), digestive system, respiratory system, circulatory system (exclude arterial and venous systems), excretory system, sense organs and reproductive system].	

MODE OF TRANSACTION
Class room Lectures and face to face interaction ICT enabled Presentations Presentation of students Seminar Group discussion Assignments and Field study, Interview

MODE OF ASSESSMENT				
Internal Assessment (15 Marks)				
a.	Classroom participation (20%):	3 Mark		
b.	Test papers I (40%):	6 Mark		
c.	Assignment (20%):	3 Mark		
d.	Seminar/ Viva (20%):	3 Mark		
External Assessment (60 Marks):		Duration: 2, No of Questions: 21		
Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	20
Paragraph	7	Up to 7	5	30
Essay	2	1	10	10
Total				60

MODULE WISE MARK DISTRIBUTION

Module	Marks
Module I	16
Module II	26
Module III	11
Module IV	26

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COURSE CODE –BZL4B05L				
CORE COURSE V: PRACTICAL - I: ANIMAL DIVERSITY				
Credit	Hours/week (Practical)	Marks		
		Internal	External	Total
4	2	20	80	100

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Identify</i> and describe specified protists and acoelomate & pseudocoelomate nonchordates and perform the culture of selected protists; understand the histological features of coelenterate, platyhelminth and nematode.	Analyse	2
CO2	<i>Identify</i> and describe specified coelomate non-chordates and the transverse sections of annelids; Perform mounting of the specified organs of selected nonchordates.	Apply	3
CO3	<i>Identify</i> and describe specified chordates and specified bones of chordates; Prepare key for identification of venomous snakes; Perform mounting and dissection of specified organ systems of chordates.	Create	7
CO4	<i>Identify</i> and describe selected vertebrates and specified bones of vertebrates.	Understand	8

COURSE CONTENT

Module I	36 Hours
<p style="text-align: center;">CORE COURSE PRACTICAL- I*A</p> <p>ANIMAL DIVERSITY: NONCHORDATA Part - I</p> <p>[Students are expected to make sketches with notes, while they study the specimens in the laboratory/field itself the record must carry sketches with notes of all specimens, mountings and dissections. Emphasis must be on scientific accuracy and not on beauty of sketches.]</p> <p>Section A. Study of the following non-chordate specimens:</p> <p>(Choose useful and harmful forms from different habitats. All animals intended for type study are to be included. Slides / museum preparations are to be used; charts / models may be used in exceptional cases. Students are expected to identify the specimens by their generic names and assign them to the respective phyla and classes).</p> <p>1.Protists: Amoeba, Noctiluca, Ceratium, Entamoeba, Trichonympha, Paramecium [any 4]</p> <p>2.Poriferans: Leucosolenia/Scypha or Spongilla, Sponge gemmule, spicules</p> <p>3.Cnidarians: Sedentary hydrozoans: Hydra, Obelia, Obelia medusa [any 2] Pelagic hydrozoans: Physalia/ Velella Pelagic scyphozoan: Aurelia/ Rhizostoma Common anthozoans: Adamsia, Edwardsia, Madrepora, Fungia, Tubipora, Gorgonia [any 3]</p> <p>4.Platyhelminths: Free living flat worm: Bipalium Dugesia Parasitic flat worms: Fasciola/Taenia solium</p> <p>5.Aschelminths: Parasitic round worms: Ascaris/Ancylostoma/ Wuchereria</p> <p>6.Minor Phyla: Sipunculus/Bonellia or any other specimen</p> <p>7.Local Biodiversity Record: Observe water samples from the locality for live protists and make a field note.</p> <p>8.Demonstration of culture methods of Protists[Amoeba/Euglena/Paramecium].</p> <p>Section B. Histology</p> <p>Transverse sections of a coelenterate [Hydra], platyhelminth [Dugesia] nematode (Ascaris male & female).</p>	
Module II	36 Hours
<p style="text-align: center;">CORE COURSE PRACTICAL- I*B</p> <p style="text-align: center;">ANIMAL DIVERSITY: NON-CHORDATA Part- II</p> <p>Section A. Study of the following Coelomate Non-chordate specimens:</p> <p>1. Annelids: Polychaetes: Aphrodite, Chaetopterus, Arenicola, Tomopteris [any 2] Common earthworm: Megascolex / Pheretima</p>	

Leech: Hirudinaria, Heamadipsa, Branchellion [any 2]

2. Arthropods: Items of evolutionary / taxonomic importance - Limulus, Streptocephalus [any 1]

Common fouling barnacle - Lepas / Balanus

Parasitic crustaceans- Sacculina, Cymothoa, Argulus [any 2]

Crustacean of the sandy shore- Emerita / Albunea Symbiotic crustacean – Eupagurus Economically important crustacean - Penaeus, Scylla

[any 1]

Vectors - Cyclops, Aedes, Musca, Xenopsylla [any 2]

Insect pests - Lepisma, termite queen, Pest of paddy, pest of coconut, pest of stored grains [any 5]

Aquatic insects - Belostoma, Nepa, Ranatra [any 2]

Predatory insect - Dragonfly, Ant-lion, Mantis [any 1]

Insect which camouflages - Carausius / Phyllium Common myriapods - Scolopendra/ Scutigera, Julus/ Spirostreptus/Jonespeltis [any 2]

Common arachnids - Palamnaeus/ Buthus, Spider/ tick/mite [any 2]

3.Molluscs:

Inter tidal mollusks - Chiton, Patella, Haliotis, Onchidium, Aplysia [any 2]

Ornamental gastropods -Cypraea, Murex, Turbinella[any 2]

Poisonous gastropod - Conus

Pelecypods of economic importance - Perna, Pinctada, Teredo, Ostrea [any 2]

Scaphopod - Dentalium

Cephalopods of economic/evolutionary importance

- Sepia, Loligo, Octopus, Nautilus [any 3]

1. Echinoderms: Antedon, Asterias, Ophiothrix, Cucumaria, Echinus, cake urchin, heart urchin [any 3]

2. Hemichordate: Balanoglossus

3. Onychophoran: Peripatus (Evolutionary significance)

4. Local Biodiversity Record: Observation of butterflies/dragonflies or any other non-chordate group of the locality and prepare a field note.

Section B. Histology

Compare TS of any two annelids [Neanthes/ Earthworm/ Leech].

Section C. Mountings

1. Earthworm : Setae (a few loose setae) [Minor]

2. Neanthes: Parapodium [Minor]

3. Penaeus : Appendages [Minor]

4. Cockroach : Salivary apparatus [Major]

5. Honeybee/ plant bug: Mouth parts [Minor]

Section D. Dissections (Digital versions to be downloaded or procured as per UGC guidelines)

1. Penaeus : Nervous system [Major]

2. Cockroach : Nervous system [Major]

CORE COURSE PRACTICAL- I*C
ANIMAL DIVERSITY: CHORDATA Part - I

[Students are expected to make sketches with notes, while they study the specimens in the laboratory and field. The record must carry notes of all specimens, mountings and dissections. Emphasis must be on scientific aspects. The record sheets related to part I and part II must be bound together to get a single Record.]

Section A. Study of the following Chordate specimens:

(Students are expected to identify the specimens by their generic names and assign them to the respective phyla /classes/ orders)

1. Urochordates: Ascidia, ascidian tadpole, Salpa, Doliolum [any 2]
2. Cephalochordates: Branchiostoma
3. Agnathans: Myxine, Petromyzon, Ammocoetes larva [any 1]
4. Fishes:
 - a. Common elasmobranchs - Chiloscyllium, Stegostoma, Sphyrna, Pristis, Trygon, Narcine, Astrapes [any 3]
 - b. Common edible fishes (marine) - Sardinella, Rastrelliger, Cynoglossus, Parastromateus, Trichiurus, Cybium, Thunnus [any 3]
 - c. Common edible fishes (Inland) - Etroplus, Mugil, Wallagonia, Tilapia, Catla, Cirrhina, Labeo, Cyprinus [any 3]
 - Fishes with special adaptive features - Hippocampus, Belone, Hemiramphus, Exocoetus, Tetraodon, Pterois, Ostracion, Heteropneustes, Clarias, Anus, Anabas, Channa, Echeineis,
 - d. Antennarius, Amphisila, Anguilla [any 5]

Amphibians: Common amphibians - Duttaphrynus, Euphlyctis, Rhacophorus, Ambystoma, Axolotl larva, Ichthyophis/Uraeotyphlu [any 3]
5. Reptiles:
 - a. Common lizard - Hemidactylus, Calotes, Mabuya (Eutropis)[any 1]
 - b. Lizards with special adaptations - Draco, Chamaeleo, Phrynosoma [any 2]
 - c. non-venomous snakes - Ptyas, Gongylophis, Lycodon, Indotyphlops [any 2]
 - Venomous snakes - Naja, Daboia, Bungarus, Echis [any 2]
 - d. Water snake - Hydrophis / Enhydris / Xenochrophis
 - e. Arboreal snake - Dendrelaphis / Python / Ahaetulla
6. Key for identification of venomous and non-venomous snakes.
7. Local Biodiversity Record: Observe fishes/amphibians or any other vertebrate group (any one group) of the locality in their natural habitat and prepare a field note.

Section B. Histology

1. Branchiostoma - T. S. through pharyngeal region

Section C.

Mountings

1. Sardine: Cycloid scale [Minor]
2. Shark: Placoid scale [Minor]
3. Shark/Frog/Calotes: Brain [Minor] - Demonstration only.

Section D. Dissections (Digital versions to be downloaded or procured as per UGC guidelines)

1. Mullet/ Sardine: Alimentary canal (Major)
2. Shark: IX and X cranial nerves on one side (Major) - Demonstration only.
3. Frog: V cranial nerve - branches, root and ganglion on one side (Major) Demonstration only
5. Frog/Calotes: Arterial system on one side (demonstration only).

Section E. Osteology

1. Frog: Typical, 8th, 9th Vertebrae,
2. Frog: Pectoral & Pelvic girdles
3. Snake Vertebrae [show zygosphenes and zygantrum]
4. Carapace and plastron of turtle/tortoise.

Module IV – Social and Human Development in Kerala**36 Hours****CORE COURSE PRACTICAL- I*D****ANIMAL DIVERSITY: CHORDATA Part - II****[Section A. Study of the following Vertebrate specimens:****1. Birds:**

- a. Fossil bird - Archaeopteryx
- b. Flightless bird - Rhea, Struthio [any 1]
- c. Wetland birds - Jacana, Duck, Egret, Heron, Ibis, Stork [any 2]
- d. Shore birds - Gulls, Plovers, Terns [any1]
- e. Migratory birds - Pelican, Crane, Flamingo [any1]
- f. Birds of Prey - Falcon, Eagle, Kite, Shikra, Owl [any2]
- g. Features and adaptations of: duck, parrot, kingfisher, owl, kite and woodpecker [draw sketches of the beaks and feet of 4 birds]

2. Mammals:

- a. Common insectivore - Suncus, Hedgehog [any1]
- b. Common rodent - Rattus, Bandicoot, Funambulus [any1]
- c. Common bat of Kerala - Pteropus, Megaderma, Pipistrellus [any 1]
- d. Small Carnivore - Jungle Cat, Herpestes, Civet [any 1]

3. Local Biodiversity Record: Observe birds/mammals (any one group) of the locality in their natural habitat and prepare a field note.

Section B. Osteology

- a. Pigeon/ Domestic Fowl: Cervical vertebra, Pectoral girdle and Sternum, Pelvic girdle with Synsacrum [mention the component bones].
- b. Rabbit: Skull showing dentition, Atlas, axis, typical vertebra, scapula and pelvic girdle.

MODE OF TRANSACTION

Live Dissections, Demonstration of Dissections, Class room lectures, Exhibiting specimens from the museum, ICT enabled Presentations, Field study, taking photos and videos of the biodiversity by students, WhatsApp group discussions

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

- a. Classroom participation (20%): 6 Mark
- b. Lab involvement, Performance & Punctuality: 4 Mark
- c. Class Test : 6 Mark
- d. Record: 4 Mark

External Assessment (80 Marks): Duration: 4 Hrs., No of Questions: 9

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Spotters	6	6	3	18
Minor	2	2	9+12	21
Major	1	1	22	22
Viva				3
Record				16
Total				80

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Comment [AP1]: Internal Assessment and module wise mark distribution are required

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SEMESTER 5

COURSE CODE –BZL5B06

CORE COURSE VI: CELL BIOLOGY AND GENETICS

Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Understand</i> the principles and applications of various types of light microscopes, electron, Scanning-tunnelling and atomic force microscope and illustrate the histological and histochemical processing of tissues	Understand	4
CO2	<i>Explain</i> the basic structure of a eukaryotic cell and the structure and functions of plasma membrane, mitochondria,	Analyse	9

	lysosome, cytoskeletal elements and interphase nucleus		
CO3	<i>Illustrate</i> the nucleosome organization of chromatin and higher order structures; structure of chromosomes and giant chromosomes	Apply	8
CO4	<i>Enumerate</i> eukaryotic cell cycle and cell division by amitosis, mitosis and meiosis	Create	11
CO5	<i>Explain</i> the causes of transformation, characteristics of transformed cells and the role of proto-oncogenes and tumour suppressor genes in malignant transformation; mechanism and significance of apoptosis	Evaluate	9
CO6	<i>Enumerate</i> allelic and non-allelic gene interactions; supplementary, complementary, polymeric, duplicate and modifying genes and polygenic inheritance.	Understand	2
CO7	<i>Illustrate</i> multiple allelism and solve problems related to blood group inheritance.	Apply	4
CO8	<i>Explain</i> characteristics of linkage groups and linkage map; crossing over and calculation of recombination frequency; sex-linked, sex-influenced and sex-limited characters; sex differentiation and disorders of sexual development.	Analyse	6
CO9	<i>Describe</i> the mechanisms of sex determination including chromosomal, genic, haploid-diploid mechanisms; the hormonal and environmental influence on sex determination and gynandromorphism.	Understand	3
CO10	<i>Explain</i> mutagenesis, mutagens and chromosomal and gene mutations.	Evaluate	9
CO11	<i>Enumerate</i> the classification and grouping of human chromosomes; numerical and mutational human autosomal and sex chromosomal anomalies; polygenic human traits and genetic counselling.	Evaluate	10

COURSE CONTENT	
Module 1	7 Hours
<p>Techniques in Cell Biology</p> <p>Microscopy (4 hrs)</p> <p>Light microscope: principles and uses; use of oil immersion objective. Types of light Microscopes: Bright-field, Phase contrast and Fluorescence microscope. Camera Lucida: Principle and uses. Micrometry. Electron microscope: Principle, applications; advantages and disadvantages. Principles</p>	

and applications of - Scanning Electron Microscope (SEM); Scanning-tunnelling microscope and atomic force microscope.

Histological Techniques

(2 hrs)

Preparation of materials for light microscopy (for temporary and permanent mounts): Fixation: common fixatives: buffered formalin, ethanol, Bouin's solution and Carnoy's fluid (mention composition). Processing of the fixed tissue: mention dehydration, infiltration, and embedding. Sectioning: Rotary microtome (brief description), uses. Staining: Mention deparaffinization, hydration, staining, dehydration and mounting. Histological stains: Haematoxylin and Eosin. Vital stains: Neutral red and Janus green.

Histochemical Techniques

(1 hr)

Mention the techniques for the demonstration of proteins (mercuric bromophenol blue method), carbohydrates (Periodic Acid Schiff's (PAS) method) and lipids (Sudan Black B method)

Module 2

12 Hours

Structure of Eukaryotic cell

Plasma membrane

(6 hrs)

Chemical composition and structure (unit membrane concept and fluid mosaic model), membrane lipids and membrane fluidity; significance of membrane fluidity; membrane proteins-integral proteins, peripheral proteins and lipid-anchored proteins; membrane carbohydrates.

Interactions between cells and their environment - extracellular space, glycocalyx, extracellular matrix - Mention basal lamina, collagen, fibronectin, proteoglycans and laminins.

Interaction of cells with other cells - cell adhesion molecules, selectins, immunoglobulins, integrins and cadherins. Modifications of the plasma membrane - microvilli, desmosomes, nexuses, tight junction and gap junction.

Functions: trans-membrane transport mechanisms - diffusion, osmosis, active transport, ion transport (channels), co-transport, bulk trans-membrane transport - exocytosis, endocytosis.

Membrane receptors: Mention insulin receptors.

Mitochondria

(2 hrs)

Ultra-structure; mitochondrial membranes; functions of mitochondria; Biogenesis of mitochondria.

Lysosomes

(1 hr)

Structure and function; polymorphism in lysosomes, lysosomal enzymes. Concept of GERL Golgi body - Endoplasmic Reticulum - Lysosome complex).

Cytoskeleton

(1 hr)

<p>Location, ultrastructure, biochemical composition and functions of microfilaments, intermediate filaments and microtubules.</p> <p>Interphase nucleus (2 hrs)</p> <p>General structure and functions; nucleo-cytoplasmic index; ultrastructure of nuclear membrane and nuclear pore complex (NPC), functions of NPC; Nucleoplasm - Composition and function; Nucleolus - Structure, composition, nucleolar organizer, nucleolar cycle and functions of the nucleolus.</p>	
Module 3	2 Hours
<p>Structure of chromatin</p> <p>Nucleosome organization and higher-order structures; Chromosome structure; Giant chromosomes - Polytene chromosomes: structure, puffs and bands; Endomitosis; significance. Lamp brush chromosomes: structure, loops and significance.</p>	
Module 4	4 Hours
<p>Cell Cycle & Cell division</p> <p>Cell Cycle: G1, S, G2 and M phases - Checkpoints; Go phase. Cell division: Amitosis (brief account); Mitosis: description of all stages, cytokinesis and significance; Meiosis: description of all stages and significance. Role of centriole in animal cell division.</p>	
Module 5	2 Hours
<p>Cancer and Apoptosis</p> <p>Classification of Cancer- Malignant and Benign, Characteristics of cancer cells; causes of transformation; protooncogenes and tumor suppressor genes and their role in transformation. Apoptosis and its significance.</p>	
Module 6	5 Hours
<p>Interaction of genes</p> <p>Allelic interactions: incomplete dominance and co-dominance with examples. Non- allelic interactions: epistasis (inheritance of plumage colour in poultry), mention dominant and recessive epistasis. Supplementary genes (example: inheritance of comb pattern in poultry). Complementary genes, mention any one example. Polymeric genes, mention one example. Duplicate genes, mention one example. Modifying genes. Atavism, Penetrance and Expressivity. Polygenic (quantitative) inheritance (example: skin colour in man).</p>	
Module 7	7 Hours
<p>Multiple alleles</p> <p>Definition and characteristics; example: coat colour in rabbits. Blood group genetics: ABO blood group system; MN blood group and Bombay phenotype. Inheritance of Rh factor; mention erythroblastosis foetalis. Problems related to blood group inheritance (5 problems). Isoalleles, mention any one example.</p>	

Module 8	8 Hours
<p>Linkage and Recombination</p> <p>Definition and characteristics of linkage groups, Morgan's work on <i>Drosophila</i>. Types of linkage: complete and incomplete - examples; Linkage groups.</p> <p>Crossing over and recombination, Calculation of Recombination Frequency and Percentage; Linkage map, Map Distance; Mitotic Recombination (brief).</p> <p>Sex-Linked Characteristics: Types of sex-linkage - X linked characters - Colour blindness and haemophilia in humans, holandric genes - hypertrichosis.</p> <p>Dosage compensation - Barr body - Lyon hypothesis.</p> <p>Sex-Influenced and Sex-Limited Characteristics.</p> <p>Sex Differentiation: Testis-determining factor (TDF), Müllerian inhibition factor. Disorders of Sexual Development (short notes) - XX males and XY females, Point mutations in the <i>SRY</i> gene and testicular feminization.</p>	
Module 9	3 Hours
<p>Sex determination</p> <p>Chromosomal mechanism of Sex-Determination: Male heterogametic and female heterogametic mechanism of sex determination. Genic Sex Determining Systems - Genic balance (ratio) theory of Bridges. Haploid-diploid mechanism of sex determination, honey bee as example.</p> <p>Environmental Sex Determination: Example - <i>Bonellia</i>, Crocodile.</p> <p>Hormonal influence on sex determination: Example - sex reversal in fowl and free martin in cattle; Gynandromorphism - types and causes. Intersex (brief).</p>	
Module 10	3 Module
<p>Mutations</p> <p>Chromosome mutations: numerical (euploidy and aneuploidy) and structural changes (deletion, duplication, insertion, inversion, translocation).</p> <p>Gene mutations: types- spontaneous, induced, somatic, gametic, forward and reverse.</p> <p>Point mutation: Types- deletion, insertion, substitution, transversion and transition. Mutagenesis- Natural and artificial mutagenesis, Mutagenic agents:</p> <p>a) UV radiation and ionising radiation b) Base analogues, alkylating and intercalating agents.</p>	
Module 11	4 Hours

Human Genetics

Classification and grouping of human chromosomes (Patau's scheme). Chromosomal anomalies and disorders: Autosomal - (Down's, Patau's, Edward's and Cri du Chat syndromes). Sex chromosomal - (Turner's and Klinefelter's syndromes). Gene mutations: Autosomal mutation - albinism, PKU, alkaptonuria, galactosemia, Tay-Sach's syndrome, Gaucher's disease, Sickle cell anaemia, thalassemia and brachydactyly. Sex chromosomal mutations: haemophilia, Lesch- Nyhan syndrome, dermal hypoplasia. Polygenic traits: cleft palate / lip, club foot and hydrocephaly. Eugenics, Euthenics and Euphenics.

MODE OF TRANSACTION

Class room Lectures and face to face interaction
ICT enabled Presentations
Presentation of students Seminar Group discussion
Assignments

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

- | | |
|-----------------------------------|--------|
| a. Classroom participation (20%): | 4 Mark |
| b. Test papers I (40%): | 8 Mark |
| c. Assignment (20%): | 4 Mark |
| d. Seminar/ Viva (20%): | 4 Mark |

External Assessment (80 Marks) Duration 2.5 Hours, No of Questions: 27

MODULE WISE MARK DISTRIBUTION

Module	Marks
Module I	19

Module II	24
Module III	2
Module IV	7
Module V	2
Module VI	14
Module VII	7
Module VIII	19
Module IX	2
Module X	7
Module XI	7

REFERENCES:

Module 1-5 (Cell Biology)

- De Robertis EMF (2011): Cell and molecular biology; 8th Edition, ISBN- 9780781734936 0781734932, Lippincott Williams & Wilkins, 734 pages
- Gerald Karp (2013): Cell Biology; 7th Edition, ISBN-10: 1118318749, Wiley, 872 pages
- Gupta, P. K.(2018): Cell and Molecular Biology, Revised 5th edition, ISBN, 978-93-5078- 154-8, Rastogi Pubs.,1192 pages
- Kleinsmith, L. J. & Kish, V. M.(1995): Principles of Cell and Molecular Biology, 2nd Edition, ISBN-10: 0065004043 Harper Collins College Pubs, 809 pages
- Niel O. Thorpe (1984): Cell Biology. ISBN-10: 0471805246, John Wiley & Sons, 752 pages
- Philip Sheeler and Donald E. Bianchi (1983): Cell Biology - Structure, Biochemistry and Functions; 2nd Edition, ISBN-10: 0471889075, John Wiley & Sons, 688 pages
- Sharma, A. K. & Sharma, A.(1980): Chromosome Techniques; 3rd Edition, ebook ISBN: 9781483100845, Butterworth, 724 pages
- Verma, P.S. & Agarwal, V.K.(1999): Cytology. S., Chand & Co., 504 pages

Module 6-11 (Genetics)

- Brooks, R. J. (2008): Genetics: Analysis and Principles.3r d Edition, ISBN-10:0071287647, Irwin/McGraw-Hill, 844 pages
- Gardner, E. J., Michael J. Simmons and Peter Snustad (2006): Principles of Genetics. 8thEdition, ISBN-10: 8126510439, Wiley, 740 pages
- Good Enough, U.(1979): Genetics. 2nd Revised edition, ISBN-10: 003050886X, Holt R&W
- John Ringo (2004): Fundamental Genetics- Online ISBN 9780511807022 Cambridge University Press, 462 pages
- Peter Snustad & Michael J. Simons (2011): Principles of Genetics;6t h Edition, ISBN 1118129210, JW & S, 784 pages
- Read Andrew and Dian Donnai (2015): New Clinical Genetics, 3rd Edition, ISBN- 10:0073525308, McGraw Hill, 480 pages

- Ricki, L.(2011): Human Genetics: Concepts and Applications. 10th Edition, WCB MGH
- Robert H. Tamarin (1998): Principles of Genetics, 6th Edition, ISBN-10: 0697354628 William C Brown Pub, 680 pages
- Tom Strachan and Andrew Read (2018): Human Molecular Genetics,5th Edition, ISBN 9780815345893 JW & S, 770 pages.

COURSE CODE –BZL5B07				
CORE COURSE VII: BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
4	4	20	80	100

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Illustrate</i> the steps in genetic engineering and animal cell culture	understand	4
CO2	<i>Explain</i> transfection methods, transgenic animals and ethical issues of transgenic animals	Evaluate	5
CO3	<i>Enumerate</i> the applications of biotechnology	Apply	2
CO4	<i>Understand</i> the biological diversity of microbial forms and the various techniques for handling microbes in the laboratory	Apply	3
CO5	<i>Enumerate</i> the basic structure and life cycle of bacteria and viruses	Understand	8
CO6	<i>Understand</i> the industrial and medical importance of microorganisms	Analyse	9
CO7	<i>Describe</i> different types of immunity and the cells and organs of the immune system	Understand	2
CO8	<i>Explain</i> antigen, antibody, immunity and major histocompatibility complex	Evaluate	7
CO9	<i>Enumerate</i> autoimmune and immunodeficiency diseases and immunology of tumour and organ transplantation	Apply	6

COURSE CONTENT	
Module I	12 Hours
Genetic Engineering and Animal cell culture Genetic Engineering (10 hrs)	

<p>Concept and scope of biotechnology - Mention branches of biotechnology.</p> <p>Introduction to the concept of Recombinant DNA Technology: Cloning vectors (Plasmid, pBR322, Phages, Cosmids,), Virus vectors, YAC vector and bacterial artificial chromosomes (BACs).</p> <p>Enzymes: Type II Restriction endonucleases, polynucleotide kinase, exonuclease, terminal transferase, reverse transcriptase and DNA ligase.</p> <p>Construction of Recombinant DNA: Preparation of vector and donor DNA, Joining of vector DNA with the donor DNA, Introduction of recombinant DNA into the host cell and selection of transformants (brief account).</p> <p>Animal Cell Culture (2 hrs)</p> <p>Cell culture media (Natural and Defined), Preparation and Sterilization, Primary cell culture, Cell Lines, Pluripotent Stem Cells, Cryopreservation of cultures. Somatic cell fusion and HAT selection of hybrid clones - production of monoclonal antibodies.</p>	
Module II	5 Hours
<p>Transgenic Organisms</p> <p>Transfection Methods: (Chemical treatment, Electroporation, Lipofection, Microinjection, Retroviral vector method, Embryonic stem cell method and Shot Gun Method). Transgenic Animals: (Fish, Pig, Sheep, Rabbit, Mice, Goat and Insects), Knock Out Mice. Human Cloning and Ethical Issues of transgenic Animals.</p>	
Module III:	7 Hours
<p>Applications of Biotechnology</p> <p>Molecular diagnosis of genetic diseases (Cystic Fibrosis, Huntington's Disease and Sickle Cell Anaemia). Vaccines and Therapeutic agents, Recombinant DNA in Medicines (Recombinant Insulin and Human Growth Hormone). Human gene therapy (gene therapy for severe combined immune deficiency).</p> <p>Enzymes in detergents and leather industries, Heterologous protein production, Biofiltration, Bioremediation, Bioleaching, Molecular pharming and Bioreactors. Molecular markers (brief account) RFLP, RAPD, VNTR, SNPs and their uses.</p>	
Module IV:	8 Hours
<p>Introduction and Methods in Microbiology</p> <p>Introduction (1 hr)</p> <p>Microbial Diversity: Archaeobacteria, Eubacteria, Prochlorophyta, Algae, Fungi, Protozoa, Viruses, Viroids, Prions, Mycoplasma and Rickettsias</p>	

<p>Methods in Microbiology (7 hrs)</p> <p>Sterilization: Physical and Chemical methods - Dry and Moist Heat, Pasteurization, Radiation, Ultrasonication. Disinfection, Sanitization, Antiseptics, Sterilants and Fumigation. Preparation of culture media: Selective, Enrichment and Differential media. Plating techniques and Isolation of pure colonies.</p> <p>Staining: Simple staining, Negative staining and Gram staining. Culture preservation techniques: Refrigeration, Deep freezing, Freezing under liquid Nitrogen and Lyophilisation.</p>	
Module V:	9 Hours
<p>Basic Concepts in Bacteriology and Virology</p> <p>Bacteria: Structure of a typical Bacterium, Different types of bacterial culture (Batch, Synchronous, Arithmetic), Bacterial growth: Growth phases, Methods of growth determination.</p> <p>Basic Concepts of Virology: General characteristics and classification of viruses. Bacteriophages: Diversity, lytic and lysogenic Phages (Lambda and P1 Phage), Applications of bacteriophages. Oncogenic Viruses.</p>	
Module VI	9 Hours
<p>Industrial and Medical Microbiology</p> <p>Industrial Microbiology (4 hrs)</p> <p>Bioengineering of microorganisms for industrial purposes: Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) - citric acid, ethanol, wine, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase). Bioinsecticides (Bt) and Steroid biotransformation.</p> <p>Medical Microbiology (5 hrs)</p> <p>Normal microflora of the human body: skin, throat, gastrointestinal tract and urogenital tract. Diseases caused by: (with reference to causative agent, symptoms, mode of transmission and control measures).</p> <ol style="list-style-type: none"> Bacteria: anthrax, tuberculosis, typhoid, whooping cough, pneumonia, cholera, gonorrhoea, and syphilis. Viruses: polio, chicken pox, herpes, hepatitis, rabies, dengue, AIDS and chikungunya. Protozoa: malaria, kala-azar and toxoplasmosis. Fungi: dermatomycoses and opportunistic mycoses. 	
Module VII	6 Hours

Cells and organs of immune system	
Introduction	(1 hr)
Immunity: Natural and acquired, active and passive, immunization, vaccines, mechanisms of innate immunity - barriers, inflammation, phagocytosis.	
Cells of the immune system	(3 hrs)
B- cells, T - cells, NK cells, monocytes, macrophages, neutrophils, basophils, eosinophils, mast cells, and dendritic cells (APCs).	
Organs of the immune system	(2 hrs)
Lymphoid organs: Primary (thymus, bone marrow) and secondary (lymph nodes, spleen).	
Module VIII	9 Hours
Antigens, antibodies, immunity and MHC	
Antigens	(3 hrs)
Types, factors for immunogenicity, exogenous antigens, endogenous antigens, adjuvant, haptens, epitopes, antigen-antibody reaction - precipitation reaction, agglutination reaction, agglutination inhibition reaction.	
Immunoglobulins	(2 hrs)
Structure, classification and biological functions. Mention immunoglobulin gene families - K and A light chain families and the heavy chain family.	
Immunity	(2 hrs)
Types of Immunity: humoral and cell mediated immunity, primary and secondary response, generation of cytotoxic T- cells (CTLs), NK cell mediated cytotoxicity, ADCC and cytokines (brief).	
Major Histocompatibility Complex	(2 hr)
MHC, HLA, Class I MHC, Class II MHC molecules and structure. Mention Class III MHC.	
Module IX	9 Hours
Autoimmune and Immunodeficiency diseases, Tumor and transplantation immunology	
Autoimmune diseases	(2hrs)
Autoimmune diseases: Systemic (SLE, multiple sclerosis and rheumatoid arthritis). Organ specific- (Hashimoto's thyroiditis, Grave's disease, Myasthenia gravis)	
Immunodeficiency disease	(3hrs)
Primary (Bruton's Disease, Di-George syndrome and SCID)	
Secondary (AIDS) - Clinical course of HIV - acute infection, seroconversion, window period,	

chronic latent phase - lymphadenopathy and crisis phase. Mention antiretroviral therapy (ART)

Tumor immunology (2 hrs)

Malignant transformation of cells, tumor antigens, immune response to tumor antigens. Immunotherapy.

Transplantation Immunology (2hrs)

Transplantation Antigens, Various organ transplantation (liver, kidney, heart, skin), Xenotransplantation

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled Presentations

Presentation of students Seminar Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

- a. Classroom participation (20%): 4 Mark
- b. Test papers I (40%): 8 Mark
- c. Assignment (20%): 4 Mark
- d. Seminar/ Viva (20%): 4 Mark

External Assessment (80 Marks) Duration 2.5 Hours, No of Questions: 27

Comment [AP2]: Check Whether the hour of duration is 2.5 Hours?

Comment [A3]: Yes 2.5 is correct

Comment [A5]: Done

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	13
Module II	5
Module III	7
Module IV	8
Module V	9

Module VI	8
Module VII	7
Module VIII	12
Module IX	11

Comment [AP4]: Module wise m distribution is required

REFERENCES:

Module 1-3 (Biotechnology)

1. Bernard R. Glick and Jack J. Pasternak (2002) Molecular Biotechnology - Principles and applications of recombinant DNA, 3rd Edition, ISBN-10:1555812244, ASM press, 860 pages
2. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis, 2nd Edition, ISBN: 9780121361105, Academic Press, 255 pages
3. Butler, M. (2003) Animal cell culture and technology: The basics, 2nd Edition, ISBN 9781859960493, CRC Press, 256 pages
4. Colin Ratledge and Bjorn Kristiasen (2012) Basic Biotechnology, 3rd Edition, online ISBN-9780511802409, Cambridge University Press, 578 pages
5. Dominic W.C. Wong (2006) The ABCs of gene cloning, ISBN: 9780387286792, Springer International Edition.
6. Dubey, R.C.(2006) A text book of biotechnology, 4th Revised Edition, S.
7. Chand & Co., 725 p.
8. James D. Watson, Gilman Michael, Jan Witkowski and Mark Zoller (1992), Recombinant DNA: A short course; 2nd Edition, W.H. Freeman
9. Mahajan Ritu, Anita Dua (2012) Introduction to Basics of Biotechnology, ISBN 139789382174080, Vayu Education of India
10. Mansi E.M.T, C. F. A. Bryce, Arnold L. Demain and A.R. Allman (2001) Fermentation Microbiology and Biotechnology, 3rd Edition, eBook ISBN -9780429190629, Taylor and Francis, 555 pages
11. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- genes and genomes- A short course. 3rd Edition, ISBN-10: 0716728664, Freeman and Co., 474 pages

Module 4-6 (Microbiology)

1. Atlas RM. (1997) Principles of Microbiology, 2nd Edition, ISBN-10: 0815108893 William T. Brown Publishers, 1298 pages
2. Chakraborty.P.A.(2009) Text Book of Microbiology, ISBN-10: 8173810818 New Central Book Agency, 1026 pages
3. Edward K. Wagner, Martinez J. Hewlett, David C. Bloom and David Camerini (2007) Basic Virology, 3rd Edition, ISBN-10:1405147156, Wiley Blackwell, 580 pages
4. Prescott L.M., Harley, J.P. and Klein. D.A.(2008) Microbiology, 7th Edition, McGraw Hill Inc., New York.
5. Rao, A.S. (1997) Introduction to microbiology, ISBN-10: 8120312171, Prentice Hall, 216 pages
6. Reddy SR and Reddy SM. (2005). Microbial Physiology, ISBN-10: 817233530X, Scientific Publishers India, 348 pages
7. Stolp H. (1998) Microbial Ecology Organisms Habitats Activities, 1st Edition, ISBN10:0521276365, Cambridge University Press, 324 pages

8. Subba Rao NS. (1999) Soil Microbiology 4th Edition, ISBN: 9788120413832 Oxford & IBH Publishing Co., 424 pages
9. Wheelis, Mark (2010) Principles of Modern Microbiology, ISBN-10: 076371075X , Jones And Barlett Publishers, New York.

Module 7-9 (Immunology)

- a. Abul K. Abbas, Andrew H. Lichtman & Shiv Pillai (2017) Cellular & Molecular Immunology 8th Edition, Paperback ISBN: 9780323479783, Elsevier, 608 pages
- b. Andrew E Williams (2011) Immunology Mucosal and Body Surface Defenses, Ist Edition, ISBN: 0470090049, Wiley and Blackwell, 398 pages
- c. David Male, Jonathan Brostoff, David Roth and Ivan Roitt (2013) Immunology, 8th Edition, ISBN: 9780323080583, Elsevier, 482 pages
- d. Helen Chapel, Mansel Haeney, Siraj Misbah & Neil Snowden (2014) Essentials of Clinical Immunology 6th Edition, ISBN: 978-1-118-47295-8, Wiley Blackwell, 376 pages
- e. Ian Todd, Gavin Spickett & Lucy Fairclough (2015) Immunology Lecture Notes 7th Edition, 1118451643, Wiley Blackwell, 248 pages
- f. Jeffrey K. Actor (2011) Immunology & Microbiology, 2nd Edition, ISBN: 9780323074476, Elsevier, 192 pages
- g. Kenneth Murphy, Paul Travers & Mark Walport (2009) Janeway's Immunobiology, 7th Edition, ISBN 978-0-8153-4123-9, Garland Science, 865 pages
- h. Lauren Sompayrac (2015) How the Immune System Works, 5th Edition, ISBN: 978-1-11899781-9, Wiley Blackwell, 160 pages
- i. Owen, Punt and Stanford (2013) Kuby's Immunology, 7th Edition, ISBN-10: 1464119910, W.H. Freeman, 692 pages
- j. Peter J. Delves, Seamus J., Martin Dennis, Burton J. Ivan &M. Roitt (2012) Roitt's Essential Immunology 12th Edition, ISBN: 978-1-444-39482-5, Wiley & Blackwell, 288 pages
- k. Peter Parham (2014) The Immune System, 4th Edition, ISBN-10: 0815345267, W.W.Norton & Co., 532 pages
- l. Warren Levinson (2016) Review of Medical Microbiology & Immunology 14th Edition, ISBN- 10: 0071845747, Mc Graw Hill Education, 832 pages
- m. William E paul (2012) Fundamental Immunology 7th Edition, ISBN-10: 9781451117837,Lippincot Williams & Wilkins, 1312 pages

COURSE CODE – BZL5B08				
CORE COURSE VIII: BIOCHEMISTRY AND MOLECULAR BIOLOGY				
Credits	Hours/week	Marks		
		Internal	External	Total
4	4	20	80	100

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		

CO1	<i>Understand</i> the elements of biological importance and the non-covalent interactions that stabilize biomolecules.	Understand	2
CO2	<i>Describe</i> the classification, types, structure, reactions and biological roles of carbohydrates, and diabetes Type I and II.	Apply	1
CO3	<i>Enumerate</i> the properties and classification of amino acids and their standard abbreviations; hierarchical levels of protein structure, classification, separation, purification and sequencing of proteins.	Analyse	4
CO4	<i>Explain</i> the classification and functions of lipids and fatty acids; chemistry and structure of nucleic acids and sequencing of DNA.	Understand	8
CO5	<i>Understand</i> the classification, nomenclature and properties of enzymes; enzyme action, coenzymes, cofactors, isozymes, ribozymes and allosteric enzymes.	Create	11
CO6	<i>Explain</i> glycolysis, Kreb's cycle, glycogenesis, glycogenolysis, gluconeogenesis, HMP pathway; amino acid and fatty acid oxidation and oxidative phosphorylation.	Analyse	6
CO7	<i>Describe</i> the mechanism of DNA duplication and the role of enzymes.	Understand	1
CO8	<i>Understand</i> the concept of gene and gene expression; genetic code and wobble hypothesis.	Evaluate	10
CO9	<i>Explain</i> the mechanism of transcription and post-transcriptional modification of hnRNA.	Understand	3
CO10	<i>Enumerate</i> the processes of translation and post-translational modification and targeting of peptides.	Apply	5
CO11	<i>Describe</i> the regulation of <i>trp</i> operon, C-value, repetitive DNA, satellite DNA, selfish DNA, overlapping genes, pseudogenes, cryptic genes, transposons and retrotransposons.	Understand	2
CO12	<i>Explain</i> the structure and life cycle of bacteriophages and the gene transfer mechanisms in bacteria.	Apply	6

COURSE CONTENT

Module I	1 Hours
Introduction	

Elements of biological importance; non-covalent bonds that stabilize biomolecules - Hydrogen bonds, hydrophobic interactions and Van der Waals Interactions.	
Module II	6 Hours
<p>Carbohydrates</p> <p>Monosaccharides: Aldoses and ketoses, trioses, tetroses, pentoses and hexoses; glyceraldehyde, dihydroxyacetone, ribose, deoxyribose, ribulose, glucose and fructose. Cyclization of pentoses and hexoses, optical activity and mutarotation, inversion and invert sugar, monosaccharides as reducing agents, Osazones. Disaccharides: Glycosidic bond, reducing and non-reducing disaccharides, maltose and sucrose as examples.</p> <p>Polysaccharides: Starch and glycogen, amylose and amylopectin, homo and heteropolysaccharides. Mention the biological functions.</p>	
Module III	7 Hours
<p>Amino acids, peptides and protein</p> <p>Proteinogenic amino acids, abbreviations (three letter and single letter) of the standard amino acids, structure and classification and general properties of amino acids, isoelectric point, peptide bonds, nonstandard amino acids.</p> <p>Peptides and proteins: Classification of proteins - simple, conjugated and derived. Structure of proteins: primary, secondary, tertiary and quaternary structure. Denaturation of proteins.</p> <p>Separation and purification of proteins: Paper chromatography, column chromatography, ion exchange chromatography, size exclusion chromatography, affinity chromatography and high - performance liquid chromatography (Brief account only).</p> <p>Electrophoresis: Mention (a) Polyacrylamide Gel Electrophoresis (PAGE) b) Agarose Gel Electrophoresis.</p> <p>Sequencing of peptides: Sanger's method, Edman degradation procedure and Mass spectrometry (Brief account only)</p>	
Module IV	8 Hours
<p>Lipids and Nucleic acids</p> <p>Lipids (3 hrs)</p> <p>Classification and functions (simple, compound, derived and miscellaneous lipids). Fatty acids: saturated and unsaturated; triglycerides; mention phospholipids; lecithins; cephalins; phosphoinositides; prostaglandins and cholesterol. Mention the clinical significance of lipid profile estimation.</p> <p>Nucleic acids (5 hrs)</p> <p>Chemistry and structure of purines and pyrimidines, structure of nucleotides (ATP, dATP and cAMP),</p>	

<p>Watson - Crick model of DNA, Different forms of DNA, the secondary and tertiary structure of tRNA. Sequencing of DNA by Sanger's method. Mention Maxam-Gilbert sequencing.</p>	
Module V	4 Hours
<p>Enzymes and co-enzymes</p> <p>Classification, nomenclature and properties of enzymes; Active centre, mechanism and theories of enzyme action, enzyme inhibition, co-enzymes (NAD, FAD) and cofactors. Mention isozymes, ribozymes and allosteric enzymes.</p>	
Module VI	10 Hours
<p>Metabolism of carbohydrates, proteins and lipids</p> <p>Glycolysis, Kreb's cycle, glycogenesis, glycogenolysis, gluconeogenesis and HMP pathway. Amino acid oxidation and production of urea. β-oxidation of fatty acids. Brief account on redox reactions, redox potentials, electrochemical gradients, electron transport chain, oxidative phosphorylation, proton gradient and chemiosmotic synthesis of ATP.</p>	
Module VII	4 Hours
<p>DNA Replication</p> <p>Meselson and Stahl experiment, Semi-conservative and semi-discontinuous, priming of Okazaki fragments, primer removal and joining of Okazaki fragments, enzymes of DNA replication (brief account)</p>	
Module VIII	5 Hours
<p>Gene and genetic code</p> <p>Gene concept</p> <p>Classical and modern concepts, housekeeping and luxury genes. Gene action: gene expression and gene products; one gene one enzyme hypothesis; one gene one polypeptide hypothesis. Central dogma of molecular biology, reverse transcription and modified central dogma.</p> <p>Genetic code</p> <p>Deciphering of genetic code, experiments of Nirenberg and Khorana, codon assignments, properties of the genetic code and wobble hypothesis.</p>	
Module IX	7 Hours

<p>Transcription</p> <p>RNA polymerases of eukaryotes and prokaryotes; promoters, terminators, enhancers and silencers.</p> <p>Transcription unit, mono and polycistronic transcription units; coupling of transcription with translation in bacteria.</p> <p>Initiation, elongation and termination of transcription (brief account).</p> <p>Post transcriptional modification of the primary transcript - hnRNA, capping, poly (A) tailing and splicing (brief account), spliceosomes.</p>	
Module X	8 Hours
<p>Translation</p> <p>Activation of amino acids and aminoacyl tRNA synthetases; role of tRNA as adaptor molecules in translation. Role of ribosomes and active centres of ribosomes. Initiation, elongation and termination of translation. Post translational modification of the peptide chain: cleavage, formation of disulfide-bridges, acetylation, glycosylation, myristoylation, sulphation, hydroxylation, prenylation, nitrosylation, ubiquitination and Sumoylation.</p> <p>Protein folding and role of molecular chaperones; Protein targeting (brief account)</p>	
Module XI	9 Hours
<p>Regulation of gene expression and organization of genome Regulation of gene expression Operon organization of bacterial transcription units; lac operon and its regulation, trp operon and its regulation. Regulatory RNAs - ncRNAs, miRNAs, piRNAs, siRNAs and RNA interference. Mention CRISPR-Cas9 and targeted genome editing.</p> <p>Organization of genome</p> <p>Sequence components of eukaryotic genome - non-repetitive, moderately repetitive and highly repetitive DNA; satellite DNA. Mention selfish DNA. C-value and C-value paradox. Overlapping genes, pseudogenes, cryptic genes, transposons and retrotransposons. Human genome and human genome project (brief account). Mitochondrial genome (brief account).</p>	
Module XII	3 Hours
<p>Genetics of bacteria and phages</p> <p>Conjugation in bacteria. Transduction - generalized and specialized; sexduction. Structure and life cycle of a bacteriophage; temperate and virulent phages; lysogeny and lysis.</p>	

MODE OF TRANSACTION

Class room Lectures and face to face interaction
ICT enabled Presentations
Presentation of students Seminar Group discussion
Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

- a. Classroom participation (20%): 4 Mark
- b. Test papers I (40%): 8 Mark
- c. Assignment (20%): 4 Mark
- d. Seminar/ Viva (20%): 4 Mark

External Assessment (80 Marks) Duration 2.5 Hours, No of Questions: 27

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	2
Module II	7
Module III	7
Module IV	17
Module V	2
Module VI	19
Module VII	2
Module VIII	2
Module IX	17
Module X	9
Module XI	24

REFERENCES:**Module 1-6 (Biochemistry)**

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2. David L. Nelson and Michael Cox (2017): Lehninger Principles of Biochemistry 7th Edition, ISBN-10: 1-4641-2611-9, W.H. Freeman, 1172 pages
3. David P. Plummer (2017)- Introduction to Practical Biochemistry, 3rd Edition, ISBN-10: 9780070994874, McGraw Hill Education, 498 pages
4. Donald Voet, Charlotte W. Pratt and Judith G. Voet (2001): Principles of Biochemistry 4th Edition, ISBN-10: 9780471417590, Wiley
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6. Gerald Michal and Dietmar Schomburg (2012): Biochemical Pathways: An Atlas of Biochemistry and Molecular Biology 2nd Revised Edition, ISBN-10: 9780470146842, Wiley Blackwell, 416 pages
7. Jeremy M Berg, Lubert Stryer, John L. Tymoczko, Gregory J Gatto (2015): Biochemistry 8th Edition, ISBN-10: 1464126100, W.H. Freeman, 1120 pages
8. Keith Wilson and John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology, 6th edition, ISBN-10: 9780521731676, Cambridge Low Price edition, 759 pages
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Module 7-12 (Molecular Biology)

1. Brooks, R. J. (2011): Genetics: Analysis and Principles. 4th Edition, ISBN-10: 0073525286, Addison Wesley, McGraw-Hill Higher Education, 864 pages
2. Bruce Alberts, Dennis Bray Karen Hopkin and Alexander D. Johnson (2013) Essential Cell Biology, 4th Edition, ISBN-10: 0853696470, Garland Publishing, 864 pages
3. Bruce Alberts, Karen Hopkin, Alexander D. Johnson, David Morgan, Martin Raff, Keith Roberts, and Peter Walter (2019) Essential Cell Biology, 5th Edition, ISBN-10: 0393680371, Garland Science,
4. Burns, G. W. & Bottino, P. J. (1989): The Science of Genetics. 6th Edition, ISBN 0023174005, Macmillan, 491 pages
5. Gangane, S. D. (2008): Human Genetics 3rd Edition, ISBN 10: 8131211282, Elsevier
6. Gardner, E. J., Michael J. Simmons and Peter Snustad (2006): Principles of Genetics. 8th Edition, ISBN-10: 8126510439, Wiley, 740 pages
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10. Harvey Lodish, Arnold Berck, Kaiser & M. Krieger (2007): *M o l e c u l a r C e l l B i o l o g y* 6th Edition, ISBN-10: 0716776014, Freeman, 973 pages
11. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick (2017): *M o l e c u l a r B i o l o g y o f t h e G e n e* 7th Edition, ISBN-10: 9332585474, Pearson Publication, 912 pages
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15. Lynn Jorde John Carey Michael Bamshad (2015): *M e d i c a l G e n e t i c s* 5th Edition,ISBN: 9780323188357, Elsevier, 368 pages.
16. Nancy Craig, Rachel Green, Carol Greider, Gisela Storz, Cynthia Wolberger andOrna Cohen-Fix (2014): *M o l e c u l a r B i o l o g y - P r i n c i p l e s o f g e n o m e f u n c t i o n* 2nd Edition, ISBN- 10: 0198705972, Oxford, 936 pages.
17. Robert J Brooker (2011): *G e n e t i c s - A n a l y s i s & P r i n c i p l e s* 4th Edition, ISBN-10: 0073525286, Mc Graw Hill, 864 pages.

COURSE CODE –BZL5B09

CORE COURSE VIII: METHODOLOGY IN SCIENCE, BIostatISTICS AND BIOINFORMATICS

Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Explain</i> science, its importance, disciplines and the major steps in formulating a hypothesis, various hypothesis models, theory, law and the importance of animal models, simulations and virtual testing	understand	6
CO2	<i>Illustrate</i> the principles and procedures in designing experiments and elaborate the requirements for carrying out experiments	Analyse	5
CO3	<i>Describe</i> the ethical concerns in practicing science	Evaluate	3
CO4	<i>Understand</i> the Scope and role of statistics; methods and	Apply	9

	procedures of sampling; Construction of tables, charts and graphs		
CO5	<i>Calculate</i> central tendency and measures of dispersion and application of its knowledge on hypothesis testing as well as in problem-solving	Apply	9
CO6	<i>Enumerate</i> major biological databases and database search engines	Understand	4
CO7	<i>Perform</i> DNA and protein sequence analysis, including sequence alignment and sequence similarity search using BLAST, FASTA, CLUSTAL W and CLUSTAL X	Analyse	10
CO8	<i>Understand</i> molecular phylogenetics and tools and methods for construction of phylogenetic trees	Create	6
CO9	<i>Explain</i> genome sequencing technologies, functional genomics, proteomic technologies and molecular docking and drug design	Understand	8

COURSE CONTENT

Module 1:	6 Hours
<p>Science, Scientific Studies and Methods</p> <p>Science and Scientific Studies Science as a human activity; scientific attitude; Empiricism; Science disciplines; Interdisciplinary approach.</p> <p>Scientific Methods Major steps: Observation, Defining the problem, Collection of information, Formulation of a hypothesis, Experimentation, Analysis of the results and Conclusion based on interpretation of the results. Methods in scientific enquiry: Inductive and deductive reasoning. Hypothesis: Formulation of a hypothesis, different thought processes in developing hypothesis (analogy, induction, deduction and intuition), hypothetico-deductive model, testing hypothesis, auxiliary hypothesis, adhoc hypothesis. Theories and laws in science; peer review; importance of models, simulations and virtual testing (brief account).</p>	
Module 2	4 Hours

<p>Experimentation</p> <p>Types of experiments; design of an experiment: principles and procedures; necessity of units and dimensions; repeatability and replications; documentation of experiments; Planning of Experiments: design, selection of controls, observational and instrumental requirements; Test animals used in experiments.</p>	
Module 3	4 Hours
<p>Ethics in Science and Animal Ethics</p> <p>Scientific information: Depositories of scientific information - primary, secondary and digital sources; Sharing of knowledge: transparency and honesty, Publications, Patents, Plagiarism.</p> <p>Constitution of India Article 51A (g); Prevention of cruelty to Animals Act of 1960 - Section 17.1(d), Committee for the purpose of control and supervision of experiments on animals (CPCSEA).</p>	
Module 4	4 Hours
<p>Introduction</p> <p>Definition; scope; role of statistics in life sciences; terminology and variables.</p> <p>Sample and Sampling: Sample size, sampling errors, methods of sampling. Collection/documentation of data of the experiments.</p> <p>Classification of data; Presentation of data: Tabular, Graphical and Diagrammatic (histogram, frequency polygon and frequency curve; line diagram, bar diagram and pie diagram).</p>	
Module 5	12 Hours
<p>Analysis and Interpretation of data</p> <p>Measures of central tendency: (raw data, discrete series data, continuous series data- problems are to be discussed) a) Mean, b) Median and c) Mode.</p> <p>Measures of Dispersion: (raw data, discrete series data, continuous series data - problems to be discussed)</p> <p>a) Range, b) Mean deviation, c) Standard deviation, d) Standard error.</p> <p>Hypothesis testing and Interpretation of results: (problems to be discussed) a)'t' test, b) F- test - ANOVA</p> <p>Significance of statistical tools in data interpretation; Statistics-based acceptance or rejection of hypothesis.</p>	
Module 6	8 Hours
<p>Introduction and Biological Databases</p> <p>Overview of bioinformatics, Scope and application.</p> <p>Major Databases in Bioinformatics: Biological databases, Features of a good database. Classification format of biological databases.</p> <p>Primary databases: Nucleotide sequence databases - Mention EMBL, DDBJ, Genbank; Protein</p>	

<p>sequence databases - Mention Swiss Prot, PIR, MIPS.</p> <p>Structure databases: PDB, NDB.</p> <p>Special databases - PROSITE, Pfam, CATH, OWL, PubMed.</p> <p>Secondary databases: Mention PROSITE, PRINTS. Databases of patterns, motifs and profiles, EST databases, SNP databases.</p> <p>Metabolite databases - Mention KEGG, EcoCyc.</p> <p>Database Search Engines: Entrez at NCBI of USA, SRS at EBI of England, STAG at DDBJ of Japan.</p> <p>Data retrieval with Entrez and SRS.</p> <p>Sequence submission to NCBI.</p>	
Module 7	4 Hours
<p>Sequence Analysis</p> <p>Web based and standalone tools for DNA and protein sequence analysis. Types of sequence alignment, methods of sequence alignment. Sequence similarity search - pair wise and multiple sequence alignments; BLAST, FASTA, CLUSTAL W, CLUSTAL X.</p>	
Module 8	3 Hours
<p>Molecular Phylogenetics</p> <p>Basics of Phylogenetics; molecular evolution and molecular phylogenetics, cladistics and ontology. Gene Phylogeny versus species phylogeny. Phylogenetic tree construction methods and programmes. Forms of Tree representation.</p>	
Module 9	9 Hours
<p>Genomics and Proteomics</p> <p>Genome sequencing technologies; Sanger capillary sequencing, Roche 454 (pyrosequencing), Illumina/Solexa, SOLiD System, Single molecule sequencing. Whole-genome sequence assembly, annotation and analysis. Functional Genomics: Microarrays, SAGE, ESTs; Transcriptomics; Metabolomics. Metagenomics: Concept and applications.</p> <p>Proteomics</p> <p>Aims, strategies and challenges in proteomics. Brief account on proteomics technologies: 2D-electrophoresis, iso-electric focusing, LC/MS-MS, MALDI-TOF mass spectrometry, yeast 2-hybrid system. Protein-protein interactions: experimental and computational methods; structural proteomics. Deriving function from sequence databases.</p> <p>Cheminformatics</p> <p>Molecular docking: Concept and its applications</p>	

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled Presentations
Presentation of students Seminar Group discussion
Assignments and Field study, Interview

MODE OF ASSESSMENT
Internal Assessment (20 Marks)
a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark
d. Seminar/ Viva (20%): 4 Mark
External Assessment (80 Marks) Duration 2.5 Hours, No of Questions: 27

MODULE WISE MARK DISTRIBUTION	
Module	Mark
Module I	19
Module II	7
Module III	9
Module IV	12
Module V	9
Module VI	19
Module VII	9
Module VIII	7
Module IX	19

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Antonisamy B, Prasanna S. Premkumar and Solomon Christopher (2017) Principles and Practice of Biostatistics, ISBN-10: 8131248879, Elsevier, 390 pages

Bailey, N. T. J (1995): Statistical Methods in Biology, 3rd Edition, CUP, 272 pages

Green, R. H. (1979) Sampling design and Statistical Methods for Environmental Biologists. ISBN 978-0-471-03901-3, J.W. & S. 272 pa

Gupta, S. P. (2018) Statistical Methods. 45th Revised Edition, ISBN 978-93- 5161- 112-7 (506), Sultan Chand & Co.1440 pages

Wayne W. Daniel and Chad L. Cross (2014) Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th Edition, ISBN-10: 8126551895, Wiley, 954 pages

Module 6-9 (Bioinformatics)

Anna Tramontano (2006): Introduction to Bioinformatics, ISBN-10: 1584885696, Chapman & Hall, 192 pages.

Atwood and Parry-Smith (1999): Introduction to Bioinformatics. ISBN 9780582327887, Pearson Education Asia, New Delhi, 218 pages

Caroline St. Clair and Jonathan Visick (2013): Exploring Bioinformatics 2nd Edition, ISBN 10: 1284034240, Jones & Bartlett, 300 pages

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Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. ISBN 10: 0195692306, Oxford University Press, 560 pages

Hooman Rashidi and Lukas K. Buehle (2005): Bioinformatics Basics, 2nd Edition, ISBN 9780849312830, Taylor & Francis, 360 pages

Jeffrey Augen (2004): Bioinformatics in the Post-Genomic Era: Genome, Transcriptome, Proteome, and Information-Based Medicine, ISBN-10: 0321173864, Addison-Wesley, 408p.

Jeremy Ramsden (2015): Bioinformatics - An Introduction 3rd Edition, ISBN 978-1- 44716701-3, Springer, 308 pages

Jonathan Pevsner (2015): Bioinformatics and Functional Genomics 3rd Edition, ISBN: 978-1118-58178-0, Wiley, 1160 pages

Malcom Campbell and Laurie J. Heyer (2006): Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, ISBN 10: 9780805382198, Pearson, 464 pages

COURSE CODE –BZL6B14L			
CORE COURSE IX: PRACTICAL II*A: CELL BIOLOGY, GENETICS, BIOTECHNOLOGY, MICROBIOLOGY AND IMMUNOLOGY			
Credits	Hours/week (Practical)	Marks	
		Internal	External

4	8	20	80	100
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Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	Perform experiments in cell biology and genetics including demonstration of Barr body in buccal epithelial cells of man, polytene chromosome in the salivary glands of <i>D. Melanogaster</i> larva, mitotic division in onion root tip cells, micrometry of microscopic objects, prepare whole mounts of microscopic objects, and calculate mitotic and metaphase index from slides.	Apply	7
CO2	Enumerate the inheritance of major human genetic traits, pedigree chart, normal and abnormal human karyotypes, phenotypic differences of male and female <i>Drosophila</i> and solve problems on Monohybrid, dihybrid crosses, blood groups and sex-linked inheritance.	Create	10
CO3	Understand electrophoresis, PCR, Northern blotting, Southern blotting and Western blotting, DNA sequencing and fingerprinting and isolation of genomic DNA.	Understand	1
CO4	Perform gram staining and preparation of culture media for bacteria and demonstrate bacterial motility by standard laboratory protocols.	Apply	4
CO5	Understand the detection of human blood groups and organs of immune system	Apply	6
CO6	Perform standard biochemical tests for the detection of reducing and nonreducing sugars, polysaccharides, proteins and lipids.	Apply	7
CO7	Understand the staining of mitochondria, tissue homogenization and isolation of nuclei, effect of colchicines of cell division, extraction of DNA and polyacrylamide and agarose gel electrophoresis	Understand	2
CO8	Solve basic problems in biostatistics and Bioinformatics	Apply	10

COURSE CONTENT

Module 1	72 Hours
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RACTICAL II*A

CELL BIOLOGY, GENETICS, BIOTECHNOLOGY, MICROBIOLOGY &
IMMUNOLOGY [72 hrs] [4 hrs/week]

Section A: Cell Biology

1. Study of diversity of eukaryotic cells - methylene blue staining of buccal epithelium and striated muscle cells (Minor).
2. Temporary mount of buccal epithelial cells to observe Barr body (Major).
3. Mitosis: stages in onion (*Allium cepa*) root meristem by squash preparation (major).
4. Calculation of mitotic index and metaphase index in root meristem of *Allium cepa* (Major).
5. Study of the polytene chromosome of *Drosophila melanogaster* using salivary gland cells of 3rd instar larva.
6. Measurement of size of microscopic objects using ocular and stage micrometres (Major).
7. Tissues (use permanent slides of epithelial tissues, smooth muscle, cartilage, bone).
8. Preparation of permanent whole mount.
9. Study of different stages of meiosis in grass hopper testes (Demonstration).
10. Vital staining of mitochondria using insect flight muscle/check epithelium / yeast (Minor)

Section B: Genetics

1. Scheme of Pedigree chart.
2. Study of inheritance of human traits: (use Pedigree charts). Blood groups, Eye colour.
3. Genetic problems on Monohybrid, dihybrid crosses; blood groups; sex-linked inheritance (minimum ten problems to be worked out).
4. Frequency of the following genetic traits in human: widow's peak, attached ear lobe, dimple in chin, hypertrichosis, colour blindness, PTC tasting.
5. Study through photographs of the Karyotype: Down's, Klinefelter's, Turner's and Edward's Syndrome.
6. Study of phenotypic characters in male and female *Drosophila*

Section C: Biotechnology

1. Study of the principle and applications of Electrophoretic apparatus.
2. PCR-Principle and applications.
3. Study of transgenic animals.
4. Southern blotting (Principle and methodology - using flowcharts/diagrams/by visiting a diagnostic Lab)

Section D: Microbiology

1. Gram staining for the identification of Gram positive and Gram-negative bacteria (*Lactobacillus* and *Rhizobium*) (Major).
2. Bacterial motility by hanging-drop method (Demonstration).
3. Preparation of culture media for bacteria (Synthetic Media, Natural Media, Simple Media, Differential Media and Selective Media).

4. Methylene blue reduction test for assessing the quality of raw milk (Demonstration).
5. Preparation of a fungal smear - Lactophenol cotton blue staining & mounting (Minor)

Section E: Immunology

1. Identification of human blood groups (A B O and Rh).
2. Histological study of spleen, thymus and lymph nodes through slides/photographs.
3. ELISA (methodology of detection of biomolecules using flowcharts/diagrams/by visiting a diagnostic La
4. Western blotting (methodology of detection of specific proteins (using flowcharts/diagrams/by visiting a diagnostic Lab)

Module 2	72 Hours
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ACTICAL II*B

**BIOCHEMISTRY, MOLECULAR BIOLOGY,
METHODOLOGY IN SCIENCE, BIOSTATISTICS & BIOINFORMATICS**

[(72 hrs) (4 hrs/week)]

Section A: Biochemistry

1. Detection of organic constituents (carbohydrates, proteins and lipids only) from sample solutions (Major)
 - a) Detection of reducing sugar: Glucose/Fructose/Maltose [Fehling's test, Benedict's test, Moore's test, cupric sulphate test, rapid furfural test (any three) (Major).
 - b) Detection of monosaccharides [Barfoed's test]
 - c) Detection of non-reducing sugars: Sucrose [Hydrolysis test].
 - d) Identification of functional groups of carbohydrates [Selivanoff's test]
 - e) Detection of polysaccharides: Starch [Lugol's iodine test, confirmatory heating & cooling test].
 - f) Detection of proteins: [Biuret test, Nitric acid test, Xanthoproteic test].
 - g) Detection of lipids: [Sudan III or IV test, Spot test].
2. Preparation of Normal, molar and standard solutions and serial dilutions.
3. Separation of amino acids (or any other compounds) from a mixture by using paper chromatography
4. Determination of concentration of unknown solutions using Photo electric colorimeter.

Section B: Molecular Biology (Any four items)

1. Cell fractionation and isolation of nucleus.
2. Study of the effects of Colchicine on mitosis in the root meristem of *Allium cepa*.
3. Differential staining for DNA and RNA in human cheek epithelial cells (demonstration).
4. Poly acrylamide gel electrophoresis.
5. Agarose gel electrophoresis.
6. Isolation of DNA from animal tissues.
7. Isolation of RNA from animal tissues.

Section C: Methodology in Science, Biostatistics and Bioinformatics

(Any 10 items of the following)

1. Design an experiment to prove a hypothesis by testing the specificity of the enzyme salivary amylase on starch.
2. Measure the size of given leaves / any sample of data and calculate the mean, median and mode (raw data, discrete series & continuous series).
3. Measure the size of given shells / any sample of data and represent it in a graphical form and interpret it.
4. Calculate the standard deviation of the given set of data (raw data, discrete series & continuous series). Enter the data in Excel, calculate SD and record the screen shots of steps and results.
5. Census the avian fauna / any fauna of two different areas and present the data in a suitable graphical

form. Compare by t-test.

6. Construct a frequency curve with mean \pm SD using suitable data. Draw the same in Excel or using any free software and record it.

7. Prepare a frequency polygon with mean \pm SD utilizing appropriate data.

8. Draw a bar diagram with mean \pm SD employing suitable data.

9. Construct a histogram with mean \pm SD utilizing suitable data. Do the same with software

10. Draw a pie diagram using suitable data. Draw the same in Excel or using any free software.

11. Formulate a hypothesis of any scientific observation made by you.

12. Sequence retrieval from databases.

13. Sequence similarity search using BLAST.

14. Multiple sequence alignment.

15. Construction of phylogenetic tree .

16. Docking studies (Demonstration).

MODE OF TRANSACTION

Live Dissections, Demonstration of Dissections, Class room lectures, Exhibiting specimens from the museum,

ICT enabled Presentations , Field study, taking photos and videos of the biodiversity by students, WhatsApp group discussions

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

- e. Classroom participation (20%): 6 Mark
- f. Lab involvement, Performance & Punctuality: 4 Mark
- g. Class Test : 6 Mark
- h. Record: 4 Mark

External Assessment (80 Marks): Duration: 4 Hrs., No of Questions: 9

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Spotters	6	6	3	18
Minor	2	2	9+12	21
Major	1	1	22	22
Viva				3
Record				16

Total	80
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4. Panjarathinam R (2009) Practical Medical Microbiology; 1st Edition, ISBN-10: 9350907348, Jaypee Brothers Medical Publishers, 192 pages
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7. Sundara S. Rajan: Practical Manual of Microbiology ; ISBN-10: 8126110104, Anmol Publications, 166 pages
8. Susan Mahler Zneimer (2016) Cytogenetic Laboratory Management: Chromosomal,FISH and Microarray-Based Best Practices and Procedures;1st Edition, ISBN-10:9781119069744, Wiley- Blackwell, 840 pages
9. Bansal M P(2015) Molecular Biology and Biotechnology: Basic Experimental Protocols The Energy and Resources Institute, TERI, 392 pages
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17. Sawbney S. K. and Singh, R. (2001) Introductory Practical Biochemistry, ISBN- 10: 8173193029, Narosa Publ, 470 pages

SEMESTER 6

COURSE CODE –BZL6B10				
CORE COURSE X: PHYSIOLOGY AND ENDOCRINOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Describe</i> the regulation of digestion in man, nutrition in pregnancy and infancy, nutritional disorders, balanced diet, starvation, fasting and obesity.	Knowledge	6
CO2	<i>Discuss</i> the mechanism of transport and exchange of respiratory gases and its neurophysiological control and physiological problems in diving mammals, new-born, and aged individuals.	Understand	6
CO3	<i>Describe</i> functions, composition, coagulation, transfusion, agglutination, and clinical analysis of blood, hemoglobinopathies, types of heart and common cardiovascular problems.	Understand	6
CO4	<i>Summarize</i> the osmoregulatory mechanisms in animals; excretion and its hormonal control and common renal disorders in man.	Understand	6
CO5	<i>Illustrate</i> the ultrastructure of skeletal muscles and biochemical events and energetics of muscle contraction.	Analyse	6
CO6	<i>Classify</i> the different types of nerve cells, glial cells and nerve fibers, and the mechanism of nerve impulse transmission	Understand	6
CO7	<i>Analyse</i> the types, physiology and significance of bioluminescence, and the structure and functions of electric organs.	Analyse	6
CO8	<i>Describe</i> invertebrate neuro-endocrine organs and hormones, vertebrate endocrine glands, their hormones and functions	Knowledge	6

CO9	<i>Explain</i> the concept of neurosecretion and the mode of action of peptide and steroid hormones.	Create	6
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COURSE CONTENT	
Module I	5 Hours
<p>Nutrition Regulation of digestive activity: Nervous and hormonal control; Ruminant digestion; Nutrition in pregnancy, infant nutrition, breast feeding, composition of breast milk; Importance of dietary fibres; Balanced diet; Nutritional disorders: anorexia, acidity, ulcer, flatulence; starvation, fasting and its significance; Obesity: causes and consequences.</p>	
Module II	6 Hours
<p>Respiration Gaseous exchange and transport of respiratory gases (brief account), Oxygen- Haemoglobin dissociation curve; Respiratory pigments, structure and properties of Hb; Neurophysiological control of respiration; Physiological problems in diving mammals, new-born and aged individuals.</p>	
Module III	6 Hours
<p>Circulation Blood: functions and composition; Coagulation of blood (Enzyme cascade theory); Clinical analysis of blood, ESR; Haemodynamics; Haemostasis, haemolysis and jaundice, hemoglobinopathies; Blood transfusion and agglutination, aphaeresis. Types of heart; ECG; Common cardio-vascular problems: Abnormal variations in BP, Tachycardia, Bradycardia, Myocardial infarction, heart failure, cerebral hemorrhage and cerebro-vascular accident.</p>	
Module IV	6 Hours
<p>Osmoregulation and Excretion Osmoconformers and osmoregulators; Water conservation in desert forms; Osmotic and ionic regulation in terrestrial, fresh water and marine animals; Types of excretion, urea cycle; Human kidney: Urine formation with counter-current mechanism and hormonal regulation; Common renal disorders: haematuria, uremia, proteinuria, renal hypertension, nephritis, renal calculi, oedema, acidosis and alkalosis; Dialysis.</p>	
Module V	5 Hours

<p>Muscle Physiology</p> <p>Structure of vertebrate skeletal muscle: EM structure of Myofibrils and Myofilaments, contractile proteins; Mechanism of muscle contraction: Ultra structural changes (sliding filament theory); physiology, biochemistry and energetics of muscle contraction; energy sources, role of creatine phosphate, cori cycle; Muscle twitch, fatigue, tetany and rigor mortis.</p>	
Module VI	6 Hours
<p>Nerve Physiology</p> <p>Different types of nerve cells; glial cells, giant nerve fibre of crustaceans and cephalopods; regeneration of medullary fibres, neurotrophins; Nerve impulse transmission, synapses and neuromuscular junctions, synaptic transmission (electrical and chemical), neurotransmitters.</p>	
Module VII	2 Hours
<p>Bioluminescence and Bioelectricity</p> <p>Classification of bioluminescence: symbiotic, extracellular and intracellular; Physiology and significance of light production; Structure and functions of electric organs.</p>	
Module VIII	12 Hours
<p>Invertebrate and Vertebrate endocrinology</p> <p>Neuro- endocrine organs and hormones in crustaceans and insects.</p> <p>Classification of hormones: Amine, peptide and steroid hormones.</p> <p>Endocrine glands in man (hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenal, thymus, pineal and gastro-intestinal): their hormones and functions (brief account); Hormonal disorders.</p> <p>Hormones of reproduction: Testes, ovaries and placenta, their hormones and physiological effects; role of hormones in female sexual cycle; hormone related female and male sexual dysfunctions.</p>	
Module IX	6 Hours
<p>Concept of neurosecretion and hormonal action</p> <p>Hypothalamus-hypophysial interactions, hypothalamus releasing and inhibiting hormones and their roles, Neuro-hormonal integration, Neuro-endocrine pathways, Regulation of hormone secretion.</p> <p>Hormonal action: Hormone receptors; Mechanism of action of peptide and steroid hormones; mode of action of insulin and thyroxine; positive and negative feedback regulation.</p> <p>Topics for assignments/seminars</p> <p>(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)</p> <ol style="list-style-type: none"> 1. History, aim, scope and branches of Physiology. 2. Absorption of carbohydrates, proteins, and lipids. 	

3. Conducting system of the heart.
4. Composition and functions of lymph.
5. Gross and micro structure of human kidney.
6. Endocrine disorders in man: Cushing's disease, Addison's disease, diabetes mellitus, diabetes insipidus, dwarfism, gigantism, cretinism, myxoedema and goitre.

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled presentations

Presentation of students Seminar / Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

- a. Classroom participation (20%): 3 Mark
- b. Test papers I (40%): 6 Mark
- c. Assignment (20%): 3 Mark
- d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Marks
Module I	7
Module II	14
Module III	9
Module IV	9
Module V	12
Module VI	7
Module VII	7
Module VIII	7

Module IX	7
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COURSE CODE –BZL6B11				
CORE COURSE XII: REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Explain</i> the reproductive strategies in invertebrates and vertebrates and structural and functional features of human reproductive system	Analyze	1

CO2	<i>Describe</i> process of fertilization, pregnancy, gestation, placentation, parturition and lactation in humans.	Create understand	10
CO3	<i>Explain</i> the scope of reproductive technologies in infertility management; prenatal diagnostic techniques and methods of fertility control	Analyse	8,5
CO4	<i>Understand</i> the phases and theories of development, and classification of eggs	Apply	1
CO5	<i>Enumerate</i> the types of cleavage, arrangement of blastomeres, germ layers and their derivatives, cell lineage in Planocera and different types of the blastula.	Understand	7
CO6	<i>Illustrate</i> the early developmental process of egg in <i>Amphioxus</i> , frog, chick and man	Apply	11
CO7	<i>Explain</i> the basics of cell differentiation and its genetic control, stem cells and applications of stem cell technology	Create	4
CO8	<i>Describe</i> parthenogenesis, types, and significance	Understand	1
CO9	<i>Explain</i> fate map construction, Spemann's constriction experiments on amphibian embryos, organizers in development, embryonic induction, gradient experiments in sea urchin eggs, cloning experiments in sheep and teratogenesis	Evaluate	5

COURSE CONTENT

Module I	6 Hours
<p>Introduction and Human Reproductive system</p> <p>Introduction to Reproductive Biology</p> <p>Importance and scope. Reproductive strategies in invertebrates and vertebrates; semelparity and iteroparity. Sex patterns; Mention sex reversal with examples.</p> <p>Human Reproductive system</p> <p>Male reproductive system: structure of testis, semen production and composition. Female reproductive system: structure of ovary and graafian follicle, ovulation, mention corpus haemorrhagicum, corpus luteum and corpus albicans. Accessory reproductive organs in male & female Secondary sexual characteristics. Menstrual cycle and its hormonal control (brief account of oestrous cycle in mammals).</p> <p>Gametogenesis: spermatogenesis and oogenesis.</p>	

Module II:	3 Hours
<p>Fertilization, Pregnancy, Gestation, Placentation, parturition and lactation</p> <p>Fertilization: Fertilizin and anti-fertilizin, capacitation, agglutination, sperm penetration, activation of egg and amphimixis. Physiological and biochemical changes during and after fertilization. Pregnancy, Gestation, Placentation, parturition and lactation.</p>	
Module III	5 Hours
<p>Reproductive technologies</p> <p>Reproductive technologies</p> <p>Infertility and its management: Brief account of semen collection, preservation, storage, artificial insemination, surrogacy.</p> <p>Cryopreservation and embryo transfer: Collection, care and preservation of embryos; in vitro fertilization and embryo transfer: major steps; Test tube babies.</p> <p>Assisted Reproductive Techniques (ART): GIFT, ZIFT, ICSI, oocyte donation and embryo donation.</p> <p>Prenatal Diagnosis</p> <p>Different Prenatal Diagnostic techniques (invasive and non-invasive); Prevention of Female foeticide - ethical issues and laws (Mention-PNDT Act).</p> <p>Fertility control</p> <p>Natural methods, artificial methods, chemical methods, hormonal methods, surgical contraception, removal of gonads and uterus; abortion.</p>	
Module IV	3 Hours
<p>Introduction and Types of eggs</p> <p>Introduction to Embryology</p> <p>Historical Perspective (brief account): Mention phases in development. Theories: preformation, epigenesis, recapitulation and germplasm theory.</p> <p>Types of eggs</p> <p>Classification of eggs with examples based on: Amount of yolk (micro, meso & macrolecithal); Distribution of yolk (iso, Centro and telolecithal); Presence or absence of shell (cleidoic & non cleidoic); Types of development (determinate and indeterminate).</p> <p>Egg membranes: primary, secondary and tertiary; functions of egg envelopes.</p>	
Module V	3 Hours
<p>Cleavage and cell lineage</p> <p>Types of cleavage with examples based on: Plane of cleavage (Meridional, Vertical, Equatorial and Latitudinal); Amount of yolk (Holoblastic and Meroblastic); Types of development (Determinate and Indeterminate); Pattern of arrangement of blastomeres (Radial and Spiral).</p> <p>Germ layers and derivatives. Cell lineage studies in Planocera (brief account only). Different types of blastula.</p>	

Module VI	22 Hours
<p>Development of Amphioxus, frog, chick and man</p> <p>Early development of Amphioxus Brief account of fertilization. Cleavage, Blastulation, Gastrulation and Neurulation.</p> <p>Development of Frog Fertilization, Cleavage, Blastulation and fate map, Gastrulation (Morphogenetic movements) and formation of germ layers, neurulation and notochord formation, mesoderm and coelom formation; organogeny of brain and eye. Hormonal control of amphibian metamorphosis.</p> <p>Development of Chick Structure of egg; fertilization, cleavage, Blastulation, gastrulation and formation of germ layers. Salient features of chick embryo at primitive streak stage, 24-, 33- and 48-hours stages. Development and functions of extra embryonic membranes.</p> <p>Development of Man Cleavage and formation of morula, development of blastocyst, implantation, gastrulation up to the formation of germ layers. Human placenta; functions of placenta.</p>	
Module VII	3 Hours
<p>Cell Differentiation and Gene action during development Cell differentiation, totipotency, pluripotency, dedifferentiation and redifferentiation. Controlled gene expression during development; Homeotic genes, Mention Hox- genes. Stem cells - embryonic and adult stem cells; their significance and applications.</p>	
Module VIII	2 Hours
<p>Parthenogenesis Definition and types. Natural parthenogenesis: Arrhenotoky, Thelytoky, Obligatory and Facultative. Artificial parthenogenesis. Significance of parthenogenesis.</p>	
Module IX	7 Hours
<p>Experimental Embryology & Teratology</p> <p>Experimental Embryology Construction of fate map, vital staining, marking with carbon particles and radioactive tracing. Spemann's constriction experiments on amphibian embryos, potency of nuclei and importance of grey crescent. Organizers in amphibian development (primary, secondary & tertiary organizers). Embryonic induction. Gradient experiments in sea urchin eggs. Cloning experiments in sheep.</p> <p>Teratology Environmental disruption in animal development: Teratogenic agents and their effects (alcohol, drugs,</p>	

nicotine and other chemicals), infections (Herpes virus, Cytomegalovirus and Rubella virus), metabolic imbalance (malnutrition and autoimmunization) (brief account).

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled Presentations

Presentation of students /Seminar Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

- | | |
|-----------------------------------|--------|
| a. Classroom participation (20%): | 3 Mark |
| b. Test papers I (40%): | 6 Mark |
| c. Assignment (20%): | 3 Mark |
| d. Seminar/ Viva (20%): | 3 Mark |

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Marks
Module I	7
Module II	4
Module III	9
Module IV	9
Module V	12
Module VI	7
Module VII	7
Module VIII	7

Module IX	17
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COURSE CODE –BZL6B12				
CORE COURSE XII: ENVIRONMENTAL AND CONSERVATION BIOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	Explain the structure of ecosystem and its functioning through energy flow and nutrient cycling	Understand	3
CO2	Sketch the biogeochemical cycles and understand the concept of limiting factors.	Apply	6

Comment [AP6]: PSO No is missing

Comment [A7]: Done

CO3	Describe the ecology of population, community and habitat as a self-regulating system	Understand	4
CO4	Analyse the various types of population interactions and appraise the co-evolution.	Analysis	4
CO5	Discuss the diverse environmental and sustainability challenges ranging from local to global and the establishment of perfect harmony between economic development, social issues and environmental conservation.	Understand	4
CO6	Design several tools and techniques employed for studies on populations, communities and ecosystems.	Create	11
CO7	Asses the threats to biodiversity, and strategies adapted for the conservation of diversity of organisms	Evaluate	3
CO8	Describe the various international strategies for conserving biodiversity	Understand	2
CO9	Describe the toxic chemicals, their toxicity levels and the health hazards caused by them	Understand	9

COURSE CONTENT	
Module I	6 Hours
<p>Introduction, Ecosystem and Energetics</p> <p>Introduction to Environmental biology: Definition, divisions of ecology, modern branches and scope.</p> <p>Ecosystem-Structure and functions: Concept of ecosystem, characteristics; Structure (components) of ecosystem (pond as an example); Mention kinds of ecosystems.</p> <p>Ecosystem Energetics: Photosynthetic production and energy fixation; Energy flow in the ecosystem, Energy flow and laws of thermodynamics, Energy transfer and energy transformations [Trophic dynamics or community dynamics (Lindeman’s model of energy flow)]; Ecological efficiency.</p> <p>Productivity of ecosystem: Concept of productivity- standing crops, material removed and production rate; Kinds of productivity: a) Primary productivity (GPP, NPP, NCP) b) Secondary productivity).</p>	
Module II	5 Hours
<p>Biogeochemical Cycles and Limiting factors</p> <p>Biogeochemical Cycles: Basic types of biogeochemical cycles: Gaseous cycles (Carbon and nitrogen cycles) Sedimentary cycle (Phosphorous cycle).</p>	

Limiting factors: Basic concepts. Leibig's law of minimum; Shelford's law of tolerance and combined concept of limiting factors. Ecological indicators	
Module III	14 Hours
<p>Population, Community and Habitat Ecology</p> <p>Population Ecology Properties of population: density, natality, mortality, age distribution, biotic potential, environmental resistance, migration, emigration, immigration and carrying capacity. Population growth forms, J and S shaped curves.</p> <p>Community Ecology Biotic community: Definition and kinds of communities. Characteristics: Species diversity, abundance, dominance, stratification, succession, growth forms, trophic structure, co-existence, interdependence and key stone species; Concept of ecotype, ecotone and edge effect.</p> <p>Habitat ecology</p> <p>a) Marine ecology: Biotic divisions of the marine habitat, their characteristics. Pelagic realm-planktonic and nektonic adaptations. Benthic realm - littoral and abyssal adaptations. Adaptations of animals of rocky, sandy and muddy sea shores.</p> <p>b) Fresh water ecology: Lentic and lotic habitats, their characteristics, faunal characteristics and adaptations.</p> <p>c) Terrestrial ecology: Tropical wet evergreen forests and Tropical dry deciduous forests, their characteristics, adaptations of animals of forests.</p>	
Module IV	3 Hours
<p>Population Interactions</p> <p>a) Intraspecific interactions</p> <p>b) Inter specific interactions: Positive interactions- Mutualism, Commensalism and Proto-cooperation (with examples). Negative interactions- Competition, Predation and Parasitism (with examples).</p>	
Module V	4 Hours
<p>Social issues and Environment</p> <p>Sustainable development; Joint Forest Management; Goals of United Nations; Environmental ethics: Issues and possible solutions, Habitat destruction and its consequences- socio-ecological concern: wetland, paddy fields, mangrove, river encroachment, sand and clay mining; Ecological impacts of tourism.</p> <p>Disaster management: Natural & Artificial - floods, drought, earthquake, cyclone and landslides.</p>	

Module VI	4 Hours
<p>Ecological tools and Techniques</p> <p>Commonly used techniques for study of animal populations: a) Sampling of animal populations b) Trapping and collecting various groups of organisms [insects, aquatic organisms, soil organisms, Amphibians, Reptiles birds and mammals] c) Marking of animals d) Determination of age in animal groups d) Determination of home range and territory e) Population Density of animals f) Indirect method of population estimation g) Recent trends- GIS, Camera trapping, Radio collaring and Remote sensing (Brief account only)</p>	
Module VII	10 Hours
<p>Biodiversity</p> <p>Introduction, Components of biodiversity: Genetic diversity, species diversity (mention Shannon diversity index and Simpson's dominance index), community diversity and ecosystem diversity, landscape diversity; Levels of diversity in community and ecosystem diversity: Alpha, beta and gamma diversities.</p> <p>Hot spots of biodiversity. Mention hotspots in Indian region (Western Ghats and Sri Lanka, Himalayas, Indo Burma and Sundaland). Loss of biodiversity and its causes.</p> <p>Threatened species, Extinction of species, Red data book and IUCN Red list categories.</p> <p>Conservation of biodiversity and wildlife: conservation measures; Wildlife (protection Act) 1972, Conservation projects: Project Tiger, Elephant, Lion, Crocodile, Gangetic Dolphins, Kashmir Red Deer and Brow-antlered Deer (Sangai). Biodiversity conservation strategies: Protection of endangered species- Ex situ conservation (conservation in Seed banks, Gene banks, Germ plasm banks, Zoo, Botanical gardens etc.).</p> <p>In situ conservation: Wildlife Sanctuaries and National Parks (Mention examples with short notes- Thattekkad bird sanctuary, ParambikulamWLS, PeriyarWLS, Malabar WLS); National Parks- Eravikulam NP & Silent Valley NP; Biosphere Reserves - Nilgiri BR & Agasthyamalai BR; Community reserve- Kadalundy.</p>	
Module VIII	4 Hours
<p>Global strategy for conservation</p> <p>Brief notes on i) Stockholm conference/Declaration (1972), ii) IUCN, iii) WWF, iv) UNEP, v) CITES, vi) Rio Declaration vii) Rio convention on Biodiversity, 1992 (Rio Earth Summit, 1992), Rio (2012). viii) Kyoto Agreement (1997), Paris Agreement (2016) and Conference of the Parties (COP) on climate change (2018), ix) Ramsar convention (2018).</p>	
Module IX	4 Hours

Toxicants and public health hazards

- a. Toxic chemicals (biocides, automobile emissions, heavy metals, fertilizers, food additives, xenobiotics, radioactive wastes).
- b. Classification of poisons; Physico-chemical characteristics and mode of action of poisons; Accidental, suicidal and homicidal poisonings; Signs and symptoms of common poisoning and their antidotes.
- c. Levels of toxicity: Acute, sub-acute, chronic, Dose-response relationship. Measures of toxicity: LD50 and LC50.

MODE OF TRANSACTION

Class room Lectures and face to face interaction
ICT enabled Presentations
Presentation of students Seminar Group discussion
Assignments and Field study, Interview

MODE OF ASSESSMENT**Internal Assessment (15 Marks)**

- a. Classroom participation (20%): 3 Mark
- b. Test papers I (40%): 6 Mark
- c. Assignment (20%): 3 Mark
- d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Marks
Module I	7
Module II	4
Module III	9
Module IV	9
Module V	12
Module VI	7

Module VII	7
Module VIII	7
Module IX	17

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COURSE CODE –BZL6B13**CORE COURSE XIII: ETHOLOGY, EVOLUTION AND ZOOGEOGRAPHY**

Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Describe</i> the patterns and mechanisms of animal behaviour	Apply	4
CO2	<i>Illustrate</i> biological rhythms and the chemical basis of communication	Analyze	10
CO3	<i>Identify</i> major evolutionary transitions over time, and explain the tools and evidences that support current hypotheses of the history of life on earth	Create	8
CO4	<i>Describe</i> the evidences for evolution and its required corollaries	Evaluate	7
CO5	<i>Explain</i> the various theories of evolution	Apply	4
CO6	<i>Describe</i> the mechanisms by which evolution occurs	Understand	6
CO7	<i>Recognize</i> the significance of reproductive isolation in reducing gene flow between populations, biological and morphological species concepts and distinguish between prezygotic and postzygotic barriers to reproduction	Analyse	5
CO8	Review the events in human evolution	Create	1
CO9	<i>Explain</i> ecological and historical foundations for understanding the distribution and abundance of species, and their changes over time and comprehend the basic principles of biogeography as a discipline	Apply	3

COURSE CONTENT

Module 1	5 Hours
Patterns and Mechanisms in Animal Behaviour Introduction and Patterns of behaviour History (brief), scope of ethology. (a) Innate behaviour: Orientation-taxes/kinesis, simple reflexes, instincts, motivation. (b) Learned behaviour: Habituation, conditioned reflex, trial and error learning; latent learning, imprinting, insight learning, memory and learning. Neural mechanism in behaviour Role of hypothalamus in thirst and feeding; role of cerebral cortex in emotional behaviour; mammalian limbic system and control of behaviour (brief account).	
Module 2	7 Hours
Biological rhythm and Sociobiology Biological clocks/rhythms Photoperiodism, circadian rhythm; migration, orientation, navigation and homing; diapause, hibernation and aestivation (brief account) Sociobiology Social groups in termites and elephants; Chemical communication: classification and significance of pheromones (mention human pheromones also).	
Module 3	8 Hours
Course of Evolution History of Evolutionary thought History of evolutionary thought: Ideas of evolution during Pre-Darwinian, Darwinian and Post-Darwinian periods (brief account). Origin of life Biochemical origin of life (Modern hypothesis-Oparin-Haldane Theory). Major steps in the biochemical evolution of life (brief account): Origin of Earth and the primordial atmosphere, formation of simple organic molecules, formation of macromolecules or polymers, and formation of coacervates, microspheres, protocells and full-fledged living cells; origin of mitochondria and chloroplast. Experimental evidence for biochemical origin of life: Urey-Miller experiment; Other experiments; Modern ideas on the origin of life. Mention origin of prokaryotes and eukaryotes. History of Life on Earth Geological time scale (simple chart), mention Cambrian explosion. Fossils, Fossilization and Dating of fossils (brief account). Living fossils: Peripatus, Limulus and Sphenodon as examples.	
Module 4	5 Hours
Evidences of Organic Evolution i) Morphological and Anatomical, ii) Physiological and biochemical, iii) Embryological, iv) Palaeontological, v) Molecular, vi) Taxonomical evidences and vii) Biogeographical evidences	
Module 5	6 Hours
Theories of Evolution Lamarck's theory: Explanation of the major postulates of the Lamarck's theory with examples, Criticism against Lamarckism, Neo-Lamarckism, Present status of Lamarckism.	

<p>Darwin's theory: Explanation of important postulates of Darwin's theory, Examples for natural selection, Criticism against Darwinism, Neo-Darwinism (Synthetic theory of evolution). Weismann's germplasm theory; Mutation theory of De Vries. Mention the contributions of Wallace.</p>	
Module 6	5 Hours
<p>Concepts of Evolutionary Process Genetic basis of evolution: i) Mutations (brief account of gene and chromosomal mutations), ii) Variations: somatic (environmental) variations and genetic (hereditary) variations, iii) Hardy-Weinberg Principle: Hardy-Weinberg Equilibrium, Factors that upset Hardy-Weinberg Equilibrium, iv) Genetic drift: effects on population, Evolutionary bottleneck and Founder effect, importance of genetic drift in evolution; theory of punctuated equilibrium and its relevance.</p>	
Module 7	7 Hours
<p>Nature of Evolution Species and Speciation: Species concept: phylogenetic and biological species concepts; General characteristics and subdivisions of species: subspecies, semi species, sibling species, cline and deme. Speciation: Types of speciation i) Phyletic speciation ii) Quantum speciation iii) Gradual speciation; Major methods of natural speciation: Allopatric, parapatric and sympatric speciation. Isolation and Isolating mechanisms: Types of isolating mechanisms i) Geographic isolation: mention examples, ii) Reproductive isolation (a) Prezygotic isolation (habitat, seasonal, ethological, morphological, physiological, Mechanical and cytological isolation with examples), (b) Post zygotic isolation (hybrid inviability, hybrid sterility and F2 breakdown isolation with examples). Adaptive Radiation (Divergent Evolution): Cause and significance, adaptive radiation in Darwin's finches; Convergent Evolution; Pre-adaptation; Co-evolution (mention examples also).</p>	
Module 8	3 Hours
<p>Evolution of Modern Man Evolutionary trends in humans; Fore-runners of anthropoids-Parapithecus;Fore- runners of apes-Dryopithecus;Fore-runners of modern man-Ramapithecus (Kenyaipithecus), Australopithecus(The ape-man), Homo habilis(The handy man), H.erectus(Pithecanthropines), H.sapiens neanderthalensis(Neanderthal man), Homo sapiens fossilis(The Cro-magnon), Homo sapiens sapiens(Modern man), mention Denizoans and Malapan man.</p>	
Module 9	8 Hours
<p>Zoogeographical realms and Biogeography of India Geographical Distribution (a) Geographical distribution of animals: Cosmopolitan, discontinuous, bipolar and isolated distribution. (b) Barriers in animal distribution: Physical, climatic and biological barriers.</p>	

Zoogeographical realms

Zoogeographical regions with specific fauna (faunal regions): Palaearctic region, Nearctic region, Neotropical region, Ethiopian region, Oriental region and Australian region; brief description on Wallace line, Weber line and Wallacea.

Insular fauna

Faunal characteristics of continental (Madagascar and Sri Lanka) and oceanic islands (Galapagos and New Zealand).

Biogeography of India

Biogeographical zones of India: Himalayan, Desert zone, Semi-arid zone, Western Ghats, Deccan plateau, Gangetic plain, North east Indian zone, Island zone and Coastal zone (brief account only).

MODE OF TRANSACTION

Class room Lectures and face to face interaction

ICT enabled Presentations

Presentation of students Seminar Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT**Internal Assessment (15 Marks)**

- | | |
|-----------------------------------|--------|
| a. Classroom participation (20%): | 3 Mark |
| b. Test papers I (40%): | 6 Mark |
| c. Assignment (20%): | 3 Mark |
| d. Seminar/ Viva (20%): | 3 Mark |

External Assessment (60 Marks) Duration 2. Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Marks
Module I	7
Module II	4
Module III	9

Module IV	9
Module V	12
Module VI	7
Module VII	7
Module VIII	17
Module IX	7

REFERENCES:

Module 1-2 (Ethology)

1. Jerry A. Hogan. 2017. *The Study of Behavior: Organization, Methods, and Principles*. ISBN: 9781107191976. Cambridge University Press. 380 pages.
2. John Alcock & Dustin R Rubenstein. 2019. *Animal Behaviour*, 11th edition. Published by Sunderland, Massachusetts Sinauer Associates, Oxford University Press. 672 pages.
3. Lee Alan Dugatkin. 2013. *Principles of Animal Behavior*, 4th Edition. ISBN-13: 9780393920451. ISBN-10: 0393920453. W. W. Norton & Company. 576 pages.
4. Michael Breed & Janice Moore. 2015. *Animal Behaviour*. Second Edition. ISBN: 9780128015322. Academic Press. 552 pages.
5. V. K. Agarwal. 2010. *Animal Behaviour (Ethology)*. ISBN: 9788121932103, 8121932106.
6. S.Chand Publishers. 400p.

Module 3-8 (Evolution)

1. Brian K. Hall & Benedikt Hallgrímsson. 2014. *Strickberger' s Evolution*. 5th Edition. ISBN: 9789380853789, 9380853785. Publisher: Viva. 672 pages.
2. Darlington P J 1966. *Zoogeography: The Geographical Distribution of Animals*. Fourth Edition. John Wiley & Sons, Inc. 675 pages.
3. Jain P C & M.S. Anantharaman. *Palaeontology (Palaeobiology): Evolution and Animal distribution*. 9th Edition. ISBN-10: 9382956441; Vishal Publishing Co.
4. James H. Brown. 1996. *Biogeography*. ISBN-10: 0697243591; ISBN-13: 978-0697243591. William C Brown Pub., 643 pages.
5. James T. Costa. 2009. *The Annotated Origin - A Facsimile of the First Edition of On the Origin of Species*. ISBN-10: 0674032810; University Press; Annotated edition. 546 pages.
6. Niles Eldredge. 1985. *Time Frames: The Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria*. ISBN-10: 0671495550; Simon & Schuster. 240 pages.
7. Niles Eldredge. 1998. *Pattern of Evolution*. ISBN-10: 0716730464; ISBN-13: 9780716730460. W H Freeman & Co. 219 pages.
8. Richard Dawkins. 2006. *The Blind Watchmaker - Why the Evidence of Evolution Reveals a Universe without Design*. ISBN-10: 0393315703; W. W. Norton & Company. 496 pages.
9. Robert Andrew Foley & Roger Lewin. 2003. *Principles of Human Evolution* 2nd Edition. ISBN-10: 0632047046; ISBN-13: 978-0632047048. Wiley-Blackwell. 568 pages.

10. Solomon Stevens. 2017. Evolutionary Biology. ISBN-10: 1635491169. ISBN-13: 9781635491166. Larsen and Keller Education. 190 pages.

Module 9 (Zoogeography)

1. Andrews, M.I. & Joy, K.P. Ecology, Evolution & Zoogeography. S.M. Book Depot, Changanassery
2. Rastogi V. B. & Jayaraj.1998. Animal Ecology and Distribution of Animals. Kedar Nath and Ram Nath. ISBN: 5551234001809.
3. Tiwari, S. K. 1985. Zoogeography of India and South East Asia.CBS Pubs, New Delhi

COURSE CODE –BZL6B15L				
CORE COURSE XIV: ZOOLOGY [CORE COURSE] PRACTICAL - III				
Credit	Hours/week (Practical)	Marks		
		Internal	External	Total
4	8	20	80	100

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Demonstrate</i> standard laboratory experiments for the estimation of Hb, presence of hCG/abnormal constituents in urine, detection of blood pressure, bleeding and clotting time and identification of formed elements in blood.	Understand	7
CO2	<i>Identify</i> selected stages in the development of frog and chick and chosen larval forms of invertebrates and vertebrates	Analyse	7
CO3	<i>Design</i> experiments of laboratory standards to Assess the water quality parameters including, dissolved Oxygen, Carbon dioxide, hardness and pH; Examine the adulteration of selected food items and identify marine planktons and soil organism	Evaluate/ apply /create	11
CO4	<i>Demonstrate</i> the behavioural response of earthworm/dipteran larva to selected stimuli	understand	7
CO5	Describe homologous, analogous and vestigial organs, connecting links, adaptive radiation and evolution of man	Understand	7
CO6	<i>Illustrate</i> zoogeographical realms, Wallace line, Weber line, Wallacea and the distribution of <i>Peripatus</i> , lung fishes, <i>Sphenodon</i> , monotremes and marsupials	Analyse	7

CO7	<i>Identify</i> the normal and selected abnormal human karyotypes and inheritance of chosen traits from pedigree charts, ornamental and other culture fishes and chosen beneficial and harmful insects	Remember	7
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Comment [AP8]: PSO Number required

Comment [A9]: Done

COURSE CONTENT	
Module 1	46 Hours
<p>Section A. PHYSIOLOGY AND ENDOCRINOLOGY</p> <ol style="list-style-type: none"> Detection of Abnormal constituents of urine [glucose, ketone bodies and albumin] (Major). Preparation human blood smear to study the formed elements (Major). Osmotic response of RBC to saline solutions of different concentrations (Minor). Determination of Hb content in man using Haemoglobinometer (Minor) Determination blood clotting time. Determination of blood pressure. Determination of Body mass index (individuals). Study of the histology of the following endocrine glands - pituitary, thyroid, adrenal and endocrine pancreas using slides/photographs. Detection of pregnancy using standard kits (Demonstration). <p>Section B. REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY</p> <ol style="list-style-type: none"> Demonstration of chick blastoderm. Induced ovulation in fish. Study of life cycle in Drosophila. Spotters: <ul style="list-style-type: none"> Types of eggs (Insect, Amphioxus, frog, chick, and human). Cleavage in frog (use slides / diagrams/models). Shark: Yolk sac placenta. Development of Frog: Blastula, gastrula, neurula. Development of Chick: 18, 24, 32, 48 hours of incubation. Mammal: Any two mammalian embryos. Larval forms of invertebrates (any five) and vertebrates (any two). 	
Module 2	28 Hours
<p>Section A: ENVIRONMENTAL AND CONSERVATION BIOLOGY (28 hrs)</p> <ol style="list-style-type: none"> Estimation of dissolved O₂ in water sample using Winkler's method (Major). Estimation of dissolved CO₂ in pond and tap water (Major). Estimation of total hardness of water (Major). Determination of pH using pH paper / digital pH meter (Minor). Extraction of soil organism by hand picking, floatation and Berlese funnel method (Minor). Study of marine planktons (any five items up to genus level) (Minor). 	

<p>7. Study of a pond ecosystem and preparation of food chains and food web (Minor).</p> <p>8. Detection of food adulteration in selected food items (Minor).</p> <p>i) Detection of starch and urea in milk.</p> <p>ii) Detection of tea adulterated by colouring.</p> <p>iii) Detection of maida and chalk powder in wheat flour</p>	
Module 3	11 Hours
<p>1. Problems on (a) autosomal dominant and recessive (b) polygenic traits (skin colour), (c) Sex linkage (X-linked genes and Y-linked genes).</p> <p>2. Study of identical and fraternal twins.</p> <p>3. Dermatoglyphics: Identification of arch, loop and whorl patterns; total ridge count in male and female; Tri- radii, importance of atd angle, simian line.</p> <p>4. Ischiara chart (to detect red-green colour blindness).</p> <p>5. Seminars on genetics in cardiology, oncology and genetic counselling, pre-natal sexing, amniocentesis, importance of genetic screening.</p> <p>6. Pedigree studies and identification of the nature of inheritance from pedigree chart (any one trait).</p> <p>7. Identification of human karyotypes (Edwards and Patau's) from ideogram</p>	
Module 4	11 Hours
<p>AQUACULTURE, ANIMAL HUSBANDRY AND POULTRY SCIENCE</p> <p>1. Culture of fish food organisms: protozoans, rotifers and crustaceans.</p> <p>2. Maintenance of spawn and its transportation to hatching or rearing tanks.</p> <p>3. Identification of major food fishes (fresh water, estuarine and marine - 5 from each group).</p> <p>4. Study of different crafts and gears.</p> <p>5. Study of common ornamental fishes (record any seven with photograph).</p> <p>6. Breeding techniques: preparation of hormone extracts and injection of hormones to fishes; Eyestalk ablation in prawns.</p> <p>7. Study of fish products and by-products.</p> <p>8. Identification of larval forms of prawn, pearl oyster, mussel, lobster and crab.</p> <p>9. Identification of major edible crustaceans and molluscs.</p> <p>10. Identification of edible sea weeds.</p>	
Module 5	11 Hours
<p>1. Identification and brief notes on the following pests: Any two pests of paddy; coconut; banana; mango; cashew; coffee; tea; rubber; pepper; cardamom and pests of vegetables. Pests of stored products (any two).</p> <p>2. Study of damage caused by pests (damaged parts of plants, fruits and seeds, wood etc. may be used).</p> <p>3. Identification and study of insect pests/ectoparasites of man, domestic animals and wild animals: mosquitoes (different stages of life-history), head louse, pubic louse, bird louse, rat flea, Tabanus,</p>	

Hippobosca, a tick and a mite on dog/cat.

4. Identification and economic importance of the following
 - a) Honey bee and bee products
 - b) Silkworm moth: life cycle stages, silk fibre
 - c) Lac insect and stick lac or shellac.
5. Preparation of : a) tobacco decoction, b) kerosene soap emulsion, c) neem kernel suspension
6. Pesticide appliances: Dusters or sprayers a) Hand compression sprayer b) Rocker sprayer c) Knapsack sprayer/duster d) Hand automizer (any 3)

MODE OF TRANSACTION

Demonstration of experiments

Field studies

Projects

Class room Discussions

Assignments

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

Criteria of Internal Evaluation for Practical I, II and III [20 marks for each practical]

- | | |
|--|--------|
| a. Classroom participation (30%): | 6 Mark |
| b. Test papers I (30%): | 6 Mark |
| c. Lab involvement, Performance & punctuality (20%): | 4 Mark |
| d. Record (20%): | 4 Mark |

Lab involvement, Performance & Punctuality

Sl. No.	Criteria	Marks
1	Excellent	4
2	Very Good	3
3	Good	2
4	Average	1
5	Below Average	0

Class Test [1]

Sl. No.	Criteria	Marks
1	85 to 100%	6
2	65 to below 85%	5
3	55 to below 65%	4
4	45 to below 55%	3
5	35 to below 45%	2
6	Below 35%	1

Record

Sl. No.	Criteria	Marks
1	Punctuality in submission	1
2	Contents	2
3	Scientific accuracy and neatness	1
	Total Marks	4

External Assessment (80 Marks) Duration 2.5 Hours, No of Questions: 27

Scheme of question paper for Practical II and III

Question Nos.	Nature of questions	Total no of Qns	Marks for each Qn	Marks	Duration
I: Q 1-6	Spotters from various core courses: slides/specimens/apparatus/experimental set up etc.; Identification, sketches/descriptions/ reasons importance/ significance etc.	6	3	18	4 hours
II: Q 7	Minor expt: from various sections - results / explanation / graphs / sketches etc.	1	9	9	
III: Q 8	Minor expt. : from various sections - results/explanation/ graphs/ sketches	1	12	12	
IV: Q 9	Major expt.: from various sections- results/ explanation/ sketches etc.	1	22	22	
	Viva-voce			3#	
V: Record		-	-	16*	
	Total Marks			80	

★ Viva voce - Examiner may ask questions based on the principles/methodology/concepts of the experiments performed during the practical examinations

7

COMPLEMENTARY COURSE SYLLABUS

SEMESTER 1

COURSE CODE –BZL1C01				
COMPLEMENTARY COURSE I: ANIMAL DIVERSITY AND WILDLIFE CONSERVATION				
Credit	Hours/week	Marks		
		Internal	External	Total
3	2	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	Describe the general characters of protists and salient features of phylum - Rhizopoda, Ciliophora, Dinoflagellata and Apicomplexa	Understand	2,3
CO2	Enumerate the salient features and examples of Phylum - Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Onychophora, Mollusca and Echinodermata, and the structural organization of <i>Peneaus</i> sp.	Apply	1,2
CO3	Describe the characteristic features and classification of phylum Chordata with examples and, structural organization of <i>Oryctolagus cuniculus</i>	Apply	1,2
CO4	Explain levels of biodiversity, threats to biodiversity, biodiversity hotspots, importance and strategies for conservation of wildlife and sustainable development	Apply Evaluate	3,7

COURSE CONTENT

Module I	2 Hours
<p>Kingdom Protista</p> <p>General characters.</p> <p>Salient features of protozoans.</p> <p>Phylum Dinoflagellata: e.g. Noctiluca</p> <p>Phylum Ciliophora: e.g. Vorticella Phylum Rhizopoda: e. g. Amoeba</p> <p>Phylum Apicomplexa: e.g. Plasmodium (exclude life cycle)</p> <p>B: Animal Diversity</p>	
Module II	14 Hours
<p>: Animal diversity: Nonchordata - Part I</p> <p>Salient features of phyla, classification down to classes (Mention taxonomic position) (8 Hrs)</p> <p>Phylum Porifera: e.g. Leucosolenia</p> <p>Phylum Coelenterata: e.g. Obelia, Aurelia, Sea anemone</p> <p>Phylum Platyhelminthes: e.g. Fasciola, Schistosoma</p> <p>Phylum Aschelminthes: e.g. Ascaris, Enterobius</p> <p>Phylum Annelida: e.g. Arenicola, Hirudinaria, Megascolex</p> <p>Phylum Arthropoda: e.g. Limulus, Sacculina, Eupagurus,</p> <p>Phylum Onycophora: e.g. Peripatus</p> <p>Phylum Mollusca: e.g. Perna, Terebratulina, Sepia, Pinctada Phylum</p> <p>Echinodermata: e.g. Asterias, Holothuria, Sea urchin</p> <p>Type: Penaeussp. (Excludes details of larval stages) (6 Hrs)</p>	
Module III:	14 Hours
<p>Animal diversity: Chordata - Part II</p> <p>Phylum Chordata: Salient features, Mention classes (6 hrs)</p> <p>Sub phylum Urochordata e.g. Ascidia Subphylum Cephalochordata e.g. Branchiostoma Subphylum Vertebrata:</p> <p>Div I. Agnatha e.g. Petromyzon, Myxine</p> <p>Div II: Gnathostomata Super class: Pisces</p> <p>Class: Chondrichthyes: e.g. Narcine</p> <p>Class: Osteichthyes: e.g. Echeineis, Hippocampus, Heteropneustes, Scomberomorus, Pomfret</p> <p>Super class: Tetrapoda</p> <p>Class Amphibia: e.g., Ichthyophis, Salamandra, Rhacophorus, Duttaphrynus, Mention - Nasikabatrachus sahyadrensis</p>	

Class Reptilia: e.g., Chamaeleo, Chelone, Naja, Bungarus, Daboia
Class Aves e.g. Columba
Class Mammalia e.g.Pteropus
Type: Oryctolagus cuniculus (8 hrs)
External features, skeletal system, digestive system, respiratory system, circulatory system, sense organs and nervous system. [Exclude skin, skull bones, arterial system, venous system, lymphatic system, autonomous nervous system and endocrine system].

Module IV
<p>Conservation Biology</p> <p>I. Biodiversity, Levels of biodiversity (brief), significance and uses of biodiversity, Threats to biodiversity- (fragmentation, invasive species, over exploitation, poaching, climate change), extinction of species, concept of threatened species.</p> <p>II. Biodiversity hot spots, brief notes on hot spots that include Indian region (Western Ghats and Sri Lanka, Indo Burma, Himalayas and Sundaland); endemism.</p> <p>III. Wild life management and conservation- Importance of wild life, strategies of conservation (Ex situ and In situ), The Wildlife Protection Act, 1972.</p> <p>IV. Sustainable development (concept)</p> <p>V. Red Data Book, IUCN, WWF, BNHS (Brief account)</p>

MODE OF TRANSACTION
<p>Class room Lectures and face to face interaction</p> <p>ICT enabled Presentations</p> <p>Presentation of students Seminar Group discussion</p> <p>Assignments and Case studies</p>

MODE OF ASSESSMENT
<p>Internal Assessment (15 Marks)</p> <p>e. Classroom participation (20%): 3 Mark</p> <p>f. Test papers I (40%): 6 Mark</p> <p>g. Assignment (20%): 3 Mark</p> <p>h. Seminar/ Viva (20%): 3 Mark</p>
<p>External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21</p>

MODULE WISE MARK DISTRIBUTION

Module	Marks
Module I	7
Module II	28
Module III	28
Module IV	16

REFERENCES:

1. Ahluwalia, V.K. and Sunitha Malhotra (2009) Environmental Science, ISBN 10:8180522113, Ane Books
2. Ekambraanatha Ayyar, M. & Ananthkrishnan, T.N. (1993) Manual of Zoology, Chordata, Vol. II (Part II), ISBN-10:8187156384, S. Viswanathan, Madras, 882 pages
3. Ekambraanatha Ayyar, M. & Ananthkrishnan, T.N. (2009) Manual of Zoology, Chordata, Vol. II (Part I), ISBN-10:8187156384, S. Viswanathan, Madras.
4. Jordan E.L. & Verma, P.S. (2010) Chordate Zoology, ASIN: B00QUYL0ZY, Kindle Edition, S. Chand & Co. 1092 pages
5. Jordan E.L. & Verma, P.S. (2009) Invertebrate Zoology, 15th Edition, ISBN-10: 9788121903677, S. Chand & Co., 1127 pages
6. Kotpal, R.L. (2014) Modern Text Book of Zoology - Invertebrates, ISBN, 10:9350780402, Rastogi
7. Rajesh Gopal (2011) Fundamentals of Wild Life Management; ISBN-10: 8181581628, Natraj Pub., 1288 pages
8. Soper R., D.J. Taylor N.P.O. Green G.W. Stout (2005) Biological Science 3rd Edn., ISBN-10:9780521684170, Cambridge University Press.

Comment [AP10]: The words in the reference are all smooched together. This makes it difficult to read and understand the reference.

SEMESTER 2

COURSE CODE –BZL2C02

COMPLEMENTARY COURSE II: ECONOMIC ZOOLOGY

Credit	Hours/week	Marks		
		Internal	External	Total
3	2	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning	PSO No
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	Upon completion of this course, students will be able to;	Domain	
CO1	Explain parasitism and the major protist, cestode, trematode and nematode parasites of man and major insect vectors of human diseases and their control (11 hrs)	Apply	3,2
CO2	Understand major beneficial and harmful insects, damages caused to host plants and their control measures	Understand	3
CO3	Understand pisciculture, prawn, mussel and pearl culture	Understand Apply	5

COURSE CONTENT

Modules 1	11 Hours
<p>Parasitism in relation to man</p> <p>Introduction, classification of parasites and hosts (2 hrs)</p> <p>Obligatory, facultative, external, internal, hyperparasites. Definitive, intermediate, carrier and reserve hosts. Infection and infestation - Mention Hyper infection and Auto infection. Modes of infection - Inoculative, contaminative, direct and retroinfection, zoonotic diseases</p> <p>Human Parasites (5 hrs)</p> <p>Parasitic Protists - Plasmodium vivax, Entamoeba histolytica</p> <p>Cestodes - Taenia solium, mention T. saginata and Echinococcus granulosus</p> <p>Trematodes (Flukes) - Schistosoma haematobium</p> <p>Nematodes - Ancylostoma duodenale, Wuchereria bancrofti and Enterobius vermicularis</p> <p>Vectors of human diseases (4 hrs)</p> <p>Insect vectors of human diseases and their control. Anophales, Culex, Aedes, Xenopsylla, Cimex, Pediculus and Pthirus (Diseases like malaria, filariasis, yellow fever, typhus fever, dengue, plague, chikungunya, kala azar).</p>	
Module 2	14 Hours
<p>Useful Insects, Insect Pests and their control (14 hrs)</p> <p>Insect Pests (9 hrs)</p> <p>Definition of Pests, Kinds of Pests, Causes of pest outbreak.</p> <p>Nature of damage to host plants and control measures of the following pests. (Exclude structure and Life history of Pests).</p> <ol style="list-style-type: none"> 1. Spodoptera sp. (rice swarming caterpillar) 2. Leptocorisa sp. (rice bug) 3. Rhynchophorus sp. (red palm weevil) 4. Opisina sp. (Black headed caterpillar, mention biological control) 5. Aceria sp. (Coconut mite) 	

6. Helopeltis sp. (tea bug)
7. Cosmopolites sp. (Banana rhizome weevil)
8. Bactrocera sp. (Fruit fly)
9. Batocera sp. (mango stem borer)

10. Sitophilus sp. (rice weevil)

Insect control

(2 hrs)

Basic principles of chemical control and biological control. Integrated Pest Management (IPM) (Brief notes).

Useful Insects

(3 hrs)

Apiculture, Sericulture & Lac culture: Economic importance. Predatory insects, insect parasitoids.

Module 3	11 Hours
Aquaculture and Fishery Biology	
Introduction and its scope in Kerala.	(1 hr)
Pisciculture	(5 hrs)
Egg collection and hatching, induced spawning. Nursery ponds, manuring, feeding and harvesting, Ornamental fish farming (brief account). Mention common species. Fish utilization	
Prawn culture.	(2hrs)
Breeding and spawning of prawns, seed collection and culture, types of prawn farms, mention common species.	
Mussel farming	(2hrs)
Seed collection, artificial collection of seeds, induced spawning, rearing of larvae, farming methods and harvesting.	
Pearl Culture	(1 hr)
Preparation of nuclei, preparation of host and graft tissue, implantation and nursing.	

MODE OF TRANSACTION

Class room Lectures and face to face interaction
 ICT enabled Presentations
 Presentation of students Seminar Group discussion
 Assignments and Case studies

MODE OF ASSESSMENT

Internal Assessment (15 Marks)	
i. Classroom participation (20%):	3 Mark
j. Test papers I (40%):	6 Mark
k. Assignment (20%):	3 Mark
l. Seminar/ Viva (20%):	3 Mark
External Assessment (60 Marks) Duration:2 Hours, No of Questions: 21	

MODULE WISE MARK DISTRIBUTION	
Module	Marks
Module I	26
Module II	28
Module III	25

REFERENCES:

1. AtuarRahman(2017) Bee Keeping InIndia,ISBN-10:9788171641659,ICAR, India,270p.
2. Borajah,G.(1994)Lecturers on Sericulture, 2ndEdition,SBSPub.,Banglaore.
3. David B and Ananthkrishnan T. (2004) General and Applied Entomology, 2nd Edition, ISBN-10:9780070434356, Mc Graw Hill Education, 877pages
4. K K Nayar; T N Ananthkrishnan; B Vasantharaj David (1976) General & Applied Entomology, TMH.,589pages
5. Madan Mohan Rao M. (2019) An Introduction to Sericulture, 2nd Edition, ISBN- 10: 9387593975, BSPublications,201 pages
6. Shukla,G.S. &Upadhyay, V.B.(2014)EconomicZoology,ISBN-10:9350780461,RastogiPub
7. Sougata Ghosh (2013) Panicker's Textbook of Medical Parasitology, 7th Edition, ISBN- 10:9350905345, Jaypee Brothers, 280 pages
8. Srivastava,C.B.L.(2006)FisheryScienceandIndianFisheries,ISBN-10:8122500293,KitabMahal

SEMESTER 3

COURSE CODE –BZL3C03				
COMPLEMENTARY COURSE III: PHYSIOLOGY AND ETHOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Describe</i> the structure of plasma membrane and the various trans-membrane transport mechanisms	Understand	1
CO2	<i>Enumerate</i> the constituents of normal diet and the mechanism of digestion and absorption of carbohydrates, proteins and lipids and the regulation of gastrointestinal function	Apply	4,6
CO3	<i>Explain</i> the mechanism of transport of respiratory gases, control of respiration, respiratory problems and artificial ventilation	Apply Evaluate	4,6
CO4	<i>Explain</i> the structure and working of human heart and mechanism of regulation of heart beat; constituents of human blood and blood transfusion and cardiovascular problems	Analysis Evaluate	4,6
CO5	<i>Illustrate</i> the structure of human kidney, the mechanism of urine formation, hormonal control of kidney function and kidney disorders; osmoregulation and urea cycle	Apply	4,6
CO6	<i>Enumerate</i> the structure of myofibrils and myofilaments; muscle contractile and regulatory proteins and mechanism of muscle contraction	Apply	4,6
CO7	<i>Explain</i> different types of nerve cells and glial cells, maintenance of resting membrane potential, generation and propagation of action potential and synaptic transmission	Understand	4,6
CO8	<i>Describe</i> innate behavior, learned behavior, patterns of behavior and factors that affect behavior	Analysis	5,6
CO9	<i>Enumerate</i> biological rhythms, communication in animals and social organization in mammals	Analysis	5,6

COURSE CONTENT

Module 1	3 Hours
Trans-membrane transport mechanisms Structure of Plasma membrane. Fluid mosaic model. Trans-membrane transport - passive & active mechanisms, vesicular transport	

Module 2	4 Hours
<p>Nutrition</p> <p>Constituents of normal diet. Digestion of carbohydrates, proteins and lipids. Absorption of nutrients (brief account). Brief account on the neural and hormonal control of gastrointestinal function, Mention gastro intestinal hormones, BMR and obesity</p>	
Module 3	6 Hours
<p>Respiration</p> <p>Gaseous exchange and transport. Respiratory pigment - haemoglobin - properties. Control of respiration - neural & chemical (brief account). Respiratory problems - hypoxia, asphyxia, CO poisoning. Respiratory problem of high altitudes. Physiological adaptive mechanisms of diving mammals. Artificial Ventilation; heart lung machine.</p>	
Module 4	7 Hours
<p>Body fluids and circulation</p> <p>Constituents of human blood. Agglutination, coagulation of blood and haemostasis Haemolysis. Blood transfusion (short notes). Brief account on the structure and working of human heart. Pacemaker and conducting system of heart. Cardiac cycle and regulation of heart beat, ECG, Blood pressure and pulse. Cardiovascular problems (brief account) - arteriosclerosis and atherosclerosis, myocardial infarction, hypertension and thrombosis.</p>	
Module 5	6 Hours
<p>Osmoregulation and Excretion</p> <p>Osmoconformers and osmoregulators. Water retention and conservation in desert animals. Urea cycle. Ammonotelism, ureotelism and uricotelism with examples. Hormonal control of kidney function. Kidney disorders, renal hypertension, nephritis and renal failure. Dialysis and kidney transplantation (short notes)</p>	
Module 6	7 Hours
<p>Muscle Physiology</p> <p>EM structure of myofibrils and myofilament. Muscle - contractile proteins and major regulatory proteins. Chemistry and mechanism of muscle contraction. Energy for muscle contraction. Muscle twitch and muscle tetanus, isometric and isotonic contraction. All-or-none law and summation of stimuli. Muscle fatigue and rigor mortis</p>	
Module 7	7 Hours
<p>Nerve physiology</p> <p>Mention different types of nerve cells and glial cells. Maintenance of resting membrane potential; generation and propagation of action potential. Threshold stimulus, all or none response. Synapse, types of synapses, synaptic transmission and neurotransmitters.</p>	
Module 8	8 Hours
Behaviour	

<p>Innate behaviour Orientation, taxes and kinesis, simple reflexes and instincts, drive and motivation Learned behaviour Habituation, conditioned reflex, trial and error learning, latent learning, imprinting, insight learning Patterns of behaviour Habitat selection, sexual selection, co-operation, territoriality, aggression, courtship and agonistic behaviour.</p> <p>Proximate factors Neurological basis of behaviour, mention hormonal, biochemical, environmental and genetic factors that influence behaviour.</p>	
Module 9	6 Hours
<p>Biological clocks/rhythms Photoperiod, circadian rhythm, migration, navigation and homing instinct, diapause, hibernation and aestivation. Communication in animals. Social organization in mammals – Elephant and Lion as examples</p>	

MODE OF TRANSACTION
<p>Class room Lectures and face to face interaction</p> <p>ICT enabled Presentations</p> <p>Presentation of students Seminar Group discussion</p> <p>Assignments and Case studies</p>

MODE OF ASSESSMENT
<p>Internal Assessment (15 Marks)</p> <p>a. Classroom participation (20%): 3 Mark</p> <p>b. Test papers I (40%): 6 Mark</p> <p>c. Assignment (20%): 3 Mark</p> <p>d. Seminar/ Viva (20%): 3 Mark</p>
<p>External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21</p>

MODULE WISE MARK DISTRIBUTION	
Module	Marks
Module I	4
Module II	7

Module III	7
Module IV	9
Module V	12
Module VI	9
Module VII	7
Module VIII	12
Module IX	12

REFERENCES:

1. Aubrey Manning and Marian Stamp Dawkins (2012) Animal Behaviour, 6th Edition, ISBN-10:0521165148, CUP, 467 pages
2. Berry, A.K. (2008) Text Book of Animal Physiology, 8th Edition, ISBN 10:8185712034, Emkay Publications, 686 pages
3. Chatterjee, C.C. (2016) Human Physiology, 11th Edition, ISBN 10:8123928726, Medical Allied Agency.
4. Goyal, K.A. & Sastry, K.V. (2006) Animal Physiology, ISBN-10:817133864X, Rastogi Pub., 516 pages
5. John E. Hall (2015) Guyton and Hall Text book of Medical Physiology, ISBN-10:1455770051, Saunders, 1168 pages
6. Kim E. Barret, Susan M. Barman, Scott Boitano and Hedden L. Brooks (2016) Ganong's Review of Medical Physiology, 25th Edition, ISBN-10:9789339223281, McGraw Hill Education
7. Mark Ridley (1995) Animal Behaviour: An Introduction to Behavioural Mechanisms, Development and Ecology, 2nd Edition, ISBN-10:0865423903, Wiley Blackwell, 296 pages
8. Purohit, S.S. and Rajiv Ranjan (2009) Ecology, Environment and Pollution, ISBN 10:8177541692, Agrobios.
9. Rastogi, S.C. (2019) Essentials of Animal Physiology, 4th Edition, ISBN-10:8122420141, New Age International, 596 pages
10. Reena Mather (2016) Animal Behaviour, ISBN-13-9789350780480, Rastogi Pub.

SEMESTER 4

COURSE CODE – BZL4C04				
COMPLEMENTARY IV: GENETICS AND IMMUNOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning	PSO No
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	Upon completion of this course, students will be able to;	Domain	
CO1	<i>Describe</i> human karyotype, chromosomal anomalies and polygenic inheritance	Understand	8
CO2	<i>Explain</i> the mechanisms of sex determination	Apply	7,8
CO3	<i>Enumerate</i> the concept of genes, gene expression, genetic code, transcription and translation	Analysis	7,8
CO4	<i>Illustrate</i> the mechanism of recombinant DNA technology and its practical applications	Analysis	8
CO5	<i>Explain</i> the types of cancer, causes of transformation and characteristics of transformed cells	Apply	8,11
CO6	<i>Identify</i> the cells and organs of immune system, antigens and antibodies (7 hrs)	Analysis	7,11
CO7	<i>Enumerate</i> antigen-antibody interaction, generation of B-cell and T-cell response and major Immuno techniques	Analysis	7,8
CO8	<i>Explain</i> primary and secondary immunodeficiency diseases, autoimmune diseases, vaccination and vaccines	Apply	7

COURSE CONTENT

Module I	6 Hours
<p>Human Genetics</p> <p>Normal human karyotype: Classification and grouping of human chromosomes (Patau's & Denver schemes). Chromosomal anomalies and disorders (short note only). Autosomal anomalies: Phenyl ketonuria & Sickle cell anaemia. X-linked - Haemophilia and Colour blindness. Y-linked - Y-Chromosome infertility. Polygenic inheritance - Cleft palate or Cleft lip and diabetes mellitus. Prenatal diagnosis. Genetic counselling. Eugenics, Euthenics and Euphenics.</p>	
Module II	4 Hours
<p>Genetic Control of Sex</p> <p>Autosomes and sex chromosomes: Mention Barr body and its significance. Chromosomal mechanism of sex determination: genic balance theory. Control of sex; hormonal influence of sex determination; sex mosaics; Gynandro morphism</p>	
Module III	8 Hours

Genes and gene expression	
Modern concept of genes, split genes, pseudogenes, overlapping genes and transposons. Gene expression. Genetic code, transcription and translation (brief account)	
Module IV	13 Hours
Genetic Engineering	
Brief account of recombinant DNA technology - role of enzymes (restriction endonucleases, exonucleases, DNA polymerase, DNA ligase, reverse transcriptase, alkaline phosphatase, polynucleotide kinase and terminal transferase). Cloning vectors - plasmid vectors (mention pBR322), phage vectors, cosmids, viruses and YAC vector. Construction of recombinant DNA (preparation of vector DNA and donor DNA, joining of vector and donor DNAs, introduction of recombinant DNA into the host cell and selection of transformants). Methods of gene transfer. Practical applications, advantages and potential hazards.	
Module V	5 Hours
Cytogenetics of Cancer	
Types of cancer: brief account of sarcomas, carcinomas, melanomas, leukemia, lymphomas and blastomas. Characteristics of cancer cells: uncontrolled multiplication, loss of contact inhibition, metastasis, reduced cellular adhesion, metaplasia, invasiveness, growth factor secretion, cell surface alterations, alterations in transcriptome and proteome and protease secretion.	
Origin of Cancer: Carcinogens, oncogenic viruses, polygenic basis, hereditary predisposition to cancer	
Module VI	7 Hours
Cells and organs of immune system, antigens and antibodies	
Cells and organs of immune system	
Innate and adaptive immunity. Cells of immune system- B cell, T cell, NK cell and Antigen Presenting Cells (dendritic cells, macrophage cells). Organs of the immune system- Primary lymphoid Organs (Thymus, Bone marrow), Secondary lymphoid Organs (Spleen, lymph node, MALT)	
Antigens	
Antigenicity, Immunogenicity Haptens and adjuvants. Factors influencing immunogenicity. Mention human immunoglobulin gene families - A and K light chain families and heavy chain family and major histocompatibility complex (MHC) group of genes. Antibodies- Structure, different classes and Function. Monoclonal antibodies-Hybridoma technology and applications.	
Module VII	7 Hours
Antigen-Antibody interaction & Generation of B-cell and T-cell response	
Antigen - antibody interaction	
Strength of Antigen-Antibody interaction. Cross reactivity, Precipitation reactions, and Agglutination reactions. Immunotechniques - Detection of biomolecules using ELISA, RIA, and Western blot. Southern blot, Northern blot and DNA Fingerprinting (Brief account only)	
Generation of B cell and T-cell response:	
Humoral and cell-mediated response. Properties of B-cell and T-cell- epitopes. Activation and	

differentiation of B and T cells. Cytokines- brief account only	
Module VIII	4 Hours
<p>Immunodeficiency diseases, vaccines & vaccination</p> <p>Immunodeficiency diseases Primary (Bruton's disease, Di-George syndrome & SCID). Secondary types: AIDS- Mention Acute, Chronic and Crisis phase, Window period. Autoimmune disease- Mention Hashimoto's thyroiditis, Grave's disease, Myasthenia gravis and Systemic Lupus Erythematosus.</p> <p>Vaccines and Vaccination Principle of vaccination; mention Attenuated vaccines, Inactivated vaccines, Toxoid vaccines and DNA vaccines with examples</p>	

MODE OF TRANSACTION
<p>Class room Lectures and face to face interaction</p> <p>ICT enabled Presentations</p> <p>Presentation of students Seminar Group discussion</p> <p>Assignments and Case studies</p>

MODE OF ASSESSMENT
<p>Internal Assessment (15 Marks)</p> <p>e. Classroom participation (20%): 3 Mark</p> <p>f. Test papers I (40%): 6 Mark</p> <p>g. Assignment (20%): 3 Mark</p> <p>h. Seminar/ Viva (20%): 3 Mark</p>
<p>External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21</p>

MODULE WISE MARK DISTRIBUTION	
Module	Marks
Module I	9
Module II	7
Module III	9

Module IV	17
Module V	7
Module VI	17
Module VII	9
Module VIII	4

REFERENCES:

1. Darla J. Wise (2002) Immunology, A Comprehensive Review, 8th Edition, ASIN: B000RG1FTW, Blackwell, 182 pages
2. Eldon John Gardner, Michael J. Simmons and Peter Snustad (1991) Principles of Genetics, 8th Edn, ISBN-10: 0471533971, Wiley, 714 pages
3. Gangane, S.D (2012) Human Genetics, 2nd Edition, ISBN-10: 8131230228, Elsevier, 312 pages
4. Ivan Roitt (1994): Essential Immunology, 8th Edition, ISBN-10: 0632033134, Blackwell Science, 456 pages
5. Jenni Punt, Sharon Stranford, Patricia Jones and Judith A Owen (2018) Kuby Immunology, 8th Edition, ISBN-10: 1319114709, W.H. Freeman, 944 pages
6. Jogchand, S.N. (2016) Gene Biotechnology, ISBN-978-93-5262-087-6, Himalaya Publishing House, 447 pages
7. John Playfair and Gregory Bancroft (2014) Infection and Immunity, 4th Edition, ISBN: 9780199609505, OUP, 400 pages
8. Mange, E.J. & Mange, A.P. (1999) Basic Human Genetics, Rastogi Pubs.
9. Peter D. Snustad (2015) Principles of Genetics, 7th Edition, ISBN-10: 1119142288, Wiley, 627 pages
10. Ricki, L. (2014) Human Genetics: Concepts and Application, 11th Edition, ISBN-10: 0076701654, McGraw Hill Education, 480 pages
11. Scot F. Gilbert (2013) Developmental Biology, 10th Edition, ISBN-10: 0878939784, Sinauer Associates, 750 pages
12. Twyman R.M. (2001) Instant notes in Developmental Biology, VivaBooks, 421 pages

HUMAN PHYSIOLOGY COMPLEMENTARY COURSE SYLLABUS

SEMESTER 1

COURSE CODE –BZL1CO2

COMPLEMENTARY COURSE I: Human Physiology 1

Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Explain</i> the structure of a cell, plasma membrane and cell organelles, the structure of carbohydrates, lipids, proteins, control of gene activity and tissues.	Create Understand	1
CO2	<i>Discuss</i> the structure of DNA, Gene and genetic code, details of chromosomes, linkage & cross over	Understand	1, 2,8
CO3	<i>Sketch</i> the cell division	Apply	1,3
CO4	<i>Explain</i> the various Elements and laws of heredity and variation	Analyze	1, 4, 8
CO5	<i>Classify</i> the major autosomal and X-linked dominant and recessive human genetic disorders	Analyze	4

COURSE CONTENT

Module 1: Cellular organization	20 Hours
<p>1.1 Cell theory, cell principle</p> <p>1.2 Cell structure, plasma membrane (fluid mosaic model), Structure and function of cell organelles (Mitochondria, ribosome, ER, Golgi bodies, Lysosomes, cytoskeleton and interphase nucleus)</p> <p>1.3 Cell inclusions-brief description of the structure of carbohydrates, lipids and proteins.</p> <p>1.4 Unicellularity to multicellularity, differentiation. Brief mention of spatial and temporal control of gene activity.</p> <p>1.5 Tissues- brief description of major types.</p>	
Module 2: Genes and chromosomes	13 Hours

<p>2.1 Structure of DNA, DNA replication-Semiconservative method, Okazaki fragments, leading strand, Lagging strand, the role of enzymes in DNA replication</p> <p>2.2 Concept of a gene – Classical and modern concept, genetic code, introns, exons.</p> <p>2.3 Morphology of chromosomes-size, shape, karyotype, ideogram, kinds of chromosomes.</p> <p>2.4 Linkage and crossing over, sex-linked chromosomes.</p>	
Module 3: Cell division	12 Hours
<p>3.1 Cell cycle: G1, S, G2 and M phases, Checkpoints Go Phase.</p> <p>3.2 Mitosis; Description of all stages and significance.</p> <p>3.3 Meiosis. Description of all stages and significance.</p>	
Module 4: Elements of heredity and variation	12 Hours
<p>4.1 Mendel’s work and laws of inheritance (monohybrid cross, dihybrid cross, test cross).</p> <p>4.2 Brief explanation of terms-alleles, homozygosity, heterozygosity, genotype, phenotype.</p> <p>4.3 Brief description of other patterns of inheritance and genotype expression-incomplete dominance, co-dominance, multiple alleles, epistasis, pleiotropy.</p>	
Module 5: Mutations and Genetic disorders	12 Hours
<p>5.1 Gene Mutation-Kinds of mutation, classification (Somatic, gametic, point, spontaneous, induced, dominant, recessive and silent mutations).</p> <p>5.2 Gene mutation disorders - albinism, phenylketonuria, alkaptonuria, galactosemia, brachydactyly.</p> <p>5.3 Autosomal anomalies - Down’s syndrome, Edward’s syndrome, Cri du chat syndrome.</p> <p>5.4 Sex chromosomal anomalies - Klinefelter’s syndrome and Turner’s syndrome.</p>	

MODE OF TRANSACTION
<p>Class room Lectures and face to face interaction</p> <p>ICT enabled Presentations</p> <p>Presentation of students Seminar Group discussion</p> <p>Assignments and Case studies</p>

MODE OF ASSESSMENT

Internal Assessment (15 Marks)	
a. Classroom participation (20%):	3 Mark
b. Test papers I (40%):	6 Mark
c. Assignment (20%):	3 Mark
d. Seminar/ Viva (20%):	3 Mark
External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21	

MODULE WISE MARK DISTRIBUTION	
Module	Mark in
Module I	21
Module II	11
Module III	19
Module IV	14
Module V	14

REFERENCES:

- Aubrey Manning and Marian Stamp Dwakins (2012) *Animal Behaviour*, 6th Edition, ISBN-10: 0521165148, CUP, 467 pages
- Berry, A.K. (2008) *Text Book of Animal Physiology*, 8th Edition, ISBN-10:8185712034, Emkay Publications, 686 pages
- Chatterjee, C.C. (2016) *Human Physiology*, 11th Edition, ISBN 10: 8123928726, Medical Allied Agency.
- Goyal, K.A. & Sastry, K.V. (2006) *Animal Physiology*, ISBN-10: 817133864 X, Rastogi. Pub., 516 pages
- John E Hall (2015) *Guyton and Hall Text book of Medical Physiology*, ISBN-10: 1455770051, Saunders, 1168 pages
- Kim E. Barret, Susan M.Barman, Scott Boittano and Heddwen L Brooks (2016) *General Review of Medical Physiology*, 25th Edition, ISBN-10:9789339223281, McGraw Hill Education
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- Purohit, S.S.and Rajiv Ranjan (2009) *Ecology, Environment and Pollution*, ISBN 10: 8177541692, Agrobios.
- Rastogi, S.C. (2019) *Essentials of Animal Physiology*, 4th Edition, ISBN-10:8122420141, New Age International, 596 pages
- Reena Mather (2016) *Animal Behaviour*, ISBN-13-9789350780480, Rosthogi Pub.

SEMESTER 2

COURSE CODE –BZL2C03

COMPLEMETARY COURSE II: HUMAN PHYSIOLOGY- II

Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Describe</i> and Discuss the different types of nerve cells, glial cells and nerve fibers, and the mechanism of nerve impulse transmission	Knowledge Understand	1, 2
CO2	<i>Explain</i> the structure and functions of CNS and reflex actions	Apply	3
CO3	<i>Distinguish</i> the structure and functions of the Cerebellum and the Basal Ganglia	Analyze	4
CO4	<i>Explain</i> the structure and functions of the Cerebral Cortex	Apply	4
CO5	<i>Analyze</i> various states of sleep and imaging techniques	Analyze	1,6

COURSE CONTENT

Module I: The Nervous System	20 Hours
1.1 Divisions (CNS, PNS – somatic and autonomic) 1.2 Nervous tissue (neurons, nerve fibres, nerves, synapse). 1.3 Non nervous tissue and other materials (neuroglia, meninges, Cerebro-spinal fluid, Blood- CSF and blood-brain barriers). 1.4 Nerve impulse - generation, conduction, synaptic transmission, the role of calcium ions, action of transmitter substances on the postsynaptic neuron, types of transmitter substances.	
Module II: The Central Nervous System	13 Hours
2.1 Brain – an overview (Forebrain, midbrain, hindbrain). 2.2 Spinal cord – an overview of its structure and organization. 2.3 Reflex Action – monosynaptic reflex, multi-synaptic reflex, crossed extension reflex,	

Module III: The Cerebellum and the Basal Ganglia	13 Hours
3.1 The Cerebellum and its motor functions. 3.2 Anatomical functions, areas of the cerebellum. 3.3 Function of the cerebellum in overall motor control. 3.4 The basal ganglia-their motor functions, role of the basal ganglia for cognitive control, functions of neurotransmitters with basal ganglia	
Module IV: The Cerebral Cortex	12 Hours
4.1 Functions of the specific cortical areas –association areas (parieto occipito temporal, prefrontal and limbic association areas with special emphasis on Wernicke’s area and Broca’s area), area for recognition of faces, and the concept of the dominant hemisphere. 4.2 Function of the brain in communication - Sensory and Motor aspects of communication	
Module 5: States of brain activity and Techniques in neurophysiology	12 Hours
5.1 Sleep –Basic theories of sleep, Brain waves, Slow-wave sleep and REM sleep. 5.2 Brain imaging – CT, MRI, PET, CBF, EEG, Lesioning, and Electrical Stimulation of Brain (ESB).	

MODE OF TRANSACTION

Class room Lectures and face to face interaction
ICT enabled Presentations
Presentation of students Seminar Group discussion
Assignments and Case studies

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	21
Module II	11
Module III	19
Module IV	14
Module V	14

REFERENCES:

1. Schneider A.M & Tarshis B., An introduction to Physiological Psychology, Random House, New York.
2. Guyton & Hall – Textbook of Medical Physiology, 12 th Edn., Saunders.
3. Sherwood L, Thomson, Human Physiology.
4. Kalat J.W, Wadsworth C.A, Biological Psychology.
5. Levinthal C.F, Introduction to Physiological Psychology, Prentice Hall, New Delhi.
6. K. Sembulingam and Prema Sembulingam, Essentials of Medical Physiology, Jaypee brothers Medical Publishers Pvt. Ltd.
7. Chatterjee, C.C, Human Physiology, Medical Allied Agency

SEMESTER 3

COURSE CODE: BZL3C04

COMPLEMENTARY COURSE III: Human Physiology III

Credit	Hours/week	Marks		
		Internal	External	Total
3	5	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Describe</i> and Explain the Structure of eye, functions, vision	Apply	6

	and visual defects		
CO2	<i>Explain</i> and understand the Structure of ear and hearing abnormalities	Analyze	4,6
CO3	<i>Understand</i> Gustatory and Olfactory system	Analyze	4
CO4	<i>Describe</i> different Somatic sensations	Understand	4,6
CO5	<i>Describe</i> vertebrate endocrine glands, their hormones and functions	Understand	4,6

COURSE CONTENT	
Module I: The Visual System	18 Hours
1.1 Structure of the human eye, Organization of the retina and visual pathways. 1.2 Functioning of the eye, visual coding, chemistry of vision, transduction in the retina, theories of colour vision, visual perception. 1.3 Visual defects (myopia, hypermetropia, presbyopia, astigmatism, cataract, colour blindness, nyctalopia).	
Module II- Auditory System	16 Hours
2.1 Anatomy of the auditory system. 2.2 Auditory pathways, auditory perception and hearing abnormalities. 2.3 Statoreceptors.	
Module III- Gustatory and Olfactory system	16 Hours
3.1 Anatomy of taste buds and its function, primary sensations of taste, taste thresholds and intensity discrimination, taste preferences and control of the diet. 3.2 Taste pathways and transmission of signals into the central nervous system. 3.3 Organization of the olfactory membrane, sense of smell and stimulation of the olfactory cells. 3.4 Categorizing smell, the transmission of smell signals into the central nervous system	
Module IV- Cutaneous senses (Somatic sensations)	20 Hours
4.1 Classification – the mechanoreceptive somatic senses (tactile and position), thermos receptive senses (heat and cold) and pain sense. 4.2 Detection and transmission of tactile sensations – tactile receptors, detection of vibration, tickling and itch. 4.3 Sensory pathways for transmitting somatic signals into the central nervous system, somatosensory	

<p>cortex, position senses, position sensory receptors.</p> <p>4.4 Thermal sensations - thermal receptors, their excitation and transmission of thermal signals.</p> <p>4.5 Pain – purpose, types, pain receptors, pain suppressive system, pain sensation.</p>	
Module V- Endocrine system	20 Hours
<p>5.1 Introduction to endocrinology, an overview of the importance of endocrine glands.</p> <p>5.2 Mode of action of hormones and influence on growth and behaviour.</p> <p>5.3 Major endocrine glands – their location, structure, hormones produced and their role (Hypothalamus, pituitary, thyroid, Parathyroid, Pancreas, adrenal, gonads, thymus, pineal body, placenta).</p>	

MODE OF TRANSACTION
<p>Class room Lectures and face to face interaction</p> <p>ICT enabled Presentations</p> <p>Presentation of students Seminar Group discussion</p> <p>Assignments and Case studies</p>

MODE OF ASSESSMENT
<p>Internal Assessment (15 Marks)</p> <p>a. Classroom participation (20%): 3 Mark</p> <p>b. Internal Assessment Test (40%): 6 Mark</p> <p>c. Assignment (20%): 3 Mark</p> <p>d. Seminar/ Viva (20%): 3 Mark</p>
<p>External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21</p>

MODULE WISE MARK DISTRIBUTION	
Module	Mark

Module I	21
Module II	11
Module III	21
Module IV	14
Module V	14

REFERENCES:

1. K. Sembulingam and Prema Sembulingam, Essentials of Medical Physiology, Jaypee brothers Medical Publishers Pvt. Ltd.
2. Guyton & Hall, Textbook of Medical Physiology 12th Edn., Saunders.
3. Sebastian M.M, Animal Physiology, Madonna.
4. 4 Kalat J.W, &Wadsworth C.A, Biological Psychology.
5. Barrett E. Kim, Barman M. Susan et.al; Ganong's review of Medical Physiology, Tata McGraw Hill Education Pvt. Ltd.
6. Sarada Subrhmian and K. MadhavanKutty, A Text Book of Physiology. Orient Longman Publication.
7. Sujith K. Chaudhari, Concise Medical Physiology, New Central Book Agency, Delhi.
8. A. K. Jain, Text Book of Physiology Vol.1 & 2, Avichal Publications.

COURSE CODE –BZL3 C06				
COMPLEMENTARY COURSE IV: HUMAN PHYSIOLOGY-IV				
Credit	Hours/week	Marks		
		Internal	External	Total
3	5	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	Discuss and explain and the regulation of food intake, Role of hormones, and eating disorders.	Understand Apply	4
CO2	Analyze the Physiological basis of thirst	Analyze	4,6
CO3	Discuss and analyses the physiological basis of sexual behaviour	Analyze	4,6

CO4	Discuss the Neural basis of emotion	Evaluate	4
CO5	Analyze and discuss the brain damage and Neuroplasticity	Analyse Understand	4

COURSE CONTENT	
Module I: Physiological basis of hunger	20 Hours
1.1 Neural control of food intake - Role of the hypothalamus, Neural centers that influence Mechanical process of feeding. 1.2 Factors that regulate the quantity of food intake, role of hormones (effect of Cholecystokinin, Peptide YY, GLP, Ghrelin). 1.3 Short-term regulation of food intake, intermediate and long-term effects of food intake. (Effect of blood concentrations of glucose, amino acids, lipids on hunger and feeding), temperature regulation of food intake. 1.4 Obesity - causes and treatment, eating disorders (Bulimia, Anorexia, Inanition, Cachexia, Picca).	
Module II: Physiological basis of thirst	14 Hours
2.1 Peripheral factors in water regulation. 2.2 Central factors in water regulation (cellular dehydration thirst and hypovolemic thirst).	
Module III: Physiological basis of sexual behaviour	20 Hours
3.1 Hormones and sexual development – Fetal hormones and the development of reproductive organs, Sex differences in the brain, Perinatal hormones and behavioural development, Puberty: hormones and development of secondary sexual characteristics. 3.2 Effects of gonadal hormones on adults – Male reproduction-related behavior and testosterone, Female reproduction-related behavior and gonadal hormones. 3.3 Neural mechanisms of sexual behavior – Structural differences between the male hypothalamus and female hypothalamus, the hypothalamus and male sexual behavior, the hypothalamus and female sexual behavior	
Module IV Neural basis of emotion	18 Hours
4.1 Role of frontal lobes. 4.2 Behavioural functions of the hypothalamus and associated limbic structures, Reward centers, Rage – its association with punishment centers, placidity and tameness. 4.3 Functions of Amygdala.	
Module V- Brain Damage and Neuroplasticity	18 Hours
5.1 Causes of brain damage – Brain tumors, Cerebrovascular disorders (Cerebral haemorrhage, Cerebral ischemia), Infections of the brain (Bacterial infections, Viral infections), Neurotoxins, Genetic factors, Apoptosis. 5.2 Neuropsychological disorders – Epilepsy (Grand Mal Epilepsy, Petit Mal Epilepsy and Focal	

Epilepsy), Parkinson's disease, Huntington's disease, Multiple sclerosis, Alzheimer's disease.

MODE OF TRANSACTION

Class room Lectures and face to face interaction
ICT enabled Presentations
Presentation of students Seminar Group discussion
Assignments and Case studies

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

- a. Classroom participation (20%): 3 Mark
- b. Test papers I (40%): 6 Mark
- c. Assignment (20%): 3 Mark
- d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	21
Module II	11
Module III	19
Module IV	14
Module V	14

REFERENCES:

1. Schneider A.M & Tarshis B, An introduction to Physiological Psychology, Random House, New York.
2. Guyton & Hall, Saunders, Textbook of Medical Physiology.
3. Sherwood L, Thomson, Human Physiology.

4. Kalat J.W, Wadsworth C.A, Biological Psychology.
5. Levinthal C.F, Introduction to Physiological Psychology, Prentice Hall, New Delhi.
6. Pinel P.J John, Biopsychology, Pearson.
7. Neil.R.Carlson, Physiology of behavior, Pearson publishers.
8. Barrett E. Kim; Barman M. Susan et al., Ganong's Review of Medical Physiology; Tata McGraw Hill Education Pvt. Ltd.
9. Alcock John, Animal Behavior, 6 th edition, Sinauer Associates, Inc. Sunderland, Massachusetts.
10. Carlson, Neil, R., Physiology of Behavior, 8 th edition, Pearson

ELECTIVE COURSE SYLLABUS

SEMESTER 6

COURSE CODE –BEC3C03				
ELECTIVE COURSE I: HUMAN GENETICS				
Credits	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	Explain the characteristics, nomenclature and classification of human chromosomes; non-disjunction of chromosomes and the phenotypic effects of chromosome structural modifications	Analysis	1
CO2	Sketch the construction of pedigrees of Sex-linked and Autosomal dominant and recessive gene mutation disorders and presentation of molecular genetic data in pedigrees	Apply	4
CO3	Classify the major autosomal and X-linked dominant and recessive human genetic disorders	Apply	4
CO4	Explain multifactorial inheritance	Analyse	6
CO5	Discuss the basic genetics of reproduction and development	Understand	2
CO6	Explain the prenatal diagnostic techniques, major genetic services and genetic counselling	Understand	2
CO7	Asses human genetic variations, archaeogenetic of South	Evaluate	9

	Asia and genetic origin of Indian populations		
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COURSE CONTENT	
Module I:	16 Hours
<p>Human chromosomes Classification and nomenclature History of classification and nomenclature of human chromosomes - various Conferences and their contributions: Denver, Chicago, Paris and Stockholm Conferences. Characteristics of A to G groups of chromosomes. Various banding techniques - G-banding, Q-banding, R-banding, C-banding, Y-banding, NOR banding. Fluorescence in-situ hybridization (FISH) Non-disjunction of Chromosomes Meiotic non-disjunction, mitotic non-disjunction, non-disjunction of autosomes, non-disjunction of sex chromosomes and mosaicism Chromosome structural modification and the human phenotype Ring chromosome, Iso chromosomes, Philadelphia chromosome, Cri-du-chat syndrome (5p-syndrome) Prader willi syndrome, Fragile X- Syndrome (Martin Bell syndrome), Burkitt's lymphoma (14q+ syndrome)</p>	
Module II	4 Hours
<p>Human Pedigrees Gathering family history, Symbols of Pedigree, construction of pedigrees, Pedigrees of Sex-linked and Autosomal (dominant and recessive), X-linked dominant and recessive gene mutation disorders. Presentation of molecular genetic data in pedigrees.</p>	
Module III	8 Hours
<p>Chromosomal Disorders Autosomal dominant disorders Familial hyper cholesterolemia, metabolic and genetic control of cholesterol, Huntington's disease. Marfan's syndrome (Arachnodactyly). Ehlers-Danlos Syndrome (Rubber man or the Elastic Woman). Autosomal recessive disorders Cystic fibrosis - CF gene and protein, Detection of CF homozygotes and carriers, hereditary microcephaly. X-linked dominant and recessive disorders Duchenne muscular dystrophy, identification of the DMD gene, carriers and hemizygotes, X-SCID.</p>	
Module IV	4 Hours

<p>Multifactorial Inheritance Congenital heart diseases (ASD and VSD), Alzheimer's disease, Schizophrenia, Intelligence</p>	
Module V	9 Hours
<p>Genetics of Reproduction and Development Prenatal development: genes and hormones. Errors in sexual development: Defects of androgen target cells-deficiency of 5-alpha reductase, congenital adrenal hyperplasia (CAH) and sex reversal. Maternal effect genes, Segmentation and pattern formation genes, Adhesion molecules and genes, Genomic imprinting, Inbreeding in isolates. Consanguinous marriages, twin studies, biology of twinning, analysis of twin data.</p>	
Module VI	9 Hours
<p>Prenatal diagnosis, Genetic Services and Genetic Counselling Prenatal diagnosis and genetic services Amniocentesis, chorionic villi sampling (CVS), fetoscopy, ultrasonography (USG), Alpha foeto protein screening, prenatal sexing. Test tube babies; Karyotyping; Genetic sequencing and future medicine. Genetic counselling Procedures and ethical concerns; History of counselling; Methods of genetic counselling - marriage counselling, directive and non- directive reason for seeking counselling; Psychodynamics of genetic counselling.</p>	
Module VII	4 Hours
<p>Evolutionary Genetics Human genetic variation - haplogroups; Human races, human variability messages from mitochondrial DNA. Archaeogenetics: Genetics and archaeogenetics of South Asia - out of Africa theory. Genetic origin of Indian populations - Indian Genome Variation initiative. Pharmacogenetics and Ecogenetics (Brief account), Mention phenocopy</p>	

MODE OF TRANSACTION
Class room Lectures and face to face interaction ICT enabled Presentations

Presentation of students Seminar Group discussion
 Assignments and Field study, Interview, Survey

MODE OF ASSESSMENT

Internal Assessment (15 Marks)	
a. Classroom participation (20%):	3 Mark
b. Test papers I (40%):	6 Mark
c. Assignment (20%):	3 Mark
d. Seminar/ Viva (20%):	3 Mark
External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21	

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	7
Module II	19
Module III	9
Module IV	9
Module V	9
Module VI	9
Module VII	17

REFERENCES:

1. Andrew P. Read and Tom Strachan (2003): Human Molecular Genetics, Third Edition; ISBN-10: 0815341822, Garland Science, 696 pages
2. Anne Gardner, Rodney T. Howell and Teresa Davies (2000): Human Genetics; ISBN- 0340763744, Arnold, London, 206 pages
3. Bruce R. Korf (2006): Human Genetics, A Problem-Based Approach; 3rd Edition, ISBN- 10: 0632046562, Wiley, 288 pages
4. Bruce R. Korf and Mira B. Irons (2012): Human Genetics and Genomics;4th Edition, ASIN: B00B9L1JHM, Wiley-Blackwell, 280 pages
5. Chris Tyler-Smith and Mark A. Jobling: Human Evolutionary Genetics: Origins, Peoples and Disease, 1st Edition, ISBN-10: 0815341857, Garlsnd Science, 458 pages

6. Elaine Johansen Mange & Arthur P. Mange (1993) Basic Human Genetics, ISBN 10: 0878934952, Sinaeur Associates, 558 pages
7. Greg Gibson (2015): A Primer of Human Genetics; 1St Edition, ISBN-10: 1605353132, Sinaeur
8. John Ringo (2014) Fundamentals of Genetics, 1st Edition, ISBN-10: 9780521006330, Cambridge University press, 478 pages
9. Julia E. Richards and R. Scott Hawley (2004): Human Genome: A User's Guide; ASIN: B002B54ISW, ELSEVIER
10. Max Levitan and Ashley Montagu (1998): Text Book of Human Genetics 3rd Edition; ISBN- 10: 0195049357, Oxford University Press
11. Miller, Orlando J. and Therman Eeva (2001): Human Chromosomes, Springer Verlag, 474 pages
12. Ricki. Lewis (2010): Human Genetics: The Basics; 1St Edition, ISBN-10: 0415579864, Routledge, 200 pages
13. Ricki. Lewis (2017): Human Genetics: Concepts and Applications: 12th Edition, ISBN- 10: 1259700933, Mc Graw Hill Education
14. Robert Nussbaum, Roderick McInnes and Huntington Willard (2015) Genetics in Medicine ,8th Edition, ISBN: 9781437706963,, Elsevier, 560 pages
15. Ronnee Yashon and M. Cummings (2011) Human Genetics and Society; 2nd Edition, ISBN- 10: 0538733217, Brooks Cole Learning, 400 pages.

COURSE CODE –BZL6E02				
ELECTIVE COURSE II: AQUACULTURE, ANIMAL HUSBANDRY AND POULTRY SCIENCE				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Explain</i> aquaculture and the process of prawn, mussel and pearl culture	Apply	4
CO2	<i>Illustrate</i> the methodology of pisciculture and understand common culture fishes and ornamental fishes	Create	4
CO3	<i>Identify</i> major fishing crafts and gear and enumerate fish utilization and preservation	Understand	2
CO4	<i>Enumerate</i> the poultry rearing techniques and understand major breeds of fowl	Analyse	3

CO5	<i>Understand</i> the major breeds of cattle, cattle feeds and diseases of cattle	Understand	1
CO6	<i>Illustrate</i> the steps in dairy processing and identify the role of dairy development in rural economy.	Evaluate	10
COURSE CONTENT			
Module I:		10 Hours	
<p>Aquaculture</p> <p>Types of aquacultures (3hrs)</p> <p>Brief account of classification of aquaculture based on:</p> <p>Environment - Freshwater, brackish water and mariculture.</p> <p>Temperature - Warm water/cold water culture.</p> <p>Culture techniques - pond aquaculture, cage culture, pen culture, raft culture, pole culture, rack culture and long line culture.</p> <p>Number of species - Mono culture and poly culture.</p> <p>Type of organism - prawn culture, shrimp culture, edible oyster culture, lobster culture etc.</p> <p>Mariculture (7hrs)</p> <p>Prawn culture: Important cultivable species in India, seed collection, spawning and larval rearing, induced breeding, types of culture systems - Pokkali culture, culture in bheries/ponds, culture and harvesting.</p> <p>Mussel culture: <i>Perna indica</i>, <i>Perna viridis</i>, Seed collection, artificial seed production, induced spawning, culture techniques and harvesting.</p> <p>Pearl culture: Method of pearl formation, selection and preparation of host, preparation of nucleus and implantation, post-operation care, post-operation culture and collection of pearls.</p>			
Module II		13 Hours	
<p>Pisciculture</p> <p>i. Egg collection; induced spawning; construction, preparation and maintenance of ponds; manuring; feeding and harvesting. Cryopreservation of fish germplasm, semen bank and preservation media.</p> <p>ii. Biology and culture of following Indian major carps: <i>Catla catla</i>, <i>Labeo rohita</i>, Biology and culture of Exotic carps: <i>Cyprinus carpio</i>(common carp), <i>Hypophthalmichthys molitrix</i>(Silver carp).</p> <p>iii. Inland fishes and Fisheries (Brief account): <i>Channa</i>, <i>Clarias</i> and <i>Etrophus suratensis</i></p> <p>iv. General account and fishery aspect of Sardine, Shark and Tuna. Mention GIFT Tilapia and Nutter (<i>Pygocentrus nattereri</i>)</p> <p>v. Ornamental fisheries: Common aquarium fishes: e.g: <i>Carassius auratus</i> (Gold fish), <i>Pterophyllum</i> spp. (Angel fish), <i>Astronotus ocellatus</i> (Oscar cichlid), <i>Poecilia reticulata</i> (Guppy), <i>Poecilia sphenops</i>(Black molly), aquarium management.</p> <p>vi. Plankton and Fishery production: Zoo and Phytoplankton - Vertical migration - Plankton and</p>			

Productivity.	
Module III	13 Hours
<p>Fishing Crafts and Gear, fish preservation and utilization</p> <ul style="list-style-type: none"> i. Fishing crafts - Mention Catamaran, Canoes and dug-out-canoes. ii. Fishing gears - Gillnet/drift gillnet, purse-seines, harpoon, Chinese dipnets, echo sounders, sonar, remote sensing. iii. Fish Spoilage and Preservation: Biochemical changes, spoilage, use of ice, freezing, canning, dehydration, salting and smoking. iv. Fish utilisation: Nutritive value, bye products, liver oil, body oil, fish meal, fish flour, Isinglass, glue, skin, fin soup, lime, chitin and chitosan. v. Diseases and parasites of Fish: Fungal infection - Epizootic Ulcerative Syndrome (EUS), Saprolegnia, Fin and tail rot disease, Dropsy. vi. Mud banks of Kerala coast. 	
Module IV	7 Hours
<p>Poultry science</p> <ul style="list-style-type: none"> i. Egg production, cable bird production, nutritive value and bye products. ii. Breeds of fowl - Exotic -Rhode Island Reds, Plymouth Rock, Naked Neck and Leghorn; Indigenous - Gramapriya, Giriraja and Kalinga Brown. iii. Poultry rearing: Selection of eggs, hatching, incubation, brooding, sexing and vaccination. iv. Poultry housing: Free range system, Semi-intensive system (deep litter system and individual cage system). v. Equipments for feeding: Nutrients for starting, growing, laying hen. vi. Common poultry feeds, food rations and feed formulation. vii. Common diseases of poultry (Ranikket, Pullorum and Fowl pox) 	
Module V	6 Hours
<p>Animal husbandry</p> <p>Introduction: History, origin, domestication.</p> <p>Breeds of cattle:</p> <p>Dairy breeds: Sindhi, Gir Draught breeds of cattle: Nagori, Kangayam Dual purpose breeds: Ongole, Haryana Exotic breeds: Jersey, Holstein - Friesian</p> <p>Native breeds: Conservation programmes, Vechur cow and Kasargod Dwarf</p> <p>Feeding: Common cattle feeds, odder</p> <p>Common diseases: Anthrax, Foot & Mouth disease.</p> <p>Parasites of cattle</p> <p>Meat hygiene: Slaughter and clean meat production - Zoonotic diseases</p>	

Module VI	5 Hours
i. Role of dairy development in rural economy, employment opportunities, white revolution. ii. Dairy processes: Straining, Filtration, Cooling, Chilling, Clarification, Pasteurisation, Freezing, Recombined milk, Soft curd milk, Skimmed and toned milk. iii. Artificial milk, Milk adulteration.	

MODE OF TRANSACTION

Class room Lectures and face to face interaction ICT enabled Presentations, Interaction with experts in the field. Presentation of students Seminar Group discussion Assignments and Field study, Interview
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MODE OF ASSESSMENT

Internal Assessment (15 Marks)	
a. Classroom participation (20%):	3 Mark
b. Test papers I (40%):	6 Mark
c. Assignment (20%):	3 Mark
d. Seminar/ Viva (20%):	3 Mark
External Assessment (60 Marks):	Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	14
Module II	19
Module III	19
Module IV	9
Module V	9
Module VI	9

REFERENCES:

1. Alikunhi, K H (1957): Fish culture in India: CMFRI Farm Bulletin (20). 144 pages
2. Ashok Kumar Rathoure, Dinesh Kumar, Nazneen Z. and Deshmukh (2015): Applied and Economic Zoology; Daya Publishing House. 326 pages.
3. Banerji, G.C (1986): Poultry 3rd Edn. , Oxford & IBH. 148 pages.
4. Banerji, G.C. (1998): A text book of Animal husbandry 8th Edn., Oxford & IBH. 1096 pages.
5. C.B.L. Srivastava (1999): A Text Book of Fishery Science and Indian Fisheries; Kitab Mahal. 527 pages.
6. Jawid Ahsan and Subhas Prasad Sinha (2010): A hand Book on Economic Zoology; S. Chand, ISBN. 9788121908764, 314 pages
7. Kurian C.V., Sebastian C.V.(1986): Prawn and Prawn fisheries in India, Hindustan Publishing Corporation. 297 pages.
8. P.R. Venkitaraman: Economic Zoology, R.S. Publications
9. P.R. Venkitaraman (1983): Text Book of Economic Zoology, Sudarsana Publications
10. Ram Prabhu Jayasurya and N Arumugam (2013): Economic Zoology; Saras Publications. ISBN-10: 938245926X, 560 pages
11. V. B. Upadhyay and G. S. Shukla (2007): Applied and Economic Zoology; Rastogi Publications. 496 pages
12. Vinita jaiswal and Kamal Kumar (2014): Jaiswal: Economic Zoology; Prentice Hall India. 280 pages

COURSE CODE –BZL6E03				
ELECTIVE COURSE III: APPLIED ENTOMOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Describe</i> the branches of entomology and insect services	Understand	2
CO2	<i>Illustrate</i> and explain the lifecycle, damages and control of insect pests of crop plants and domestic animals	Analysis	5
CO3	<i>Asses</i> the insect control strategies	Apply, Evaluate	2
CO4	<i>Explain</i> the useful insects and the products derived from bees, silkworms, and lac insects	Create	10

COURSE CONTENT

Module I:	6 Hours												
<p>General Introduction and Insect services</p> <p>Introduction to Entomology (4 hrs) Branches of Entomology: Agricultural, Forest, Veterinary, Medical, Forensic, Industrial, Nutritional and Cultural Entomology. Classification of Class Insecta to Orders. Generalized morphological organization of an insect.</p> <p>Insects in service of man (2 hrs) Insects as pollinators, parasitoids, scavengers (enhancing soil fertility), pollution indicators, model organisms for scientific research; herbivory for weed control; insects in medicine and forensic science; insects of aesthetic value; use of insect pheromones and hormones.</p>													
Module II	26 Hours												
<p>Harmful Insects: pests of crops and domestic animals</p> <p>Insects as enemies of man Definition of pests, kinds of insect pests, causes of pest outbreak, pests injurious to plants and animals, vectors of diseases.</p> <p>a) Pests of paddy (Life cycle, damage and control measures)</p> <ol style="list-style-type: none"> 1. <i>Nilaparvata lugens</i> (Brown plant leafhopper) 2. <i>Leptocorisa acuta</i> (Rice bug) 1. <i>Cnaphalocrocis medinalis</i> (Rice leaf folder) <p>2. Pests of coconut (Life cycle, damage and control measures)</p> <ol style="list-style-type: none"> 1. <i>Oryctes rhinoceros</i> (Rhinoceros beetle) 2. <i>Opisina arenosella</i> (Black headed caterpillar) 3. <i>Rhynchophorus ferrugineus</i> (Red palm weevil) <p>c) Pests of Sugarcane (damage and control measures)</p> <ol style="list-style-type: none"> 1. <i>Chilo infuscatellus</i> (Sugar cane shoot borer) 2. <i>Scirpophaga nivella</i> (Sugar cane top borer) 3. <i>Sacchariococcus sacchari</i> (Cane mealy bug) <p>4. d) Pests of plantation crops: Two example for each damage and control measures. Coffee- <i>Xylotrechus quadripes</i> (Coffee white stem borer) , <i>Coccus viridis</i> (Coffee green bug) Tea- <i>Helopeltis antonii</i> (Tea mosquito bug) <i>Toxoptera aurantii</i> (Tea aphid) Rubber- <i>Saissetia nigra</i> (Scale insect), <i>Aetherastis circulata</i> (Bark feeding caterpillar) Pepper- <i>Longitarsus nigripennis</i> (Pollu beetle) <i>Laspeyresia hemidoxa</i> (Top shoot borer) Cardamom- <i>Sciothrips cardamomi</i> (Cardamom thrips) <i>Eupterote canarica</i> (Cardamom hairy caterpillar)</p> <p>e) Pests of fruit plants: Two example for each, damage and control measures.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 15%;">Banana</td> <td>1. <i>Odoiporus longicollis</i> (Pseudostem borer)</td> </tr> <tr> <td></td> <td>2. <i>Pentalonia nigronervosa</i> (Banana aphid)</td> </tr> <tr> <td>Mango</td> <td>1. <i>Batocera rufomaculata</i> (Mango stem borer)</td> </tr> <tr> <td></td> <td>2. <i>Orthaga exvinacea</i> (Mango leaf webber)</td> </tr> <tr> <td>Cashew</td> <td>1. <i>Neoplocaederus ferrugineus</i> (Cashew stem borer)</td> </tr> <tr> <td></td> <td>2. <i>Lamida monoculalis</i> (shoot and blossom webber)</td> </tr> </table> <p>f) Pests of vegetables: Two example for each, damage and control measures. Lady's finger 1. <i>Helicoverpa</i></p>		Banana	1. <i>Odoiporus longicollis</i> (Pseudostem borer)		2. <i>Pentalonia nigronervosa</i> (Banana aphid)	Mango	1. <i>Batocera rufomaculata</i> (Mango stem borer)		2. <i>Orthaga exvinacea</i> (Mango leaf webber)	Cashew	1. <i>Neoplocaederus ferrugineus</i> (Cashew stem borer)		2. <i>Lamida monoculalis</i> (shoot and blossom webber)
Banana	1. <i>Odoiporus longicollis</i> (Pseudostem borer)												
	2. <i>Pentalonia nigronervosa</i> (Banana aphid)												
Mango	1. <i>Batocera rufomaculata</i> (Mango stem borer)												
	2. <i>Orthaga exvinacea</i> (Mango leaf webber)												
Cashew	1. <i>Neoplocaederus ferrugineus</i> (Cashew stem borer)												
	2. <i>Lamida monoculalis</i> (shoot and blossom webber)												

<p><i>armigera</i> (fruit borer)</p> <p>2. <i>Earias vitella</i> (Spotted bollworm)</p> <p>Brinjal 1. <i>Leucinodes orbonalis</i> (Shoot and fruit borer)</p> <p>2. <i>Henosepilachna vigintioctopunctata</i> Cucurbits I.</p> <p><i>Bactrocera cucurbitae</i> (Melon fly)</p> <p>2. <i>Raphidopala foveicollis</i> (Pumpkin beetle)</p> <p>f) Pests of stored products: damage and control measures</p> <p>1. <i>Tribolium castaneum</i> (Rust red flour beetle)</p> <p>2. <i>Callasobruchus chinensis</i> (Pulse beetle)</p> <p>g) Pests of domestic animals</p> <p>1. Domestic fowl <i>Menopon gallinae</i> (Shaft louse)</p> <p>2. Goat <i>Oestrus ovis</i></p> <p>3. Cattle <i>Tabanus striatus</i></p>	
Module III	11 Hours
<p>Control of Insect Pests a) Natural control b) Applied control or artificial control</p> <p>Prophylactic and curative methods: cultural, mechanical, legal methods; biological and chemical methods.</p> <p>Biological control: Ecological, biological and economic dimensions of biological control. Mention any three important biological control projects undertaken in India. Merits and demerits.</p> <p>Chemical control: Classification of insecticides- mode of entry, mode of action, on chemical nature; botanical insecticides; insecticide residue, resurgence of insect pests; pesticide appliances (hand compression sprayer, knapsack sprayer and rocker sprayer); environmental degradation of pesticides (brief account).</p> <p>Autocidal and Pheromonal control (brief accounts)</p> <p>Integrated pest management (IPM) - Features and advantages</p>	
Module IV	11 Hours
<p>Section B: INDUSTRIAL ENTOMOLOGY</p> <p>Industrial Entomology</p> <p>Productive insects:</p> <p>a) Honey bee: Apiculture in India: Scope, Diversity, Castes, Morphological and communicative adaptations. Bee products - Honey and bee wax, composition and uses,</p> <p>b) Silk moth: Types of silk worms (mulberry, eri, muga, tassar), life cycle of mulberry silkworm; sericulture and moriculture: processing and extraction of silk; composition and uses of silk.</p> <p>c) Lac insect: lac host plants, different strains of lac insects, cultivation, inoculation, harvesting and propagation of lac, composition and uses of lac.</p>	
MODE OF TRANSACTION	

Class room Lectures and face to face interaction
ICT enabled Presentations
Presentation of students Seminar Group discussion
Assignments and Field study, Interview

MODE OF ASSESSMENT	
Internal Assessment (15 Marks)	
a. Classroom participation (20%):	3 Mark
b. Test papers I (40%):	6 Mark
c. Assignment (20%):	3 Mark
d. Seminar/ Viva (20%):	3 Mark
External Assessment (60 Marks):	Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION	
Module	Mark
Module I	11
Module II	26
Module III	26
Module IV	16

REFERENCES:

1. Ali, M.S., Raju S.V.S., Raghuraman M and Tanweer Alam. 2015. A Text Book of Fundamental and Applied Entomology, ISBN-13: 978-9327248579 Kalyani Publishers
2. Atwal, A. S and Dhaliwal, G.S. 2008. Agricultural Pests of south Asia and their Management, 6th edn., Kalyani Publishers, Ludhiana.
3. Aswathi, V. B. 2012. Introduction to general and applied entomology, 3rd revised edition, ISBN: 9788172335977; Scientific Publishers (India), 499 pages.
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5. David, B.V. and V.V. Ramamurthy. 2016. Elements of Economic Entomology 8th Edition. ISBN: 978-0994869104; Brillion Publishing; 8th Edition edition, 400 pages.

6. Dhaliwal, G.S. 2016. Essentials of Agricultural Entomology, ISBN: 978-9327251340, Kalyani Publishers, 450 pages
7. Metcalf, C.L., & Fint, W.P. 1973 Destructive and Useful Insects, USDA/ TMH
8. Omkar. 2017. Industrial Entomology. ISBN 978-981-10-3303-2, Springer Nature Singapore Pte Ltd. 469 pages
9. Pedigo, L.P. and Rice, M.E., 2015. Entomology and Pestmanagement., 6th edn, ISBN: 978-1- 4786-2285-7, Waveland Press, Inc.,
10. Ragumoorthi, K.N., M.R. Srinivasan and V. Balasubramani. 2016. Principles of Applied Entomology, ISBN: 978-8190255820.
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13. Vasantharaj David, B. and T N Ananthkrishnan. 2004. General and Applied Entomology 2nd edition, ISBN: 9780070434356; McGraw Hill Education 1200 pages .

OPEN COURSE SYLLABUS

SEMESTER 5

COURSE CODE –BZL5D01				
OPEN COURSE I: REPRODUCTIVE HEALTH AND SEX EDUCATION				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Understand</i> the reproductive health, and importance of sex education for teen and youth.	Understand	2
CO2	<i>Explain</i> the chromosomal mechanism of sex determination and sex chromosomal anomalies.	Analyse	3
CO3	<i>Describe</i> the structural and functional features of human reproductive system, fertilization, implantation, pregnancy, gestation, placenta, parturition and lactation.	Apply	6
CO4	<i>Explain</i> the scope of reproductive technologies in infertility management and the assisted reproductive	Analyse	4

	techniques.		
CO5	<i>Understand</i> the different methods of prenatal diagnosis and associated ethical issues	Understand	2
CO6	<i>Describe</i> the different methods of fertility control.	Analyse	5
CO7	<i>Understand</i> the symptoms, mode of transmission, diagnosis and treatment of different sexually transmitted diseases and their socio-economic dimensions.	Understand	1
CO8	<i>Describe</i> sexual orientation, sexual abuse and myths	Evaluate	10
CO9	<i>Understand</i> the ethical aspects of sex	Evaluate	10

COURSE CONTENT

Module I:	2 Hours
<p>Introduction Definition; Reproductive health - problems and strategies; reproductive rights; importance of sex education for teen and youth.</p>	
Module II	3 Hours
<p>Sex determination and Chromosomal anomalies Chromosomal mechanism of sex determination; Barr body; twin studies; sex reversal; Sex chromosomal anomalies: Turner's syndrome and Klinefelter's syndrome.</p>	
Module III	17 Hours
<p>Human Reproduction Male reproductive system: Structure of testis, male accessory organs; Semen production and composition; ejaculation. Spermatogenesis, Male Sex hormones Female reproductive system: Structure of human ovary; development of primary follicle; structure of graafian follicle; fallopian tubes; uterus; external genitalia; mammary glands. Oogenesis. Female Sex hormones Menstrual cycle and hormonal control; brief account of fertilization, implantation, pregnancy, gestation, placenta, parturition and lactation (Brief account on hormonal control of lactation).</p>	
Module IV	10 Hours
<p>Infertility and assisted reproductive technologies Infertility: Causes and problems in male and female. Infertility management: semen collection, preservation and storage, artificial insemination, surrogacy. Cryopreservation and embryo transfer: Collection, care and preservation of embryos. In vitro fertilization (IVF) and embryo transfer: Major steps; Test tube babies. Assisted Reproductive Techniques (ART): GIFT, ZIFT,</p>	

ICSI, oocyte donation and embryo donation.	
Module V	4 Hours
Prenatal Diagnosis Different methods: Ultrasonography, amniocentesis, chorionic villus sampling and alpha-foetoprotein estimation; female foeticide: ethical issues and laws (Mention- PNDT Act).	
Module VI	4 Hours
Fertility Control Natural methods; artificial methods; chemical methods; hormonal methods; contraceptive devices; surgical contraception; abortion, legal termination of pregnancy.	
Module VII	7 Hours
Sexually transmitted infectious diseases Symptoms, mode of transmission, diagnosis, treatment and prophylaxis of AIDS, syphilis, gonorrhoea, herpes (genital), human papilloma virus and genital warts, hepatitis, gonococcal vulvo vaginitis, Trichomonal vaginitis. Mention the term venereal disease. Socio economic dimensions of STD.	
Module VIII	5 Hours
Sexual orientation, sexual abuse and myths Homosexuality and bisexuality (mention LGBT), oral sex, animal sex, cyber-sex, sexual abuse, premarital and extramarital sex, sexual perversions, paraphilia, child abuse, prostitution, sexual hygiene, protection of children from sexual offences (POCSO) Act, 2012 (brief account only), sexual myths.	
Module IX	2 Hours
Ethical aspects of sex Healthy relationship with opposite sex, role of counseling, gender discrimination in family and society.	

MODE OF TRANSACTION
Class room Lectures and face to face interaction ICT enabled Presentations Presentation of students Seminar Group discussion

Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (15 Marks)	
a. Classroom participation (20%):	3 Mark
b. Test papers I (40%):	6 Mark
c. Assignment (20%):	3 Mark
d. Seminar/ Viva (20%):	3 Mark
External Assessment (60 Marks):	Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	2
Module II	7
Module III	19
Module IV	17
Module V	7
Module VI	2
Module VII	9
Module VIII	9
Module IX	2

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7. Vander, Sherman and Luciano (2003): *Human Physiology*, 9th Edition, ISBN- 10: 9780072437935, McGraw Hill, 864 pages
8. <http://www.biologydiscussion.com/essay/reproductive-health-in-human-problems-and-strategies/5167>
9. <http://stayteen.org/sex-ed/article/why-sex-education-important>
10. <http://www.onlymyhealth.com/importance-sex-education-among-youth-1301382451>
11. <http://www.livestrong.com/article/246343-how-to-make-friends-with-the-opposite-sex/>
12. <http://stories.plancanada.ca/gender-discrimination-starts-at-home/>

COURSE CODE –BZL5D02				
OPEN COURSE II: NUTRITION, HEALTH AND HYGIENE				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>Describe</i> the basic concepts in nutrition	Understand	2
CO2	<i>Demonstrate</i> the understanding of nutrients and energetics	Analysed	6
CO3	<i>Perform</i> first aid management in emergency situations (4 hrs)	Apply	7

COURSE CONTENT

Module I:	3 Hours
Key concepts in Nutrition Basic Nutrition Concepts: Nutrition, Food energy - Kilocalories, Nutrients, Nutrient Density. Nutritional needs of body, classification of foods. Factors Influencing Food Selection: Flavor, Demographics, Culture and Religion, Social and Emotional Influences, Health, Environmental Concerns, Food industry and media (short notes only) Nutrients and non-nutrients: Six classes of nutrients: Carbohydrates, Fats, Protein, Vitamins, Minerals, Water; functions of these nutrients. Mention essential nutrients.	
Module II	19 Hours
Nutrition and Energetics Digestion, Absorption and Metabolism (14 hrs) Classification, Sources and nutritional significance of carbohydrates, proteins and fats. Gastrointestinal tract, digestion and absorption of carbohydrates, proteins and fats. Mention dietary fibers, essential and non essential amino acids, saturated, unsaturated and essential fatty acids. Deficiency of Protein — Protein energy malnutrition (PEM), Kwashiorkor, Marasmus. Energy Metabolism (5 hrs) Energy value of macronutrients, factors affecting the caloric value of foods, PFV (Physiological Fuel Value) of foods, low calorie modifications, Bomb calorimeter, Basal metabolic rate (BMR), factors affecting BMR; Thermic effect of food and thermogenesis. Energy balance and Body mass index (BMI).	
Module III	4 Hours
First Aid Management in Emergency Situation Dog bite; Insect sting: scorpion, Bee and wasp; Snake bite: venomous and non-venomous snakes; Haemotoxic Venom and Neurotoxic Venom; Antivenom and Polyvalent snake antivenom; First aid for Road accidents and drowning; Risks of self-medication practices	

MODE OF TRANSACTION

Class room Lectures and face to face interaction
ICT enabled Presentations

Presentation of students Seminar Group discussion
Assignments and Field study, Interview

MODE OF ASSESSMENT	
Internal Assessment (15 Marks)	
a. Classroom participation (20%):	3 Mark
b. Test papers I (40%):	6 Mark
c. Assignment (20%):	3 Mark
d. Seminar/ Viva (20%):	3 Mark
External Assessment (60 Marks):	Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION	
Module	Mark
Module I	44
Module II	26
Module III	9

REFERENCES:

1. Martin Eastwood (2003): Principles of Human Nutrition, Second edition. ISBN: 978-0-63205811-2. Blackwell Science Ltd, 680 pages.
2. Brian Walker, Nicki R Colledge, Stuart Ralston and Ian Penman (2014): Davidson's Principles of Practice of Medicine. 22nd Edition; eBook ISBN:9780702057199, Elsevier, 1392 pages
3. Harvey Washington Wiley: Wiley's Health Series, Vol. 1: Nutrition Hygiene Physiology; Wiley
4. John Hall (2015): Guyton and Hall Textbook of Medical Physiology; 13th Edition, Hardcover ISBN: 9781455770052, Paperback ISBN: 9781455770168, Elsevier, 1168 pages
5. Michael J. Gibney (2012): Public Health Nutrition, ISBN: 978-1-444-34204-8, Blackwell, 392 pages
6. Michael J. Gibney (2005): Clinical Nutrition, ISBN10 0632056266, Blackwell, 496 pages
7. Singh, H.D., Sarada Subramanyam, and K. Madhavankutty (2014): Textbook of Human Physiology; ISBN 10: 8121902169, S. Chand & Co.

COURSE CODE –BZL5D03				
OPEN COURSE III: APPLIED ZOOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	<i>List and describe</i> the pests and vectors, their habits, damages and control measures and mechanisms of insect pest management.	Apply	3
CO2	<i>Develop</i> personal, academic, employability and self-management skills in apiculture, lac-culture, sericulture and vermiculture	Evaluate	2
CO3	<i>Demonstrate</i> an understanding of the various strategies in pisciculture, prawn culture, mussel culture and pearl culture	Analyse	2
CO4	<i>Recognize</i> the significance of poultry farming and its economic implications in rural India	Create	
CO5	<i>Reviews</i> Indian breeds of cattle and goats and the strategies in their breeding	Understand	1
CO6	<i>Recognize</i> the significance of parasitic mode of life and their implications in human health	Apply	4

COURSE CONTENT

COURSE CONTENT	
Module I:	18 Hours
<p>Vectors and Pests</p> <p>Insect P</p> <p>Definition of pest and Types of pests. Nature of damage caused and control measures of the following pests:</p> <p>(a) Pests of paddy: Spodoptera mauritia (Rice swarming caterpillar), Leptocorisa acuta (Rice bug); (b). Pests of coconut: Oryctes rhinoceros (Rhinoceros beetle), Rhynchophorus ferrugineus (Red palm weevil); (c). Pests of stored products: Sitophilus oryzae (Rice weevil), Callasobruchus chinensis (Pulse beetle); Termites.</p> <p>Insect Pest Management</p> <p>Principles of Cultural control, Mechanical controls, biological control, control, Integrated pest management (IPM)</p> <p>Vectors of Human Diseases</p> <p>Mention habits, disease caused and control measures of the following Blackflies, Sandflies, Tsetse</p>	

flies, Mosquitoes: Anopheles, Culex & Aedes, and Hard ticks, Ectoparasitic insects: human lice, rat flea.	
Module II	11 Hours
<p>Animal Breeding and Animal Cultures</p> <p>(a) Apiculture: Brief description of adaptations of social bees used for honey harvesting - mention Apis dorsata, Apis cerana, Apis florea, and Tetragonula iridipennis; Bee keeping equipments and methods; Honey bee products: bee wax and its uses, chemical composition of honey and uses; Bee pollination, Economics of bee keeping.</p> <p>(b) Sericulture: Brief description of Bombyx mori (Mulberry silk moth); Silkworm rearing and extraction of silk, Economics of sericulture; Types of silk: Tassar, Muga and Eri silk.</p> <p>(c) Lac-culture: History, Morphology of lac insect, host plants, Natural infection, Artificial infection (inoculation), methods in lac-culture and economics of lac products.</p> <p>(d) Vermiculture: Varieties of earthworms and their economic importance, Methods of vermicomposting: basic requirements, preparation of vermibed, collection of compost, vermiwash, Effect of vermiwash on yield and quality of crops.</p>	
Module III	4 Hours
<p>Aquaculture</p> <p>Brief account on Pisciculture, Prawn culture, Mussel culture, Pearl culture and ornamental fish culture (with examples).</p>	
Module IV	6 Hours
<p>Poultry Farming Introduction, Importance of egg production, Nutritive value of eggs, factors affecting egg size; Breeds of fowl: a) Exotic breeds: Rhode Island Red, Plymouth Rock, New Hampshire. b) Indigenous breeds: Chittagong, Gangus; Brief notes on Poultry Housing and Equipment.</p>	
Module V	6 Hours
<p>Animal Husbandry</p> <p>Introduction, Exotic and Indian breeds of Cattle and Goats, Artificial insemination, Storage of semen, Embryo transfer technology, Short notes of common diseases: Anthrax, Foot and mouth diseases, Rinderpest, Brucellosis, Peste des Petits Ruminants (PPR).</p>	
Module VI	9 Hours
<p>Parasitology</p> <p>Introduction - Commensalism, Phoresis, Parasitism, Symbiosis, Host-parasite Relationship, Physiology, immunology and biochemistry of parasitism, Mention Definitive host, Intermediate host, Reservoir and Zoonosis.</p>	

Human Parasites: Mention the habits, habitat, life cycle, mode of infection, control measures of the following parasites: Entamoeba histolytica, Giardia lamblia, Leishmania donovani, Plasmodium vivax, Taenia solium and Wuchereria bancrofti.

MODE OF TRANSACTION

Class room Lectures and face to face interaction
 ICT enabled Presentations
 Presentation of students Seminar Group discussion
 Assignments and Field study, Interview

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

- a. Classroom participation (20%): 3 Mark
- b. Test papers I (40%): 6 Mark
- c. Assignment (20%): 3 Mark
- d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks): Duration 2 Hours, No of Questions: 21

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I	24
Module II	19
Module III	9
Module IV	9
Module V	9
Module VI	9

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