Dr. AMBEDKAR GOVERNMENT ARTS COLLEGE

(AUTONOMOUS)

CHENNAI - 600 039

(Accredited by NAAC at level "B")

M.Sc. (Zoology)

FOR CANDIDATES ADMITTED FROM 2022-23 ONWARDS

Syllabus

Under Choice Based Credit System

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (LOCF)

PG AND RESEARCH DEPARTMENT OF ZOOLOGY

Based on UGC – Learning Outcomes-Based Curriculum Framework
Course Structure under Choice Based Credit System
(For the candidates admitted from the academic year 2022-2023 onwards)

Sem. No	Part	Course	Subject code	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
								Int	Ext	
I	A	CC-I	22PAAZC1	Functional Morphology of Invertebrates	6	4	3	25	75	100
	A	CC-II	22PAAZC2	Phylogeny and Functional Morphology of Chordates	6	4	3	25	75	100
	A	CC-III	22PAAZC3	Evolution and Animal Behaviour	6	4	3	25	75	100
	A	CCP*	Even Sem.	**Practical –I - Invertebrata, Chordata, Evolution and Applied Entomology**	3	-	-	40	60	100
	A	CCP*	Even Sem.	**Practical –II- Cell and Molecular Biology, Genetics and Environmental Biology**	3	-	-	40	60	100
	A	CEC-I	*	Any one from Elective-I Subjects	4	3	3	25	75	100
	B	SBE - I	22PASBE1	Employability Skills	2	2	3	25	75	100
				Total	**30**	**17**				
II	A	CC-IV	22PBAZC1	Cell and Molecular Biology	5	4	3	25	75	100
	A	CC-V	22PBAZC2	Molecular Genetics	5	4	3	25	75	100
	A	CC-VI	22PBAZC3	Environmental Biology and Biodiversity Conservation	5	4	3	25	75	100
	A	CCP-VII	22PBAZC4	**Practical –I - Invertebrata, Chordata, Evolution and Applied Entomology**	3	4	3	40	60	100
	A	CCP-VIII	22PBAZC5	**Practical –II- Cell and Molecular Biology, Genetics and Environmental Biology**	3	4	3	40	60	100
	A	CEC-II	**	Any one from Elective-II Subjects	4	3	3	25	75	100
	A	EDS-I	22PBAZD1	Biostatistics and Bioinformatics	3	3	3	25	75	100
	B	SBE - II	22PBSBE2	Leadership and Communication Skills	2	2	3	25	75	100
				Total	**30**	**28**				

Sem. No	Part	Course	Subject code	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
								Int	Ext	
III	A	CC-IX	22PCAZC1	Biochemistry and Biophysics	5	4	3	25	75	100
	A	CC-X	22PCAZC2	Animal Physiology	5	4	3	25	75	100
	A	CC-XI	22PCAZC3	Immunology	5	4	3	25	75	100
	A	CCP**	Even Sem.	**Practical -III Biochemistry, Developmental Biology Immunology and Bioinstrumentation**	3	-	-	40	60	100
	A	CCP**	Even Sem.	**Practical - IV Animal Physiology, Biotechnology and Aquaculture**	3	-	-	40	60	100
	A	CEC-II	***	Any one from Elective-III Subjects	4	3	3	25	75	100
	A	EDS-II	22PCAZD2	Microbiology	3	3	3	25	75	100
	B	SBE - III	22PCSBE3	Managerial Skills	2	2	3	25	75	100
	C	Internship	22PCINT1	Internship	-	2	-	-	-	-
				Total	**30**	**22**				
IV	A	CC-XII	22PDAZC1	Developmental Biology	6	4	3	25	75	100
	A	CC-XIII	22PDAZC2	Biotechnology	6	4	3	25	75	100
	A	CCP-XIV	22PDAZC3	Practical -III Biochemistry, Developmental Biology Immunology and Bioinstrumentation	3	4	3	40	60	100
	A	CCP-XV	22PDAZC4	Practical - IV Animal Physiology, Biotechnology and Aquaculture	3	4	3	40	60	100
	A	CEC-IV	****	Any one from Elective-IV Subjects	5	3	3	25	75	100
	A	CEC-V	****	Any one from Elective-V Subjects	5	3	3	25	75	100
	B	SBE - IV	22PDSBE4	Personality Development	2	2	3	25	75	100
				Total	**30**	**24**				
				Overall Total	**120**	**91**				

CORE ELECTIVE COURSES:

***Elective-I** (Any one subject of the following Core Elective chosen by the candidate)		***Elective-II** (Any one subject of the following Core Elective chosen by the candidate)	
Sub. Code	**Core Elective Courses**	**Sub. Code**	**Core Elective Courses**
22PAAZE1A	Applied Entomology	22PBAZE2A	Bio Instrumentation
22PAAZE1B	Fishery Biology	22PBAZE2B	Biophysics

*****Elective-III** (Any one subject of the following Core Elective chosen by the candidate)		******Elective-IV** (Any one subject of the following Core Elective chosen by the candidate)	
Sub. Code	**Core Elective Courses**	**Sub. Code**	**Core Elective Courses**
22PCAZE3A	Mammalian Endocrinology	22PDAZE4A	Research Methodology
22PCAZE3B	Molecular Developmental Biology	22PDAZE4B	Human Genetics

*******Elective-V** (Any one subject of the following Core Elective chosen by the candidate)	
Sub. Code	**Core Elective Courses**
22PDAZE5A	Aquaculture
22PDAZE5B	Bio-Oceanography

SEMESTER-I

M.Sc. Degree Programme in Zoology

FIRST SEMESTER				
Course code		**22PAAZC1**		
Name of the course		**FUNCTIONAL MORPHOLOGY OF INVERTEBRATES**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC-I	**Core**	**4**	**6**	**25 + 75=100**

Course Objectives:

- To understand the principles of taxonomy and new trends in taxonomy
- To understand the anatomical organization of organ system and the relative position of individual organs of invertebrate animals in relation to its function
- To analyse the phylogenetic significance of invertebrate with advances and complexity of various habitats.
- To analyse the evolutionary position of the invertebrate larval forms

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UNIT I : Animal Taxonomy and Invertebrate origin (18hrs)

Principle of animal taxonomy - Species concept; International code of zoological nomenclature - Taxonomic procedures. New trends in taxonomy (Molecular taxonomic tools, Species identification tools and e-taxonomic resources)

Origin of coelom formation - Organization of coelom –Acoelomates – Pseudocoelomates – Coelomates: Protostomia and Deuterostomia. Origin and evolution of Metazoa – theories**,** Origin of Bilateria - Theories on origin of metamerism

UNIT II : Locomotion and Feeding in Invertebrates (18hrs)

Locomotion in Protozoa (Pseudopodia, Flagella and ciliary movement), Parasitic protozoans. Organization of skeleton in sponges - Hydrostatic movements in coelenterates, Annelids and Echinoderms

Patterns of feeding in lower metazoans- Filter feeding in polychaeta, Mollusca and Echinodermata.

UNIT III : Nervous System, Respiration and Excretory structures of Invertebrates

(18hrs)

Primitive nervous system in Coelenterates. Advanced nervous system in Annelids, Arthropods (Crustacea and Insecta), Mollusca (Cephalopods)

Respiration : Organs of respiration: gills, lungs and trachea - Respiratory pigments and Mechanism of respiration in invertebrates

Organs of excretion: coelomoducts, nephridia and Malphigian tubules. Mechanism of Excretion - Osmoregulation in invertebrates

UNIT IV: Larval forms of Invertebrates (18hrs)

Parasitic adaptations of helminth parasites - Larval forms of Trematoda and Cestoda.

Crustacean larva and their significance - Cephalopods as advanced molluscs, Torsion and detorsion in gastropods, Molluscan larva and their evolutionary significance

Echinoderm larva and its evolutionary significance

UNIT V : Minor Phyla (18hrs)

Minor Phyla: Structural peculiarities and affinities of:

Rotifera , Chaetognatha, Phoronida, Endoprocta and Ectoprocta.

Text Books :

1. Barrington, E.J.W. Invertebrate Structure And Function. Thomas Nelson And Sons Ltd., London.
2. Barnes, R.D. Invertebrates Zoology, III, Edition. W.B. Saunders Co. Philadelphia

Reference Books:

1.Hyman, L.H. Year The Invertebrates, Protozoa Through Ctenophora, Mcgraw Hill Co., Ny
2. Jagerstein, G. Evolution Of Metazoan Life Cycle, Academic Press, New York & London.
3. Hyman, L.H. The Invertebrates. Vol. 2. Mcgraw Hill Co., New York.
4. Hyman, L.H. The Invertebrates. Vol. 8. Mcgraw Hill Co., New York And London.
5 Russel-Hunter, W.D. A Biology Of Higher Invertbrates, The Macmillan Co. Ltd., London.
6. Hyman, L.H. The Invertebrates Smaller Coelomate Groups, Vol. V.Mc.Graw Hill Co., NY
7. Read, C.P. Animal Parasitism. Parasitism. Prentice Hall Inc., New Jersey.
8. Parker, T.J., Haswell W.A. Text Book of Zoology, Macmillan Co., London

Web Resources

www.sanctuaryasia.com
www.iaszoology.com
http://www.earthlife.net

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	To recall the basic concepts of animal taxonomy and classify the primitive forms, relate their origin and phylogenetic significance	**K2,K3,K6**
CO2	Explains the structural organization and functions of locomotory organs and feeding patterns	**K2,K3**
CO3	To compare the nervous, respiratory and excretory structures and to analyze its working mechanism in invertebrates	**K2,K4**
CO4	Identifies the larval forms in invertebrates and their evolutionary significance	**K3,K5**
CO5	Understands the structure peculiarities and affinities of a few organisms belonging to minor Phyla.	**K2,K4**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	2	2
CO2	2	3	2	2	3	2
CO3	2	2	3	2	3	3
CO4	3	2	2	3	2	3
CO5	3	3	2	2	3	2
Total of CO-PSO mapping	**13**	**13**	**11**	**12**	**13**	**12**
Average of CO-PSO mapping	**2.6**	**2.6**	**2.2**	**2.4**	**2.6**	**2.4**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FIRST SEMESTER				
Course code		22PAAZC2		
Name of the course		PHYLOGENY AND FUNCTIONAL MORPHOLOGY OF CHORDATES		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC -II	**Core**	**4**	**6**	**25 + 75=100**

Course Objectives:

- To analyse the origin and phylogenetic significance of chordates.
- To understand the morphology and comparative anatomy of vertebrate animals.
- To understand the evolution of vertebrates by integrating structure, function and development

UNIT I: Evolutionary position of Chordates (18hrs)

Prochordate phylogeny- Origin and ancestry of Chordates. Origin and classification of vertebrates. Evolutionary position of Ostracoderms and Placoderms – Evolutionary significance of Dipnoi – Origin of Amphibia – Golden age of Reptiles - Major types of Dinosaurs and reason for extinction, Affinities of Archaeopteryx, Origin of mammals.

UNIT II:Integuments and Circulation in Vertebrates(18hrs)

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

Evolution of heart in fishes, amphibians, reptiles, birds and mammals. Evolution of aortic arches and portal systems

UNIT III :Respiratory organs and Evolution of kidney in Vertebrates (18hrs)

Comparative account of respiratory organs in fishes, amphibians, reptiles, birds and mammals. Evolution of kidney and their ducts in vertebrates

UNIT IV : Skeletal system in Vertebrates (18hrs)

Comparative account of jaw suspensorium, Types of vertebra of vertebrates. Comparision of pectoral girdle and pelvic girdle forelimbs, hindlimbs, in amphibians, reptiles, birds and mammals

UNIT V :Sense organs and Brain in Vertebrates (18hrs)

Sensory Receptors in vertebrates - Organs of olfaction, taste and hearing in vertebrates - Lateral line system and Electroreception in fishes.
Comparative anatomy of the brain in vertebrates in relation to its functions

Text Books :

1. Young J.Z. Life of Vertebrates Oxford University Press, London.
2. Young J.Z. Life of Mammals Oxford University Press, London.
3. Colbert E.H. Evolution of Vertebrates John Wiley And Sons Inc. New York.
4. Kent C.J. Comparative Anatomy of Vertebrates.
5. Waterman A.J. Chordate Structure And Functions Macmillan Co. New York.
6. Lovetrup S. The Phytogeny of Vertebrates John Wiley And Sons Inc., London.
7. Joysey K.A. And Kemp T.S. Vertebrate Evolution Oliver And Boyd, Edinberg.
8. Romer A.S. Vertebrate Paleontology University of Chicago Press, Chicago.

Reference Books:

1.Alexander R.N., Year The Chordata, Cambridge University Press London.
2. Barrington Ejw, The Biology Of Hemichordates And Protochordates, Oliver And Boid Edinberg.
3. Bourne G.H., The Structure And Function Of Nervous Tissue Academic Press New York.
4. Honyelli A.R. The Chordates Cambridge University Press, London
5. Smith H.S. Evolution Of Chordate Structure, Hold Rinehart And Wintoin Inc. New York
6. Walter H.A. And Sayles L.D. Biology Of Vertebrates Macmillan And Co. New York
7. Romer A.S. Vertebrate Body W.P. Sanders Co., Philadelphia.

Web Resources

http://www.mcwdn.org/Animals/Animals.html
animaldiversity.org
www.iaszoology.com
https://www.britannica.com/animal/chordate

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	To explain the origin and to recall the evolutionary position of Chordates	**K5,K6**
CO2	To discuss the vertebrates integument and functioning of circulatory system	**K4,K6**
CO3	To outline the comparative anatomy of respiratory organs and kidney in Vertebrates	**K2,K3**
CO4	To relate the skeletal organisation with the body framework of ver tebrates	**K2,K4**
CO5	Recognise the importance of sensory organs and to identify and relate the structural details of the brain organization and compare with different group of vertebrates	**K2,K4,K5**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2	2	2
CO2	3	2	3	2	3	2
CO3	2	3	2	3	2	3
CO4	2	2	3	3	3	2
CO5	3	3	2	2	3	3
Total of CO-PSO mapping	**13**	**13**	**12**	**12**	**13**	**12**
Average of CO-PSO mapping	**2.6**	**2.6**	**2.4**	**2.4**	**2.6**	**2.4**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FIRST SEMESTER				
Course code		22PAAZC3		
Name of the course		EVOLUTION AND ANIMAL BEHAVIOUR		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC -III	**Core**	**4**	**6**	**25 + 75=100**

Course Objectives:

- To identify the eras and periods of the geological time scale
- To understand the modern evolutionary concepts and mechanisms in genetic diversity.
- To analyse the evolution of genes, molecules and genetic relationship among organisms
- To study the principles, understand , evaluate information and mechanisms of animal behaviour and their types.
- Develop skills, concepts and experience to understand all aspects of animal behaviour.

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UNIT I : **Modern Understanding of Evolution(18hrs)**

Evolutionary time scale – eras – periods – epoch . Emergence of Evolutionary theories- Lamarckism and Darwinism – concepts - Evolutionary synthesis - Modern Synthetic theory of evolution Modern understanding of Natural selection- Stabilizing, diversifying and directional selection. Polymorphism- Transient and Stable- Evolutionary significance of Polymorphism. Rates of Evolution- Horotely, Bradytely and Tachytely

UNIT II : Molecular Evolution (18hrs)

Molecular Evolution - Role of genes in evolution - Assessment of molecular variation and genetic relationship among organisms. Nucleotide and Amino acid sequences comparisons and phylogeny - Molecular clocks of evolution

UNIT III : Higher Categories of Evolution (18hrs)

Patterns and trends in Evolution – Microevolution, Macroevolution and Megaevolution Adaptive trends in evolution - quantifying adaptation. Origin of higher categories- Simpson's adaptive grid. Phylogenetic gradualism and punctuated equilibrium. Population genetics- Gene frequencies in population- Analysis of gene frequencies in natural populations- Factors influencing gene frequencies in population. Human Evolution- Evolution of Anthropoid primates – The first Hominids - Origin of Modern man.

UNIT IV : Classification of Animal Behaviour and Chronobiology (18hrs)

Principles of Ethology. Classification of animal behaviour – Inborn animal behaviour- (Taxis, kinesis, Reflex, Instincts) - Acquired animal behavior- Learning, Imprinting and Reasoning behavior. Chronobiology - Biological clock- Biological rhythms in animals

UNIT V: Sociobiology and Communication among animals (18hrs)

Sociobiology - Territoriality, Aggressive behavior and Sexual and Mating behaviour among animals - Altruism – Group selection and kin selection

Communication in animals – Types of communication in animals- Components . Visual communication in honey bees and birds. Auditory(Vocal /Sound) communicationin birds and mammals. Chemical communication– Pheromones of insects, Pheromones of mammals.

Text Books :

1. Merrel, D.J. Evolution and Genetics. Holt, Rinchart and Winston, Inc.
2. Smith, J.M. Evolutionary Genetics. Oxford University Press, New York.
3. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston London
4.Anmol.Recent Advances In Animal Behaviour. 1994,
5. Reena Mathur: Animal Behaviour, Rastogi & Co., Meerut.

Reference Books:

1. Dobzhansky, Th. Genetic and Origin of Species. Columbia University Press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M Valentine. Evolution. Surjeet Publication, Delhi
3. Futuyama, D.J. Evolution Biology, Suinuaer Associates, INC Publishers, Dunderland.
4. Hartl, D.L. A Primer of Population Genetics. Sinauer Associates. Inc, Massachusetts.
5. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
6. King, M. Species Evolution –The role of chromosomal change .The Cambridge University Press, Cambridge.

Web Resources

www.animalbehaviorsociety.org
http://www.sanctuaryasia.com

https://www.edge.org/conversation/freeman_dyson-biological-and-cultural-evolution

https://www.nature.com/scitable/knowledge/.../how-does-social-behavior-evolve-132602
https://en.wikibooks.org/wiki/Animal_Behavior/Evolution

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	To identify the eras of Geological time scale and to analyse evolutionary synthesis, various patterns of evolution	**K1,K2,K3**
CO2	Outlines the role of genes in molecular evolution and identifies its relationship with other groups of organisms	**K2,K3**
CO3	Understand population evolution and analyse gene frequencies Identify the trends in the evolution of modern man based on fossil history	**K2,K5**
CO4	Describe the various behavioural patterns exhibited by animals Analyze and identify innate and learned behavior among animal. Identify and discuss the rhythmicity of behavioural expressions in animals.	**K2,K3,K4**
CO5	Assess complexity involved in behavioural traits and evaluate hormones and their role in aggression and reproduction, identify the communication in animals and relate it to their behaviour	**K5,K2**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	2	1
CO2	3	3	2	3	2	1
CO3	3	3	3	3	2	1
CO4	3	3	2	3	2	2
CO5	3	3	2	3	2	2
Total of CO-PSO mapping	**15**	**15**	**12**	**15**	**10**	**07**
Average of CO-PSO mapping	**3**	**3**	**2.4**	**3**	**2**	**1.4**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

SEMESTER-II

SECOND SEMESTER				
Course code		**22PBAZC1**		
Name of the course		**CELL AND MOLECULAR BIOLOGY**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC- IV	**Core**	**4**	**5**	**25 + 75=100**

Course Objectives:

- To understand the dynamics of cytoskeleton, cell communications and signal transduction mechanisim
- To elaborate the molecular mechanisms of prokaryotic and eukaryotic DNA replication and repair mechanism
- To understand the mechanisms of eukaryotic transcription and translation process
- Understand the regulatory mechanism of cell cycle and acquire knowledge of programmed cell death

UNIT I: Cytoskeleton and Cell Communication (15 hrs)

Cytoskeleton - Microfilaments and microtubules - structure and dynamics - Role of Microtubulin, kinesin and dynein in cell movements. Cell- adhesion and Communication - Cell adhesion molecules (Cadherins, Selectins and Integrins) – Types of cell junctions- Gap junctions and connexions

UNIT II : Signal Transduction and Cell cycle (15 hrs)

Signal transduction mechanisms - Cell surface receptors –Signalling pathways- Second messenger system - Signalling from plasma membrane to nucleus
Cell cycle - cyclins and cyclin dependent kinases, Regulation of CDK - cyclin activities. Regulation of cell cycle in eukaryotes

UNIT III : Genome organization, DNA replication and repair (15 hrs)

Genome Organization - Repetitive, Non repetitive DNA, C- value paradox, Cot curves, Morphological and Functional elements of Eukaryotic Chromosomes - Chromatin organization, Histones, Nucleosomes, Centromere and Kinetochore, Telomere. Forms of DNA. Eukaryotic DNA Replication - Molecular mechanism and Enzymology. Mechanism of DNA repair –Direct, excision, Mismatch and recombinational repair

UNIT IV : Eukaryotic transcription and translation (15 hrs)

Eukaryotic transcription - Factors and regulation of transcription - RNA processing - Antisense and ribozyme technology – initiation of splicing, polyadenylation - Circular RNA and IncRNA
Molecular mechanisms of antisense molecules, miRNA, siRNA, gene silencing. Post transcriptional modifications. Eukaryotic translation – Mechanism and Regulation. Post translational modifications

Trafficking mechanisms (Secretory and endocytotic pathways) - Intracellular protein traffic - Uptake into ER – protein sorting.

UNIT V : Oncogenes and Programmed cell death (15 hrs)

Biology of cancer - Oncogenes - Retroviral and Proto-oncogene. Role of Tumor suppressor genes. Apoptosis - Programmed cell death - mechanism and significance - Genes involved in apoptosis

Text Books :

1.Molecular Cell Biology By Lodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. And Darnell J., W. H. Freeman And Co.
2.Fundamentals of Molecular Biology-Veer Bala Rastogi-Ane's Student Edition - 2010
3.Molecular Cell biology, J. Darnell, H. Lodish and D. Baltimore, Scientific American Book, Inc., USA.
4. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Ratf, K. Roberts, and, J. D. Watson, Garland Publishing Inc., New York.

Reference Books:

1 . Cell And Molecular Biology By De Robertis- E. D. P., I. S. E. Publication.
2. Molecular Biology By Turner P. C. And Mc Lennan , Viva Books Pvt. Ltd.
3. Advanced Molecular Biology By Twyman R. M., Viva Books Pvt. Ltd.
4. Molecular Biology By Freifelder D., Narosa Publication House.
5. Gene VIII By Benjamin Lewis, Oxford Press.
6. Molecular Biology of Gene By Watson J. D. Benjamin Publication.

Web Resources

www.cellbio.com
http://www.ibiblio.org/virtualcell/index.htm
https://www.cliffsnotes.com/study-guides/biology/biochemistry-ii/dna-structure-replication-and-repair/dna-recombination-and-repair

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Describe the chemical composition of cell membrane and relates its function in transport of molecules across cell membranes.	**K1,K2**
CO2	Understands the dynamics of cytoskeleton and identifies the various cell to cell communication process	**K1,K2,k3**
CO3	Understands the eukaryotic replication and identifies the DNA repair mechanisms	**K1,k2**
CO4	To evaluate the role of regulatory factors and mechanism of eukaryotic transcription and translation in the synthesis of proteins.	**K2,k6**
CO5	To recall the events of cell cycle and to understand the role of cell cycle regulatory proteins, identifies the oncogenes and cancerous cells, genes involved in apoptosis	**K1,K2,K3**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	2	
CO2	3	3	3	3	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	2	2	2
CO5	3	3	3	3	2	2
Total of CO-PSO mapping	**15**	**15**	**15**	**13**	**10**	**06**
Average of CO-PSO mapping	**3**	**3**	**3**	**2.6**	**2**	**1.2**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

SECOND SEMESTER				
Course code		**22PBAZC2**		
Name of the course		**MOLECULAR GENETICS**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC -V	**Core**	**4**	**5**	**25 + 75 = 100**

Course Objectives:

- To understand the concept of molecular genetics, gene structure and its regulation
- To understand the the mechanism of gene recombination
- Relate the conventional and molecular methods for gene mapping
- Understand the cause and effect of mutations and chromosomal alterations
- Discuss and analyse karyotyping, chromosome mapping and linkage maps, epigenetic modifications and its role in genetic diseases.

UNIT I : Gene Regulation and Microbial Genetics (15 hrs)

Molecular Structure of gene - Fine structure analysis of genes. Gene regulation – Operon inducible concept – GAL and LAC operon concept – Attenuation- trp Operon
Microbial genetics: Bacterial transformation, conjugation, transduction (Specialised and Generalised) and sexduction,

UNIT-II : Gene Recombination (15 hrs)

Gene Recombination : Homologous and Non-homologous recombination. Site-specific and transpositional recombination. Mobile DNA elements – transposable elements, IS elements, P elements, Retrotransposons

UNIT III : Gene Mapping Methods (15 hrs)

Quantitative genetics: Heritability and its measurements, Quantitative trait loci (QTL) mapping. Outline of Human Genome Project and its significance. Chromosome mapping, Linkage maps - Physical map – LOD score for linkage testing. Gene mapping methods: Tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, genome analysis and DNA foot printing. Mapping genes by interrupted mating,

UNIT IV: Mutations and Chromosomal abberations (15 hrs)

Mutation: Types of mutation, Molecular mechanisms of mutations - Mutagens - Detection of mutant types - Insertional mutagenesis.. Chromosomal abberations- Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Gene editing and CRISPR technology -TALENS

UNIT V: Human Genetics (15 hrs)

Human chromosome complement, karyotype preparation, chromosome banding, Pedigree analysis - Genetic cause, diagnosis and treatment of the following single gene mutation disorders (Thalassemia and sickle cell anemia, Duchenne muscular dystrophy, Fragile-X-

syndrome,).Inborn errors of metabolism carbohydrate metabolism (Galactosemia, Glycogen storage disorders with reference to Von Gierke disease), amino acid metabolism (Phenylketonuria, Alakptonuria, Albinism and Homocysteinuria), Lysosomal storage diseases (Tay- Sachs disease, Niemann Pick disease, Gaucher's disease), Nucleotide metabolism (Gout, Lesch-Nyhan syndrome), Screening for genetic disorder and diagnosis – Amniocentesis, FISH technique

Text Books :

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications Of Recombinant DNA. ASM Press, Washington.
2. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. And Carroll, S.B. In: Edition. Introduction To Genetic Analysis. W. H. Freeman And Co.
3. Immanuel,C And Vincent ,S., Applied Genetics. MJP Publishers
4. Verma,P.S. And Agarwal,V.K. 2004. Genetics. 8 th Edition. S.Chand and Co.

Reference Books:

1.Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Viii Ed. Principles Of Genetics. Wiley India.

2.Snustad, D.P., Simmons, M.J. (2009). Principles Of Genetics. V Edition. John Wiley And Sons Inc.

3.Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts Of Genetics. Xi Edition. Benjamin Cummings.

4.Russell, P. J. (2009). Igenetics- A Molecular Approach. Iii Edition. Benjamin Cummings.

Web Resources

https://www.genome.gov/genetics-glossary/Sex-Linked
https://www.vedantu.com/biology/mutagens
www.ncbs.res.in
www.omim.org

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	To summarize the molecular mechanisms by which genetic material controls the character of organisms. Analyses the fine structure of the gene, understands the concepts of microbial genetics	**K1.K2,K4**
CO2	Compares homologous and non-homologous gene recombinations, analyses the DNA mobile elements	**K1,K2,K4**
CO3	Determines the gene mapping methods and demonstrates its importance gene analysis, Perceives ideas to explain the chromosome maps	**K2,K5**
CO4	Distinguish between different types of mutations, examines the alteration in chromosome structure and function	**K1, K3,K4**
CO5	Identify the methods of karyotyping, chromosome banding techniques and identifies the causes of genetic disorders , screening of genetic disorders.	**K2,K4,K5**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	1	2
CO2	3	3	3	3	1	2
CO3	3	3	3	3	1	2
CO4	3	3	3	3	1	2
CO5	3	3	3	3	1	3
Total of CO-PSO mapping	**15**	**15**	**15**	**15**	**05**	**11**
Average of CO-PSO mapping	**3**	**3**	**3**	**3**	**1.6**	**2.2**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

SECOND SEMESTER				
Course code		**22PBAZC3**		
Name of the course		**ENVIRONMENTAL BIOLOGY AND BIODIVERSITY CONSERVATION**		
Course No	Course Category Core / Elective / EDS	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC -VI	**Core**	**4**	**5**	**25 + 75=100**

Course Objectives

- To study the scope and the importance of biosphere, its components and biogeochemical cycles
- To examine the characteristics of population and interaction between species
- Understands the organization of community in an ecosystem and ecological succession
- Understand the dynamics of ecosystem and its productivity
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation ,management issues and other prospects of environment protection

Unit: I: Environment and Mineral Recycling(15 hrs)

Biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche. Biogeochemical cycles – Gaseous and sedimentary cycle- Carbon, nitrogen, oxygen, phosphorous and water cycles

Unit: II : **Population Ecology and Species Interactions (15 hrs)**

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Species Interactions: Types of interactions, Intra and interspecific competition, , symbiotic relationship.

Unit: III : **Community Ecologyand Ecological Succession (15 hrs)**

Community Ecology: community structure and attributes; levels of species diversity and its measurement; edge effect and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit: IV : **Ecology of Ecosystem (15 hrs)**

Ecosystem structure and function - Energy flow - Tropic structure and levels - Pyramids, food-chain and food-web - ecological efficiencies. Primary production and decomposition; Structure and function of Indian ecosystems: terrestrial (forest and grassland) and aquatic (freshwater and marine). Estuaries -Productivity of an estuary. Mangroves - Importance of mangroves in coastal ecosystems - Conservation and Management

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Unit: VApplied Ecology and Conservation Biology (15 hrs)

Applied Ecology: Bioremediation; global environmental changes , e-waste management Biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation / management strategy (Project Tiger, Biosphere reserves). Biodiversity Act of India

Text Books :

1. Odum, E. P. (1983). Basic Ecology, Saunder's College Publishing, New York.
2. Kormondy, Edward J. (2017). Concepts of Ecology, (4th ed.). New Jersey: Pearson Education
3. Sharma, P.D. (2017). Ecology and Environment,(13th ed.), Meerut: Rastogi Publication

Reference Books:

1. Bandopaghyay, J. (1985) India's Environment Crisis and response – Natraj Publishers, Dehrappn.
2. Smith, R. L. (1986). Element of Ecology, Harper and Row Publishers, New York.
3. APHA, Soli, J. Archeivala - 1988 - Wastewater treatment for pollution control - Second Ed. Tata McGraw hill Publication Company Ltd., New Delhi - ISBN-O-07-463002-4.

Web Resources

www.ecology.com
http://www.nhptv.org/natureworks/nw4.htm
www.deepspaceecology.com
https://www.khanacademy.org/science/biology/ecology/biogeochemical-cycles/a/introduction-to-biogeochemical-cycles
http://ecoursesonline.iasri.res.in/mod/page/view.php?id=4527

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Discuss the key ecological interactions and processes, the distribution and abundance of organisms	**K1, K2, K4, K5**
CO2	Relate the principles and techniques to evaluate the impact of human population growth	**K3, K4, K5**
CO3	Explain the structure of community and identifies the methods of ecological succession	**K1, K2, K4**
CO4	Describe the structure, dynamic functioning and productivity of the ecosystems	**K1, K3, K4, K5**
CO5	To understand and recall the importance of wildlife , sensitize the students on the need for conservation approaches of wildlife and prevention of extinction.	**K2, K3, K5, K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	2	3	2	2
CO2	2	2	3	3	2	2
CO3	2	3	2	3	2	2
CO4	3	2	2	3	2	2
CO5	3	3	3	2	2	3
Total of CO-PSO mapping	**12**	**12**	**12**	**14**	**10**	**11**
Average of CO-PSO mapping	**2.4**	**2.4**	**2.4**	**2.8**	**2**	**2.2**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

SECOND SEMESTER				
Course code		**22PBAZC4**		
Name of the course		**PRACTICAL- I : INVERTEBRATA, CHORDATA EVOLUTION AND APPLIED ENTOMOLOGY**		
Course No	Course Category Core / Elective /Extradiscipline	No of Credits	No of hrs /week	Total marks (Int+Ext)
CCP- VII	**Core**	**4**	**3**	**40 + 60=100**

Course Objectives

- Understand the anatomy and organ system of animals through dissections and mounting of easily available invertebrate and vertebrate animal.
- View the various specimens, photographs and study the medical importance and larval forms of invertebrates
- Correlatetheadaptive features of some veretebrates with their mode of life
- Understand the significace of living fossils and know the contributions of famous evolutionists

INVERTEBRATES (Slides/Specimen /Photographs)

1.Identification and study of selected Protozoans and Helminthes of medical importance.

Entamoeba histolytica, Plasmodium vivax, Taenia solium, Ascaris lumbricoides, Ancylostoma duodenale, Enterobius vermicularis

2. Study of Transverse sections of few animals to understand the evolution of different types of coelom.

Transverse section of *Ascaris lumbricoides*, *Taenia solium*, *Fasciola hepatica*, Neries, Hirudinaria

3.Study of prepared slides of Mouth parts to relate structure, type and feeding habit

Gnathochilarium of Millipede, mouth parts of Honey bee, Housefly, Mosquito, Bed bug and Butterfly.

4.Study of Invertebrate larval forms

Ephyra, Redia, Cercaria, Nauplius, Zoea, Protozoea, Mysis, Alima, Megalopa, Veliger, Glochidium, Bipinnaria, Ophiopluteus, Echinopluteus. Tornaria

Dissections

1. Digestive system of *Pila.*

2. Nervous system of Prawn and *Pila*

3. Reproductive system ofany insect

Mounting

1.Appendages of Prawn

2.Sting of Honey bee.

3. Pedicellaria of Sea urchin.

4. Aristotle's lantern of Sea urchin.

CHORDATES (Slides /Specimen /Photographs)

1. Study of the following specimens to bring out their affinities;

a) Amphioxus. b) Ascidian c) Petromyzon

2. Study of the following specimens with reference to their adaptive features for their respective modes of life:

a) Echeneis b) Ichthyophis c) Hyla d) Draco e) Bat

3. Study of the following skull types with reference to jaw suspensions:

a) Frog b) Rat / Rabbit

Demonstrations / Dissections

1.. Dissection of V^{th}, VII^{th},IX^{th} and X^{th} cranial nerves of Shark /any bony fish

2. Dissection of aortic arches in shark / any bony fish

EVOLUTION (Specimen / photographs)

Identification and study of fossils and their relevance in evolution

1. Molluscan fossils (Ammonoidea, Nautiloids)

2. Living fossil (Trilobite, Limulus)

3. Connecting link (Peripatus , Archaeopteryx).

4. Stick insect and leaf insect- tostudy adaptation by cryptic colouration and natural selection.

6. ObservationofMonarchandViceroybutterfliestostudyBatesianmimicry

7. Observation of forelimbs and hind limbs of vertebrates (frog, calotes ,bird and mammal)- To study the pattern of pentadactyl limb and common ancestry of vertebrates.

APPLIED ENTOMOLOGY (Slides /Specimen /Photographs)

1.Study of life cycle of hemimetabolus, holometabolus and ametabolus insects.
2.Study of parasitic and predatory insects

3.Identification of honey bees of bee colony.
4. Identification of silkworm types – Mulberry and non-mulberry silk worms

Text Books :

1.Sinha, Chatterjee and Chattopadhyay, 2014 . Advanced Practical Zoology, Books and Allied Ltd ; 3rd Revised edition

2.Lal ,S. S, 2016 . Practical Zoology Invertebrate, Rastogi Publications.

3.Verma, P. S. 2010. A Manual of Practical Zoology: Invertebates, S Chand and Company

4.Lal S S, 2009. Practical Zoology Vertebrate, Rajpal and Sons Publishing,

5.Verma P. S, 2000. A Manual of Practical Zoology: Chordates, S. Chand Limited,

Reference Books:

1.J.E. WodsedalekCharles F. Lytle 2000. General Zoology Laboratory Manual McGraw Hill Higher Education Publication

Web Resources

1.www.nuffieldfoundation.orl-biolg/practical biology
2. www.nature.com
3. https://bit.ly/3CzTEy8
4 .http://tolweb.org/Chordata/2499
5. https://www.nhm.ac.uk/
6. https://bit.ly/3Av1Ejg

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Illustrate and examine the digestive, reproductive and nervous systems of invertebrate animals. Identifies the cranial nerves and aortic arches of shark	**K2,K3,K4,**
CO2	Makes use of theknowledgeonmounting pedicellaria, appendages and sting of some invertebrate animals	**K5,K6**
CO3	Differentiates and compare the structure, function and mode of life of various invertebrate animals based on coelome organization and mouth parts.	**K4,K5,K6**
CO4	Identifies the morphology and ecological adaptations in vertebrates, correlate and categorize thevertebrates basedon their skulland jaw suspension mechanism	**K3,K4,K5**
CO5	Gains knowledge on identification of fossils, differentiates mimicry, colouration and illustrates the ancestry of vertebrates based on evolution of pentadactyl limb	**K2,K4,K5**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	2
CO2	2	2	3	2	3	3
CO3	3	2	3	3	2	3
CO4	3	3	2	2	2	2
CO5	3	2	3	2	3	3
Total of CO-PSO mapping	**14**	**12**	**13**	**12**	**12**	**13**
Average of CO-PSO mapping	**2.8**	**2.4**	**2.6**	**2.4**	**2.4**	**2.6**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low

2 – Medium

3 – High

0– No Correlation

PRACTICAL EXAMINATION

***Practical Examination will be conducted during the end of even semester (second and fourth). Each practical with 4 hours duration.**

MARK DISTRIBUTION (END SEMESTER PRACTICAL EXAMINATION)

PRACTICALS : 50 MARKS

RECORD: 10 MARKS

TOTAL: 60MARKS

Practical record to be submitted during the End Semester practical examination

QUESTION PAPER PATTERN FOR PRACTICALS

1.MAJOR PRACTICALQUESTION – 15 MARKS

2.MINOR PRACTICALQUESTION - 10 MARKS

3.MINOR PRACTICAL QUESTION- 10 MARKS

4.SPOTTERS - 5 X 3 = 15 MARKS

5.RECORD -10 MARKS

SECOND SEMESTER				
Course code		**22PBAZC5**		
Name of the course		**PRACTICAL- II: CELL & MOLECULAR BIOLOGY , GENETICS AND ENVIRONMENTAL BIOLOGY**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CCP -VIII	**Core**	**4**	**3**	**40 + 60=100**

Course Objectives

- Understands the methods to focus the microscope and to calibration of ocular and stage micrometer
- Gain knowledge in the various types of histological sectional studies of tissues by viewing through prepared slides
- Preparation of polytene chromosome in chironomous larva to analyse the banding pattern
- Understands the normal karyotype and compares the changes to identify various syndromes through karyotype photographs
- Prepare and observe the chromosome arrangement during cell division
- Identifies some Menedlian traits and draws conclusion of gene pattern from a given population
- To analyse the various water samples to study the important ecological parameters and to interpret the significance.
- Know the parasitic adaptations of the organsims with respect to their environment

CELL AND MOLECULAR BIOLOGY

1. Histological study of transverse sections in mammalian tissues - Liver, Kidney, Brain, Muscle, Pituitary, Thyroid , Pancreas and Adrenal

2. Micrometry- Cell measurements using ocular and stage micrometer- Measurement of cell from any prepared slide

3. Mounting of salivary glands of Chironomous larva. Analysis of banding pattern in polytene chromosomes.

4. Demonstration of Squash preparation of grasshopper testis to study the stages of meiosis -To observe permanent prepared slides of meiotic stages.

5. Isolation and Spectrophotometric estimation of DNA and RNA from animal liver (goat / frog)

6.Flow cytometry technique (Demonstration)

GENETICS

1. Preparation of culture medium. Culture of Drosophila – Methods of maintenance.
2. Morphology of male and female drosophila - Sex identification of Drosphila- Sex comb and abdominal segment
3. Identification of mutant forms of Drosophila-
   White eye, Yellow eye, Ebony body, Yellow body ,Vestigeal wing

4. Identification of blood groups - A, B, AB, O and Rh and reasons for occurrence of particular blood group with reference to genotypes and phenotype probabilities

5. Localization of Barr body in the Buccal smear - squamous epithelial cells. (Smear to be made and the presence or absence of Barr body to be reported giving reasons).

6. Karyotype of human chromosome (Giemsa stained) -.Normal male and female chromosomes- (photographs)

7. Identification of chromosomal abnormalities in syndromes (Down, Klinefelter and Turner) from karyotype photographs

8. Problems relating to the application of binomial theorem in population genetics with reference to Ear-lobe attachment / Tongue rolling etc.

ENVIRONMENTAL BIOLOGY

1. Estimation of aquatic primary productivity – Dark and Light bottle.
2. Estimation of Nitrites, Phosphates, Calcium and Alkalinity in water samples (sea water, brackish water and tap water)
3. Analysis of industrial effluents - TDS, TSS, BOD and COD (Demonstration).
4. Collection, Isolation and identification of Planktons (Any three fresh water and marine planktons)
5. Adaptations of animals living in deep sea.

Field trip report to be submitted along with record note book for End semester practical examination

Text Books :

1.Chaitanya K.V 2013 Cell and Molecular Biology: A Lab Manual Prentice Hall India Learning Private Limited
2. S. A Abbasi and TasneemAbbai 2002 Water Quality Indices Elsevier Publishers

Reference Books:

1.M.M. Trigunayat 2019. A Manual of Practical Zoology: Biodiversity, Cell Biology, Genetics & Developmental Biology Scientific Publishers..

2.Kishore R. Pawar, Dr. Ashok E. Desai 2018 A book of mammalian histology, Nirali Prakashan

Web Resources

https://sjce.ac.in/wp-content/uploads/2018/04/Cell-Biology-Genetics-Labor
https://www.bjcancer.org/Sites_OldFiles/_Library/UserFiles/pdf/Cell_Biology

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Experiments with the calibration of microscope using ocular and stage micrometer and measures the cell, analyse the banding pattern of polytene chromosomes from Chironomous larvae and determines its cell significance	**K4,K5,K6**
CO2	Identifies the blood groups and determines the genotypes of blood groups based on alleles, identifies the barr bodies from buccal smear and interprets its genetic significance	**K3,K4**
CO3	Recalls the sectional view of histological tissues from prepared slides, gains knowledge on identification of Drosophila mutants , able to distinguish normal and abnormal chromosomes from karyotyping charts	**K3,K4,K5**
CO4	Determination of primary production using light and dark bottle techniques. Identification of Plankton and Marine Flora **:** Phytoplankton and zooplankton Identification of locally available macroalgae, sea grass and holophytes including mangrove plants.	**K2, K3, K4, K5**
CO5	Illustrate abiotic/biotic interactions and symbiotic relationships	**K1, K2**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3
CO2	3	2	2	3	2	3
CO3	2	3	3	2	2	2
CO4	2	3	3	2	2	2
CO5	2	2	3	2	2	2
Total of CO-PSO mapping	**12**	**13**	**14**	**12**	**11**	**12**
Average of CO-PSO mapping	**2.4**	**2.6**	**2.8**	**2.4**	**2.2**	**2.4**

PRACTICAL EXAMINATION

***Practical Examination will be conducted during the end of even semester (second and fourth). Each practical with 4 hours duration.**

MARK DISTRIBUTION (END SEMESTER PRACTICAL EXAMINATION)

PRACTICALS : 50 MARKS

RECORD: 10 MARKS

TOTAL 60 MARKS

Practical record to be submitted during the End Semester practical examination

QUESTION PAPER PATTERN FOR PRACTICALS

1.MAJOR PRACTICALQUESTION – 15 MARKS

2.MINOR PRACTICALQUESTION - 10 MARKS

3.MINOR PRACTICAL QUESTION- 10 MARKS

4.SPOTTERS - 5 X 3 = 15 MARKS

5.RECORD -10 MARKS

SEMESTER-III

THIRD SEMESTER				
Course code		**22PCAZC1**		
Name of the course		**BIOCHEMISTRYAND BIOPHYSICS**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC- IX	**Core**	**4**	**5**	**25 75=100**

Course Objectives

- Understands and gains knowledge on nature of chemical bonds
- Understand the structure and biological significance of carbohydrates, amino acids, proteins and lipids.
- Understand the concept of enzyme, its mechanism of action and regulation.
- enzyme activity and its kinetics
- To understand the metabolism of major biomolecules.
- To gain knowledge on pH, buffers, and other biophysical factors
- To understand the principles of thermodynamics and radiation biology

UNIT I: Biomembranes and Biomolecules (15 hrs)

Biomembranes - Molecular composition - Transport across cell membrane- Diffusion, active transport and ionic pumps - uniports, symports and antiport - Co-transport Membrane potential - Transport across epithelia.

Classification and structure of biomolecules (Carbohydrates. Proteins, lipids and Nucleic acids)

UNIT II: Enzymes and Protein metabolism (15 hrs)

Enzymes – Factors affecting enzyme action - Enzyme kinetics – Michaelis Menten Equation – Line weaver Burk equation - Mechanism and Regulation of enzyme action. Enzyme Inhibition- . Isozymes

Protein Metabolism- Deamination, Transamination, Transmethylation, Decarboxylation, Ornithine cycle.

UNIT III: Carbohydrate, Nucleotide and lipid metabolism (15 hrs)

Carbohydrate Metabolism- Glycolysis, Krebs cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, Bioenergetics - Respiratory chain, coupled reaction, group transfer, biological energy transducers. Oxidative phosporylation. Synthesis of ATP.

Nucleotide metabolism – Biosynthesis of purine ribonucleotides and Biosynthesis of pyrimidine ribonucleotides

Lipids - Essential fatty acids. Biosynthesis of cholesterol, Beta -Oxidation of fatty acids and its Energetics

UNIT IV: pH, Buffers, Diffusion and Osmosis (15 hrs)

pH and Acid - Base balance. Henderson - Hasselbach equation Acidosis, Alkalosis. Buffers – Buffer systems of blood- biological importance.

Fick's law of diffusion and diffusion coefficient - kinetics of diffusion - Biological significance in animals - Facilitated diffusion – Gibb's-Donnan equilibrium.
Osmosis- osmotic concentration and osmotic pressure - Vant Hoff's laws - Biological significance in animals

UNIT V: Thermodynamics and Radiation Biophysics (15 hrs)

Laws of thermodynamics, entropy, enthalpy, free energy - Reversible thermodynamics and irreversible thermodynamics systems – open, closed and isolated
Ionizing radiation, units of radioactivity, exposure and dose. Principle and applications of Autoradiography. Biological effects of radiation on macromolecules - Cellular effects of radiation- Application of radioactive tracers, radiation protection and therapy.

Text Books :

1.Jain, J.L. (2001) Fundamentals of Biochemistry. Chandra and Co. Pvt. Ltd. New Delhi.

2.Vasudevan, D.M and Sreekumar. (2000)Text of Biochemistry for medical students. Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi.

3.Rama Rao, A.V. 8.8. (1986) Text of Biochemistry. L.K. and Publishers. A. P.

4.Ambika, S. (1990) Fundamentals of Biochemistry for Medical Students.

5.Arora, M. P. 2007.Biophysics. Himalaya Publishing House, New Delhi

Reference Books:

1.Murray, R. K., Granner, D. K., Maynes, P.A. and Rodwell, V.W. (1998) Harper's Biochemistry. 25th edition. McGraw Hill, New York.

2.Bums, D.M. & MacDonald, S. G. G. (1979) Physics for Biology and Premedical students. Elbs and Addisson - Wesley Publishers Ltd., London.

3.Ackerman, E. 1962. Biophysical Science. Prentice Hall Inc., USA

4.Alonso, A., And Arrondo, J.L.R.2006. Advanced Techniques In Biophysics. Springer,UK

5.Edward, A.L. 1997. Radiation Biophysics. Academic Press,NY,USA.

6.Ernster, L. (Ed.). 1985. Bioenergetics. Elsevier, Newyork, USA.

7.Ghatak K.L. 2011.Techniques And Methods In Biology. PHI Learning Pvt. Ltd. New Delhi

Web Resources

https://chem.libretexts.org/Courses/University_of_Kentucky/UK%3A_General_Chemistry/07%3A_Chemical_Bonding_and_Molecular_Geometry

https://courses.lumenlearning.com/introchem/chapter/the-three-laws-of-thermodynamics/

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Assess the formation of chemical bonds , their types and nature. Explainsthestructureof proteins and understands Ramachandran plots	**K3,K4**
CO2	Understands the mechanismofenzymeaction,enzyme kinetics, derives the Michaelis-Menten and Line-Weaver Burk equation andidentifies the enzymeinhibition mechanism	**K2, K4,K5**
CO3	Correlates and discuss the carbohydrate, protein and lipid metabolic pathways and prepare a flowchart for biochemical processes, analysethecontrolsitesand keyfunctionsof regulatory enzymes in metabolicpathways	**K4,K5**
CO4	Understands and recalls the basic biophysical concepts and biophysical factors regulating cell functions	**K2,K3**
CO5	Understands the laws of thermodynamics and analyses the biological effects of radiation	**K3,K4**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	2
CO2	3	3	3	2	3	
CO3	3	3	2	3	3	2
CO4	2	3	3	3	2	3
CO5	3	2	3	2	3	2
Total of CO-PSO mapping	**14**	**14**	**13**	**13**	**14**	**11**
Average of CO-PSO mapping	**2.8**	**2.8**	**2.6**	**2.6**	**2.8**	**2.2**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

THIRD SEMESTER				
Course code		**22PCAZC2**		
Name of the course		**ANIMAL PHYSIOLOGY**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC -X	**Core**	**4**	**5**	**25 75=100**

Course Objectives

- Explain the functioning and regulation of various organs and organ systems
- Understands the physiology at cellular and system levels, process of digestion, nutrition and absorption of different biomolecules and the process of circulation
- Understands the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient and physiology related to stress
- Gains knowledge on the process of excretion and osmoregulatory mechanism
- Understands the process of muscle contraction, organization of neurons, synapse and process of nerve conduction.
- Understand the process of thermoregulation and bioluminescence

UNIT I : Digestion and Circulation (15 hrs)

Digestion - Digestive enzymes- Digestion and absorption in the gastrointestinal tract. Role of gastrointestinal hormones in digestion.

Circulation - Haemoglobin: structure and function -. Heart - Haemodynamics, origin and conduction of cardiac impulse. Pace maker , ECG, phases of cardiac cycle.

UNIT II : Respiratory and Stress physiology (15 hrs)

Respiratory physiology — Respiratory gases – uptake – respiratory pigments – O_2 and CO_2 dissociation curves – transport of respiratory gases. Pulmonary ventilation - Respiratory centres : organization and function.

Respiratory adjustments - hypoxia and oxygen therapy , dyspnoea . Adaptations at High altitude - mountain sickness and acclimatization

Stress Physiology - Basic concept of environmental stress and strain - stress resistance, stress avoidance and stress tolerance. Physiological response to oxygen deficient stress - Physiological response to body exercise - Meditation, Yoga and their effects

UNIT III : Excretory physiology and Osmoregulation (15 hrs)

Excretory physiology - Excretory products: synthesis and elimination.Mechanism of excretion – physiology- counter current mechanism - hormonal regulation- Concepts of homeostasis.

Physiological adaptation to osmotic and ionic stress; mechanism of cell volume regulation - Osmoregulation in aquatic and terrestrial environments.

UNIT IV : **Nerve and Muscle physiology** **(15 hrs)**

Neural physiology – Neurons – action potential – nerve impulse transmission — Synapse structure - synaptic transmission - neurotransmitters

Muscle physiology- Muscle contraction – Theories – Contractile proteins - Molecular mechanism of muscle contraction. Energetics of muscle contraction

UNIT V : Thermoregulation and Bioluminescence **(15 hrs)**

Thermoregulation in poikilotherms and homeotherms - Endothermy and physiological mechanism of regulation of body temperature. Bioluminescence: light producing organs in invertebrates and vertebrates- physiology and significance

Text Books :

1. Ganong: Review Of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
2. Guyton And Hall: Text Book Of Medical Physiology (10th Ed.), W.B. Saunders, 2001
3. Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
4. Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003

Reference Books:

1.Best And Taylor's Physiological Basis Of Medical Practice (11th Ed.), Williams and Wilkins,1981.

2.Eckert, R. Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company,New York.

3.Hochachka, P.W. and Somero, G. N. Biochemical Adaptation. Princeton, New York.

4.Hoar, W.S. General and Comparative Animal Physiology, Prentice Hall of India.

5.Schiemdt Nielsen. Animal Physiology: Adaptation and Environment. Cambridge.

6.Strand, F.L. Physiology: A regulation System Approach. Macmillan Publishing Co., New York.

Web Resources

www.physiologyweb.com
https://courses.lumenlearning.com>digestive system/Anatomy and Physiology

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Understand the various parts of the alimentary canal and the process of digestion, identifies the role of enzymes in the process of digestion. Traces the pathway of oxygenated and deoxygenated blood from the chambers of the heart and compare systemic, pulmonary and coronary circulation	**K2,K3,K4**
CO2	Explain the respiratory structures and outlines the transport of respiratory gases. Strategic planning to avoid stress and understands the importance of Yoga and meditation	**K2**
CO3	To understand the biophysical factors , mechanism of urine formation in the different regions of the renal tubules. To define and identify the adaptations of animals to osmoregulatory mechanism at different environments	**K1, K2,**
CO4	Interpret the different sections of neuron which regulate nerve impulse transmission and describes its mechanism, analyses the role of contractile proteins in muscle contraction process and the molecular events associated with contraction	**K1,K2, K4**
CO5	Distinguishes the temperature regulatory mechanisms between heterotherms, homeotherms and poikilotherms	**K4**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	2
CO2	3	3	3	2	1	2
CO3	3	3	3	2	2	2
CO4	3	3	3	2	2	2
CO5	3	3	3	2	2	2
Total of CO-PSO mapping	**15**	**15**	**15**	**11**	**10**	**10**
Average of CO-PSO mapping	**3**	**3**	**3**	**2.2**	**2**	**2**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low

2 – Medium

3 – High

0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

THIRD SEMESTER				
Course code		**22PCAZC3**		
Name of the course		**IMMUNOLOGY**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC- XI	**Core**	**4**	**5**	**25 75=100**

Course Objectives

- To study the scope and importance of immunology, immunity, antigens amd antibodies
- To emphasize on the immune cells, lymphoid organs and the functioning of the immune system.
- To obtain knowledge about hypersensitivity, autoimmunity and transplantation immunology
- Understands the major cellular and tissue components which comprise the innate and adaptive immune system.
- Understand how does the immune system distinguish self from non-self

UNIT I: Immnity, Antigens and Immunoglobulins (15 hrs)

Innate and Acquired Immunity - Organization and structure of lymphoid organs - Cells of the immune system and their differentiation - Lymphocyte traffic. Antigens- Epitopes, Haptens. Adjuvants, Immunogenicity. Antigenicity, Superantigens. Immunoglobulins – Structure, types, subclasses and biological function. Organization and expression of Ig genes- DNA rearrangements -Class switching

UNIT II: Antigen - Antibody interaction,Complement system and MHC (15 hrs)

Antigen - Antibody interaction (Precipitation, Agglutination, Opsonisation, Complement fixation, immunoflourescence). Complement system: Components, control proteins and activation pathways.Major Histocompatibility Complex in mouse and HLA system in human. MHC haplotypes - Class I and class II molecules - Cellular distribution and functions

UNIT III:T-cell and B- cell generation, activation, differentiation and response

(15 hrs)

T-cell- Molecular components and structure of T-cell receptor complex - T-cell maturation - T_{H-} cell activation mechanism - T- cell differentiation. B- cell – Cell types- B-cell receptors- B-cell proliferation, maturation and activation, T_H- B- Cell interactions Mechanism of humoral and cell mediated immune response. Antigen processing and presentation

UNIT IV: Immune Mediators, Hypersensitivity and Autoimmunity (15 hrs)

Cytokines - Salient features, Types, immune response, Cytokine receptors - Cell adhesion molecules - CTL and NK cells- Mechanism of action. Immunological tolerance – central, peripheral and acquired tolerance. Hypersensitivity: Types and immunological reactions Autoimmunity and autoimmune diseases

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UNIT V: Tumour immunology and Advances in Immunology (15 hrs)

Tumour immunology – Types and role of tumor antigens, immune response to tumour. Cancer immunotherapy. Transplantation immunology – Graft rejection, tissue typing, cross matching, immune suppression. Recent Advances in Production of vaccines – Recombinant antigen vaccine, Recombinant vector vaccine and DNA vaccine. Hybridoma technology-Monoclonal antibody-Production and applications

Text Books :

1. Janeway, C.A. and P. Travers. 1997. Immunobiology. Current Biology Ltd. London.
2. Paul, W.E. 1989. Fundamentals of Immunology. Raven Press. New York.
3. Srivastava, R., Ram, B.P. and Ty!e, P. 1991. Molecular mechanism of Immune regulation. VCH Publishers, New York.
4. Kuby Immunology, W.H. Freeman, USA

Reference Books:

1. Roitt, I.M. 1994. Essential Immunology. Blackwell Scientific, Oxform ISBN.
2. Richard, A Golds, Thomas J. Kindt & Barbara A. Osborne. 2000. Kuby - Immunology. Freeman and Co. New York.
3. D.P. Stites, A.I. Terr and T.G. Parsloio. 1997. Medical Immunology. Prentice Hall, New Jersey.

Web Resources

www.immunologylink.com
http://www.proimmune.com

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Describe the structure and functions of different types of cells and organs of the immune system, differentiate the biological characteristics of the antigens and antibodies, immunoglobulins	**K2 , K3**
CO2	Explain the different types of antigen-antibody interactions and their applications, understands the pathways of complement functioning	**K2, K3**
CO3	Understand how are immune responses by CD4 and CD8 T cells and B cells are initiated and regulated.	**K1, K3**
CO4	Differentiate various immunological responses and the ways in which they are triggered and regulated by immune molecules , describe the mechanisms of hypersensitivity reactions and auto immune reactions	**K1, K2,K4**
CO5	Recognise the types and mechanisms of vaccines, Summarize immune responses against pathogens, transplantation understands the steps in monoclonal antibody production and diagnosis of immune diseases.	**K2**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	1	2
CO2	3	3	3	3	2	1
CO3	3	2	3	3	2	1
CO4	3	3	3	3	2	1
CO5	3	3	3	3	3	1
Total of CO-PSO mapping	**15**	**14**	**15**	**14**	**10**	**6**
Average of CO-PSO mapping	**3**	**2.8**	**3**	**2.8**	**2**	**1.2**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

SEMESTER-IV

FOURTH SEMESTER				
Course code		**22PDAZC1**		
Name of the course		**DEVELOPMENTAL BIOLOGY**		
Course No	Course Category Core / Elective /EDS	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC- XII	**Core**	**4**	**6**	**25 + 75=100**

Course Objectives

- Develop critical understanding of embryonic development
- Understand the process of morphogenesis and organogenesis
- Understands the importance of stem cells
- To study the advanced technologies of assisted reproduction
- Demonstrate an understanding of the metamorphosis, regeneration and aging

UNIT I : Basic Concepts of Development (18 hrs)

Gametogenesis - Biochemical events and hormonal regulation of oogenesis and Spermatogenesis. Vitellogenesis. Molecular events of fertilization. Cell surface molecules in sperm-egg recognition in animals, Factors affecting cleavage and molecular changes during cleavage and gastrulation .

UNIT II : Morphogenesis and Organogenesis in animals(18 hrs)

Cell fate and Cell lineage. Establishment of symmetry. Embryonic fields – Role of genes in pattern formation in *Drosophila*. Organogenesis – Eye lens induction and limb development in frog, Organizer concept. Gradient theory and factors affecting gradients

UNIT III : Embryonic development and Stem cells(18 hrs)

Embryonic induction. Foetal membranes in mammals - Placenta – Classification based on distribution of villi and tissues. Implantation in mammals. Stem cells- Embryonic and Adult-Characteristics of stem cells. Stem cell therapy Applications of embryonic stem cells and Ethical issues

UNIT IV : Assisted Reproductive Technology and Contraceptives (18 hrs)

Male and female infertility-Sperm abnormalities – Superovulation –IUI, In vitro fertilization (IVF) and its significance., ICSI, GIFT, ZIFT- Multiple ovulation and embryo transfer technology (MOET). Contraceptives : Anti-androgen and anti-spermiogenic compounds (LDH-CY and SP-10), Immunocontraception.

UNIT V : Metamorphosis , Regeneration and Ageing (18 hrs)

Metamorphosis in Insects and Amphibia - Morphogenetic, biochemical mechanism, hormonal control and Environmental regulation. Regeneration in Vertebrates (Tail, limb, lens and retina) - Morphogenesis and hormonal control. Factors influencing regeneration Biology of Ageing – Senescence- Characteristics of Ageing and its Mechanism

Text Books :

1.Developmental Biology, S.F. Gilbert. 4th Edn. Sinauer Associates Inc. Publishers.

2.An Introduction To Embryology: Balinsky (1981) 5th Ed. (Cbs College Publishing).

Reference Books:

1. Developmental Biology. 2nd Edn. Leon W. Browwer Saunders Year College Publishing.
2. Principles of Developmental: Paul Weiss Edited By Hafner Publishers , New York.
3. Principles of Development: Lewis Wolpert Et Al. 1998. Oxford University Press.
4. Foundations of Embryology. B. M. Patten Year & B. M. Carlson. Tata Mcgraw Hill
5. Marshall's Physiology of Reproduction Longmont, Green & Co. London

Web Resources

http://www.visembryo.com/baby/index.html
http://www.sdbonline.org/
https://www.journals.elsevier.com/developmental-biology/recent-articles
https://www.the-scientist.com/tag/developmental-biology

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Comprehend and discuss important basic concepts in developmental biology and to relate the factors that contribute to the developmental process.	**K2,K6**
CO2	Describe the process of morphogenesis and organogenesis, along with the mechanism	**K2,K3**
CO3	Explains the concept of embryonic development, identifies the placental types, gains ability to analyse the fundamentals of stem cells	**K2,K4**
CO4	Discuss the recent trends in Assisted Reproductive Technology , and ethical issues associated with it. Gains knowledge on contraceptives	**K5,K6**
CO5	illustrate mechanisms of metamorphosis , regeneration and aging process with their relevant applications	**K2**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	3	2	2
CO2	3	3	3	2	2	1
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	2	2	2	1
Total of CO-PSO mapping	**15**	**14**	**14**	**13**	**12**	**8**
Average of CO-PSO mapping	**3**	**2.8**	**2.8**	**2.6**	**2.4**	**1.6**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FOURTH SEMESTER				
Course code		**22PDAZC2**		
Name of the course		**BIOTECHNOLOGY**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC- XIII	**Core**	**4**	**6**	**25 + 75=100**

Course Objectives

- To understand the steps involved in recombinant DNA technology
- To study the various types of cloning vectors and molecular tools
- Gains knowledge to venture new avenues molecular techniques in biotechnology
- To appreciate the applications of recombinant DNA technology in medicine, pharmaceutical , agriculture and environment management, etc
- To understand the techniques of animal cell culture , tissue engineering and gene therapy

UNIT I: Recombinant DNA Technology (18 hrs)

General strategy of recombinant DNA technology and gene cloning - Restriction enzymes and ligases. Genomic libraries - c-DNA libraries - Preparation of cDNA . Vectors in gene cloning - Types of vectors- Plasmids, cosmids, lambda phage vectors, shuttle vectors, YACS, BACS, Expression vectors in bacteria and eukaryotes, Cloning vector for mammalian cells - Simian Virus 40. Screening for transformants - Characterisation of transformants. Methods of Gene transfer technology into animal cells- Transgenic animals and its application

UNIT II: Molecular Techniques in Biotechnology (18 hrs)

DNA sequencing - Isolation and sequencing of DNA- Maxim- Gilbert, Sanger's dideoxy methods., PCR and its types, Molecular markers - RAPD, RFLP, AFLP - Techniques and its applications. Blotting techniques - Southern blotting, Northern and Western blotting and its application. DNA finger printing- Techniques and applications - Biochips and Biosensors

UNIT III: Organ and Embryo culture, **Cell linesand Gene therapy (18 hrs)**

Methods of Organ and Whole embryo culture Cell lines – Types, Maintenance and culture of cell lines. Somatic Animal cell fusion – Somatic Embryogenesis and Somatic Hybridization. Tissue Engineering- Artificial skin and cartilage. Human gene therapy- Types and Methods of gene therapy – Merits and Demerits

UNIT IV: Industrial biotechnology (18 hrs)

Design of bioreactor – Stages involved in fermentation process - Brief study. Fermentation products- Primary metabolites and Secondary metabolites . Production and industrial applications of primary metabolites with reference to vitamins, Organic acids, amino acids, Antibiotics , alcoholic beverages and steroids.

UNIT V: Enzyme biotechnology and Biotechnology regulations (18 hrs)

Enzymes technology - Industrial applications and uses of microbial enzymes. Immmobilized enzymes and applications. Biotechnology Regulations- Biosafety- Hazards of Genetically modified organisms (GMO's) and GM foods .

Text Books :

1. Purohit, S. S. and S. K. Mathur, (1999), Biotechnology: Fundamentals and Application. Agro Botanica, New Delhi. ISBN. 81-87167-IO-b.
2. R. C. Dubey, (2001). A text book of biotechnology, Rajendra Printer. New Delhi. ISBN. 81-219-09 16-3.
3. Sathyanarayana,U. (2006) Biotechnology Books and Allied (p) Ltd, India.

Reference Books:

4. Alan Scragg, (1999), Environmental Biotechnology; Long Mann Publication. ISBN. 0582 276829.
5. T.A Brown (1996) Gene cloning and DNA analysis. Blackwell science, Osney Mead, Oxford, OX20EL.

Web Resources

http://www.ncbi.nlm.nih.gov/
http://www.hhmi.org/biointeractive

http://www.environmentalbiotechnology.org/
http://www.biodesing.asu.edu

https://www.mybiosource.com/learn/gene-transfer-technique/

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Illustrate the structure of genetic molecules and develop novel genetic procedures for animal welfare To develop and explain the protocols for genetically manipulating cells and produce transgenic animals	**K4, K5,K6**
CO2	Describe emerging technologies in the field of biotechnology and explain the principles of molecular diagnosis.	**K3,K4**
CO3	To describe the methodologies for handling animal cells based on their diverse characteristics and identify the correct biotechnological tools for detecting diseases at the genomic level	**K2,K3,K4**
CO4	To evaluate and analyze the fermentation process and to obtain the desired products from the cells.	**K4,K5**
CO5	To speculate on the industrial applications of microbial enzymes, implications of biotechnological regulations and design ethical solutions	**K3,K5,K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	3
CO3	3	3	3	3	3	3
CO4	2	3	3	2	2	
CO5	3	3	2	1	3	3
Total of CO-PSO mapping	**14**	**11**	**14**	**12**	**13**	**11**
Average of CO-PSO mapping	**2.8**	**2.2**	**2.8**	**2.4**	**2.6**	**2.2**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FOURTH SEMESTER				
Course code		**22PDAZC3**		
Name of the course		**PRACTICAL- III: BIOCHEMISTRY, DEVELOPMENTAL BIOLOGY AND IMMUNOLOGY**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC -XIV	**Core**	**4**	**3**	**40 + 60 =100**

Course Objectives

- Gains knowledge to prepare buffers, determine pH and quantitative blood analysis to develop analytical skills in processing biological samples
- Understands the practical applications to analyse enzymes based on their kinetic properties
- Gains knowledge in the qualitative analysis of biochemical constituents in urine
- To demonstrate the principle and applications of centrifuge, spectrophotometer, chromatography and electrophoresis.
- Learn the various developmental stages of chick embryo , metamorphic stages of frog , organogenesis from permanent prepared slides
- Acquaints knowledge on identifying immune cells from peripheral blood
- Analyses the immunotechniques to study agglutination, prcepitin test and immunoelectrophoresis

BIOCHEMISTRY:

1. Buffer preparation and determination of pH.

2. Enzyme kinetics – any one enzyme (Salivary amylase)
   a. Preparation of standard graph for maltose
   b. Effect of pH on enzyme activity
   c. Effect of temperature on enzyme activity

3. Qualitative analysis of urine- Tests for glucose, albumin and ketone bodies

4. Quantitative determination of biochemical constituents in serum of goat or human / liver of fish / chick
   a. Glucose/ Total carbohydrates
   b. Total proteins
   c. Cholesterol
   d. Urea
   e. Creatinine

5. Principle, Working mechanism and Application of
   a.Centrifuge (Analytical centrifuge)
   b.UV -Spectrophotometer
   c.Electrophoresis (Agarose gel and PAGE)
   d.Chromatography (Thin layer and Column)

DEVELOPMENT BIOLOGY (slides /specimens /photographs)

1. Different stages in development - Insect (Drosophila) and Frog Metamorphosis
2. Yolk sac placenta of shark
3. Determination of gonadosomatic index and fecundity of fish
4. Frog Embryogenesis - Cleavage stages, blastula, gastrula, yolk plug and neurula
5. Development of chick stages - Observation of live chick embryo and vital staining of incubated egg-
6. Chick Embryogenesis – Primitive streak, 18, 24, 33, 48, 72, 96 hr development
7. Chick Organogenesis – T.S through heart, eye, brain of 48 and 72 hour chick embryos.
8. Slides / Photographs showing oestrous cycle stages in mammals (Rat)

IMMUNOLOGY

1. Lymphoid organ histology –Sections of Thymus, Spleen, Bone marrow, Lymph node.

2. Preparation of peripheral blood smear to study immune cells.

3. Seperation of lymphocytes- Demonstration

4. Haemagglutination - Qualitative analysis of antigen – antibody reaction using human blood group system

5. Detection of IgG by precipitation ring test

5. Immunoelectrophoresis – Precipitin arc formation - Demonstration.

Text Books :

1.Dr.Rashmi A. Joshi and Dr. ManjuSaraswat 2002 Text book of practical Biochemistry. Jain Publishers

2.Frank C. Hay Olwyn M.R. Westwood 2002, Practical Immunology Blackwell Publishing Company

3.Gibbs, 2006, A Practical Guide to Developmental Biology Ane/ Oxford Publication

Reference Books:

1.Geetha Damodaran. K 2016, Practical Biochemistry Jaypee Brothers, Medical Publishers. Pvt. Limited

2.Keith Wilson and John Walker 2002, Principles and Techniques of Practical Biochemistry, Cambridge University Press

Web Resources

https://paramedicsworld.com/biochemistry-practicals/demonstration-of-spectrophotometer

https://www.scribd.com/doc/53764085/immunotechniques

https://www.studocu.com/en-au/document/rmit/immunology/practical/practical-immunology-practicals/312007/view

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Develops skill in preparation of buffer and determining their pH , quantitative determination of biochemical constituents from blood samples,, demonstrates enzyme kinetics through simple laboratory experiments and summarize enzyme activity factors	**K6,K5,K2**
CO2	Demonstrate the principle and functioning of bioinstruments and discuss its applications	**K2,K3**
CO3	Identifies the stages of development in Drosophila and metamorphosis of frog, applies knowledge in identifying the developmental of chick and its process of organogenesis	**K3,K4,K5**
CO4	Perceives and distinguish the immune cells by blood smear preparation and classifies the lymphoid organs based on the sectional view through prepared slides and examines their immunological role in functioning of immune system	**K2,K3,K4**
CO5	Examine the various immunotechniques pertaining to separation of lymphocytes, precipitin test, immunoelectrophoresis and immunodiffusion and evaluates its importance in clinical diagnosis	**K4,K5,K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	2	2
CO2	2	2	3	2	2	3
CO3	3	3	2	2	3	3
CO4	2	3	2	3	3	2
CO5	3	3	3	2	2	3
Total of CO-PSO mapping	**13**	**13**	**13**	**11**	**12**	**13**
Average of CO-PSO mapping	**2.6**	**2.6**	**2.6**	**2.2**	**2.4**	**2.6**

PRACTICAL EXAMINATION

***Practical Examination will be conducted during the end of even semester (second and fourth). Each practical with 4 hours duration.**

MARK DISTRIBUTION (END SEMESTER PRACTICAL EXAMINATION)

PRACTICALS : 50 MARKS

RECORD: 10 MARKS

TOTAL: 60MARKS

Practical record to be submitted during the End Semester practical examination

QUESTION PAPER PATTERN FOR PRACTICALS

1.MAJOR PRACTICALQUESTION – 15 MARKS

2.MINOR PRACTICALQUESTION - 10 MARKS

3.MINOR PRACTICAL QUESTION- 10 MARKS

4.SPOTTERS - 5 X 3 = 15 MARKS

5.RECORD -10 MARKS

FOURTH SEMESTER				
Course code		**22PDAZC4**		
Name of the course		**PRACTICAL IV- ANIMAL PHYSIOLOGY, BIOTECHNOLOGY AND AQUACULTURE**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CC -XV	**Core**	**4**	**3**	**40 + 60=100**

Course Objectives

- Understand the physiological process of respiration through simple experiment to assess the RQ in fishes
- To understand the process of salt loss and salt gain in fishes
- To perform basic haematology experiments on clotting time, bleeding time and haematin crystal formation
- To impart knowledge in proving practical skills in biotechnology by understanding DNA isolation, plasmid isolation and blotting techniques
- To understand the instrumentation and importance of gene sequencer and PCR
- To attain knowledge in morphometry and meristic characters of fishes
- To identify commercially important fishes, prawns, oysters and crabs
- To observe and study the fishing crafts and gears, fish parasites

ANIMAL PHYSIOLOGY

1. Estimation of RQ in fish with reference to temperature
2. Salt loss and salt gain in fish- Hypertonic and Hypotonic medium.
3. Determination of Bleeding and clotting time
4. Rouleaux formation in RBC
6. Preparation of haematin crystals
7. Paper chromatography: Determination of amino acid in body fluids / tissue of sheep and calculation of Rf values.

BIOTECHNOLOGY- Visit to Biotechnology laboratory to observe the demonstration of

1. Procedure for Isolation of plasmids and DNA
2. Procedure for Digestion of DNA using restriction enzymes.
3. Instrument used in Biotechnology – Principles and Working mechanism
   a) PCR b) DNA Sequencer c) Blotting techniques (Southern, Northern and Western)

Necessary book may be referred to learn the techniques. Photographs and procedures to be recorded in the Record Note books. Lab visit report to be submitted along with record note book

AQUACULTURE

1. Morphometry and Meristic characters of bony fishes
2. Identification of any 3 Indian major carp, 3 marine water fishes and 2 brackish water cultivable fishes based on morphometric and meristic characters
3. Observation and identification of the following **(Photographs / specimens / Slides / Flash cards)**
    a. Commercially important cultivable species – Crab, Lobsters, Pearl oyster, Edible oyster, *Penaeus indicus*, *Penaeus monodon, Macrobrachium rosenbergii, Litopenaeus venamei*
    b. Larvivorous fish – *Gambusia affinis*, *Poecilia reticulata*
    c. Ornamental fishes – *Carassius auratus*, , koi carp, Black moly, Angel fish
    d. Live feed- Artemia, Brachionus, larval forms of shrimp
    e. Fish farm implements- Secchis disc, pH meter, Aerator, plankton net
    f. Gears and Craft- Cast net, Drag net, Bag net
    g. Sea weeds- Gracilaria sps, Saragassum sps
    h. Fish parasites- Lernaea, Argulus and Cymothoa

Text Books :

1.G.K. Pal Pravathi Pal 2006, Text book of Practical Physiology, Oriet Blackswan

Harisha. S. 2006. An Introduction to Practical Biotechnology Laxmi Publications

2.C.J. Hiware, R.T. Powar, J.M. Gaikward and S.R. Sonawane 2015, Classification and Identification of Fresh water Fishes Daya Publishing House

Reference Books:

1. S. Janarthanam 2007, Practical Biotechnology : Methods and Protocols. University press

Web Resources

https://www.kopykitab.com/An-Introduction-to-Practical-Biotechnology-ebook

http://www.fisheriesjournal.com/archives/2017/vol5issue6/PartC/5-6-17-154.pdf

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	To conduct experiment on fishes to understand the concept of RQ, salt loss and salt gain	**K2,K3,K4**
CO2	To perform haematology experiments and identify rouleaux and haematin crystals and also determine bleeding and clotting time	**K2,K3,K5**
CO3	Discovers the experimental procedures to perform blotting techniques, isolation of DNA , sequencing of DNA and PCR	**K2,K3**
CO4	Evaluates the morphometry and meristic characters of food fishes of fresh and marine water	**K5,K6**
CO5	Identifies and complies the economically important organisms exploited in aquaculture . Gains knowledge on the use of fish farm implements , fishing gears and crafts	**K3,K4,K5**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	2	2
CO2	2	2	3	3	3	3
CO3	3	3	2	3	2	3
CO4	2	2	3	2	2	2
CO5	3	3	3	2	3	3
Total of CO-PSO mapping	**13**	**13**	**14**	**12**	**12**	**13**
Average of CO-PSO mapping	**2.6**	**2.6**	**2.8**	**2.4**	**2.4**	**2.6**

PRACTICAL EXAMINATION

***Practical Examination will be conducted during the end of even semester (second and fourth). Each practical with 4 hours duration.**

MARK DISTRIBUTION (END SEMESTER PRACTICAL EXAMINATION)

PRACTICALS : 50 MARKS

RECORD: 10 MARKS

TOTAL: 60MARKS

Practical record to be submitted during the End Semester practical examination

QUESTION PAPER PATTERN FOR PRACTICALS

1.MAJOR PRACTICALQUESTION – 15 MARKS

2.MINOR PRACTICALQUESTION - 10 MARKS

3.MINOR PRACTICAL QUESTION- 10 MARKS

4.SPOTTERS - 5 X 3 = 15 MARKS

5.RECORD -10 MARKS

ELECTIVE COURSES

LIST OF ELECTIVE COURSES

ANY ONE TO BE CHOSEN (FIRST SEMESTER)

1. APPLIED ENTOMOLOGY

2. FISHERY BIOLOGY

FIRST SEMESTER				
Course code		**22PAAZE1A**		
Name of the course		**APPLIED ENTOMOLOGY**		
Course No	Course Category Core / Elective /EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC-I	**Elective**	**4**	**4**	**25 + 75=100**

Course Objectives

- Gain knowledge on the classification of insects based on their salient features
- To identify the insect pests affecting agricultural crops and suggest methods of control
- Understand silkworms rearing and their products.
- To understand the economics and maintenance of apiary management and lac cultivation
- Gain knowledge on pest management strategies.

UNIT I: Classification and Insect biology (12 hrs)

Outline classification- Classification of following insects – Apterygota (Order- Protura,Thysanura and Aptera) and Pterygota (order - Orthoptera, Hemiptera, Diptera, Hymenoptera, Lepidoptera, Coleoptera). Metamorphosis – ametabolous, holometabolus and hemimetabolous development. Insect Organization and structure

UNIT II: Insect pests of Agricultural crops (12 hrs)

Definition of pest- Types of damage- injuries and loss caused to plants - factors governing the outbreak of pests. Pests affecting agricultural crops. Paddy (Rice stem borer, Rice gall midge, leaf hoppers, Rice ear head bug), Sugarcane (Shoot borer, Stem borer, Top borer, White grubs), Groundnuts (Red hairy caterpillar, leaf miner, stem borer, Pod bug), Coconut (Rhinoceros beetle, Red palm weevil, Black headed caterpillar), Cotton (Cotton aphids, cotton leaf hopper, cotton thrips), Pulses (Gram pod borer, Spotted pod borer, Red pod fly)

UNIT III: Sericulture (12 hrs)

Mulberry and Non-mulberry silk worms- Biology of Bombyx mori . Grainage Technology-Procedures for seed Selection for rearing. Silk worm rearing-Chawaki rearing and Late age rearing techniques. Rearing appliances- Mountages- Types and importance . Composition of cocoons – Physical characters of commercial cocoons- Defective cocoons. Silk reeling and methods of silk reeling- Reeling appliances

UNIT IV-Apiculture and Lac culture (12 hrs)

Types of Honey bees for rearing- Bee rearing- Modern bee hive structure (Langstroth hive and Newton's hive) – Bee hive equipments. Honey extractor and extraction of honey, Chemical composition, nutritional and medicinal value of honey. Bee hive products (Bee wax, Bee venom, Propolis and Royal jelly). Lac culture-Host plants for lac insect. Cultivation of lac (Inoculation, Swarming and harvesting of lac). Processing of lac,. Economic importance of Lac.

UNIT V : Insects affecting human health and Methods of Pest Management (12 hrs)

Vector borne diseases-Methods of transmission of parasitic agents with special reference to mosquitoes, Tse-tse flies and sand flies- Disease caused , symptoms, prevention and control

Pest management strategies and tools : Control methods - Natural and artificial (Mechanical, Biological, Chemical, Cultural and Physical), Hormone analogs - Integrated Pest Management (IPM)

Text Books :

1. Nayar, K. K, Ananthakrishnan, T. Nand B. V. David. General and Applied Entomology. Tata McGraw Hill Publ., New Delhi. 1989.
2. Entomology and Pest Management. Larry, P. Pedigo Prentice Hall, New Jersey. 1989.

Reference Books:

1. The Science of Entomology. William S. Romoser and John G. Stoffolano. Wm. C. Brown Publishers, England. 1994.
2. The Silkworm. An important laboratory tool. By Yataro Tazima, Kodarsha, Scientific Book Ltd., Japan. 1978.
3. Sericulture Manual: FAD, Agricultural Service Bulletin, Rome.
4. Applied Entomology: P. G. Fenemore, Allaprakash, Wiley Eastern Ltd., Delhi. 1992.

5. Park, J. E and K. Park. Textbook of social and preventive medicine. Publ. Mis. Banarasides Bharol. Jabalpur.

Web Resources

https://www.karnataka.gov.in/sericulture/
http://www.epa.gov/

www.insects.orkin.com
www.nationalgeographic.org/topics/insects

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Categorize a few insects based on ecological, behavioural, morphological and developmental attributes Examine and identify the functional morphology of insects .	**K3,K4**
CO2	Identification of important pests affecting agricultural crops like paddy, sugarcane, cotton, groundnut and coconut and suggest preventive and control measures .	**K2,K3,K4**
CO3	Differentiates between mulberry and non- mulberry silkworms and their biology and evaluates the various factors required for silkworm rearing and formulates methods to identify silk quality for marketing	**K2,K6**
CO4	Understands to develop modern bee hives for apiary management, evaluates the value of honey and by products of honey bee colony, outlines the methods for lac cultivation	**K1,K5**
CO5	Identify the potential impact of a few common insect species on human health and society in general, Ables to formulate management strategies for controlling pest	**K3,K4,K5**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	-	1
CO2	3	3	2	2	1	2
CO3	3	2	3	2	3	3
CO4	3	2	1	3	2	3
CO5	2	3	1	3	1	1
Total of CO-PSO mapping	**14**	**12**	**10**	**12**	**07**	**10**
Average of CO-PSO mapping	**2.8**	**2.4**	**2**	**2.4**	**1.4**	**2**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FIRST SEMESTER				
Course code		**22PAAZE1B**		
Name of the course		**FISHERY BIOLOGY**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC-I	**Elective**	**4**	**4**	**25 + 75=100**

Course Objectives

- Understands the bionomics and classifies the groups of fishes
- Gain knowledge on reproductive biology of fishes
- Interprets the methods of fish growth
- Perceive the role of fishes in public health
- Acquire information about capture of fisheries in India

UNIT I: BINOMICS AND CLASSIFICATION (12 hrs)

Study of habit, food, feeding adaptations, growth, reproduction behaviour, fecundity and spawning of Indian major carps, three live fishes, three exotic fishes and six economically important marine fishes. Classification of the above fishes as in Day's volumes, or in Munro's volume or in FAO Publications.

UNIT II: REPRODUCTION BIOLOGY (12 hrs)

Role of hormones in reproduction - maturity stages - morphological and histological observation of gonads – Cryopreservation.

UNIT III: GROWTH STUDY (12 hrs)

Age determination - length-weight relationship - factors influencing growth - condition factor - tagging methods.

UNIT IV: FISH GENETICS AND IMMUNOLOGY (12 hrs)

Sex determination in fish – monosex production - hormonal and chromosomal methods - hybridization techniques in aquaculture - androgenesis and gynogenesis - fish immune system.

UNIT V: FISH AND PUBLIC HEALTH (12 hrs)

Diseases caused by fishes in man - prevention. Uses of fishes as biological control of diseases in man. Fish as food for human health.

Text Books :

1. Jhingran, C. G. (1981). Fish and Fisheries of India. Hindustan Publishing Co., India.

2. Maheswari. K. (1983) Common fish disease and their control. Institute of Fisheries Education, Powarkads (M.P)

Reference Books:

1. Baluyut, E. A. (1989). Aquaculture systems and Practices. A selected review Publishing House, New Delhi.
2. Chondar, A (1970). Handbook of breeding of Indian major carps by pituitary hormone injection. Agra Satisdh Book Enterprise.
3. Das M. C. and Patnaik, P. N. (1994). Brackish water culture. Palani paramount Publications, Palani, T. N.
4. Baluyut, E. A. (1989). Aquaculture systems and Practices. A selected review Publishing House, New Delhi.
5. Chondar, A (1970). Handbook of breeding of Indian major carps by pituitary hormone injection. Agra Satisdh Book Enterprise.
6. Das M. C. and Patnaik, P. N. (1994). Brackish water culture. Palani paramount Publications, Palani, T. N.

Web Resources

http://fishcount.org.uk/farmed-fish-welfare/development-of-intensive-fish-farming

http://www.fao.org/fileadmin/templates/SEC/docs/Fishery/cage/3DAAPM_en.pdf

https://www.tandfonline.com/doi/abs/10.1080/10641262.2010.535046

http://animal-world.com/encyclo/fresh/information/Diseases.htm

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Interprets the bionomics of economically important fishes and attempts to classify fishes based on identification characters	**K1, K2, K3, K4**
CO2	Compares the different phases of maturity in fishes	**K3, K4, K5**
CO3	Recognizes the stages of growth in fishes	**K2, K3, K4, K5**
CO4	Analyses the importance of fish in public health	**K1, K2, K3, K6**
CO5	Finds out the fishery zones and the types of fisheries in these zones	**K3, K4**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	2	2
CO2	2	3	3	2	2	2
CO3	2	3	3	2	2	2
CO4	3	2	2	3	3	3
CO5	2	2	2	3	3	2
Total of CO-PSO mapping	**12**	**13**	**13**	**12**	**12**	**11**
Average of CO-PSO mapping	**2.4**	**2.6**	**2.6**	**2.4**	**2.4**	**2.2**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)
Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

SECOND SEMESTER

ANY ONE TO BE CHOSEN

1. BIOINSTRUMENTATION

2. BIOPHYSICS

SECOND SEMESTER				
Course code		**22PBAZE2A**		
Name of the course		**BIOINSTRUMENTATION**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC- II	**Elective**	**4**	**4**	**25 + 75=100**

Course Objective

- Understand the purpose of the biological technique and its usage
- Learn the preparation of solution of given percentage and molarity, process of preparation of buffer.
- To distinguish between the functioning of different types of microscopes
- Understand the theoretical basis of centrifugation and spectrophotometric technique, its working principle and biological applications.
- Learn the techniques of separation of amino acids, proteins and nucleic acids by electrophoresis and non- volatile and volatile compound separation by chromatography
- Understand the technique of animal cell culture and immunotechniques

UNIT I : Measurements , Microscopy and Cytological techniques (12 hrs)

Units of measurements- Metric system, conversion to units, pH meter- Principal and applications.Microscopes - Principle, Working mechanism and applications of Electron microscope (SEM & TEM), flourescent microscope, phase contrast microscope, photomicrography. Cytological techniques -.chromosome banding techniques (G,C,Q,R. Banding). Flow cytometry - Flourescence in situ hybridization - (FISH)

UNIT II: Centrifugation and Spectrophotometry (12 hrs)

Centrifuge - Centrifugal force and Sedimentation coefficient, Types of Centrifuge- Principle of centrifugation – Analytical, differential centrifugation and density gradient centrifugation.Principles, working mechanism and applications of colorimeter and UV-visible spectrophotometer- Beer Lambert Law. Principle and application of Flame photometer. X-ray diffraction – Principle , working and applications

UNIT III: Chromatography and Electrophoresis (12 hrs)

Phases of chromatography- Principles and applications of chromatography: Paper, thin layer, column, Ion exchange , GC and HPLC.Electrophoresis: Factors involved in electrophoresis -Principles ,working and applications of Paper, Agarose gel, and SDS-PAGE.

UNIT IV:Histological and Cryopreservation Techniques (12 hrs)

Histological techniques- Principles of tissue fixation. Processing of tissues. Chemical fixatives , Fixation by freezing - Microtomy . Staining - Mechanism of staining and vital stains – Mounting. Histochemistry - Histochemical Localization- DNA, RNA, protein, lipid and carbohydrates. Cryotechniques - cryopreservation of cells, tissues, organs and organisms- freeze fracture and freeze drying

UNIT V : **Animal Cell culture and Immunotechniques (12 hrs)**

Animal Cell Culture – Requirements of animal cell culture laboratory – Substrates, culture media, in vitro animal cell culture techniques - cell viability testing (MTT assay). Principle and Applications of Immunotechniques- Immunodiffusion, Immunoelectrophoresis, ELISA (Direct, Indirect and Competitive), RIA, Immunodetection - Immunoblotting technique

Text Books :

1.Palanichamy, S and Shanmugavelu, M. (1991) Principles of Biophysics. Palani Paramount Publication, T. N.

2. N.Veerakumari –BioInstrumentation- MJP Publishers- TamilNadu Book House

Reference Books:

1.N.Gurumani 2006 - Research Methodology for Biological sciences- MJP publishers- TamilNadu Book House- Chennai

2.V.Kumaresan and N.Arumugam,2014. Animal Biotechnology, Saras Publication – Nagercoil

Web Resources

https://paramedicsworld.com/biochemistry-practicals/demonstration-of-spectrophotomete
https://www.scribd.com/doc/53764085/immunotechniques
https://www.ibiology.org/biology-techniques/

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Compareandcontrasttheprincipleandapplicationsof electron , flourscent and phase contrast microscopy	**K2, K3, K4, K5**
CO2	To understand the working principle of centrifugation and spectroscopy and its application	**K1, K2, K3, K4**
CO3	Apply the suitable bioanalytical techniques to separate and analyse biomolecules by chromatography and electrophoresis	**K2, K3, K4, K5**
CO4	Apply knowledge to learn techniques of histology and histochemistry	**K1, K2, K3 , K4**
CO5	To discover the techniques of animal cell culture and relate the applications for the study of animal cells, tissues. To identify and demonstrate the various immunotechniques	**K2, K3, K4, K5**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	3	2	2	2
CO2	2	3	3	2	2	2
CO3	3	3	3	2	2	2
CO4	2	3	3	2	2	2
CO5	3	3	3	3	2	2
Total of CO-PSO mapping	**12**	**15**	**15**	**11**	**10**	**10**
Average of CO-PSO mapping	**2.4**	**3**	**3**	**2.2**	**2**	**2**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

SECOND SEMESTER				
Course code		**22PBAZE2B**		
Name of the course		**BIOPHYSICS**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC- II	**Elective**	**4**	**4**	**25 + 75=100**

Course Objectives

- Understands the concepts of biophysics as an interdisciplinary subject where the application of basic physical concepts are integrated with biology
- Understands basic principles of diffusion and osmosis, its biological implications
- Gains knowledge on the biophysical aspects of the cell membrane and membrane transport mechanism
- Understands the laws of thermodynamics and bioenergetics
- Gains knowledge on radiation biology and nuclear medicine .

UNIT I: Basic concepts of biophysics (12 hrs)

Diffusion and osmosis - Diffusion -kinetics of diffusion - Fick's law of diffusion and diffusion coefficient - Biological significance in animals and plants. Electrochemical gradient - Stokes-Einstein equation and Graham's law - Facilitated diffusion - Gibbs-Donnan equilibrium. Osmosis- osmotic concentration and osmotic pressure - Van Hoff's laws - Biological significance of osmosis in animals and plants

UNIT II: Biophysics of cell membrane (12 hrs)

Biophysics of cell membrane - Physico-chemical properties of cell membrane - Conformational properties of cell membranes. Membrane transport – endocytosis, exocytosis - Nutrient transport across membranes, porins facilitated diffusion, porter molecules - Facilitated transport: symport, antiport, uniport,anion porter,glucose porter - Active transport: proton pumps, Na+ K+ pumps and Ca++ pumps, ionic channels - Artificial membranes

UNIT III: Bioenergetics (12 hrs)

Bioenergetics - Thermodynamics- laws of thermodynamics, entropy, enthalpy, free energy - Reversible thermodynamics and irreversible thermodynamics - Systems – open, closed and isolated. Photo-bioenergetics - Redox couple and redox potential. Chemo-bioenergetics: electron transport and oxidative phosphorylation - Chemiosmotic theory and binding change mechanism of ATP synthesis

UNIT IV: Radiation and its biological applications (12 hrs)

Radiation biophysics - Ionizing radiation, units of radioactivity, exposure and dose Interaction of radiation with matter – photoelectric effect, ion pair production, absorption and scattering of electrons. Biological effects of radiation: effect on nucleic acids, proteins, enzymes and carbohydrates - Cellular effects of radiation : somatic and genetic

UNIT V: Nuclear medicine and its application (12 hrs)

Nuclear medicine : internally administered radioisotopes - Radioiodine in thyroid function analysis, renal, liver and lung function analysis - Application of radioactive tracers, radiation protection and therapy.

Text Books :

1. Narayanan, P. 2000. Essentials Of Biophysics.New Age International (P) Ltd. Publishers, New Delhi.
2. Roy, R.N. 1996. A Textbook of Biophysics. New Central Book Agency (P) Ltd. Calcutta
3. Srivastava,P.K. 2006. Elementary Biophysics. An Introduction.Narosa Publishing House, New Delhi.

Reference Books:

1.Ackerman, E. 1962. Biophysical Science. Prentice Hall Inc. NJ, USA
2.Alonso, A and Arrondo, J.L.R.2006. Advanced Techniques In Biophysics.Springer,Uk
3.Arora, M. P. 2007.Biophysics. Himalaya Publishing House, New Delhi
4.Edward, A.L. 1997. Radiation Biophysics. Academic Press,NY, USA.
5.Ernster, L. (Ed.). 1985. Bioenergetics. Elsivier, New York, USA.
6.Ghatak K.L. 2011.Techniques And Methods In Biology. PHI Learning Pvt. Ltd. New Delhi
7.Gupta A. 2009. Instrumentation and Bio-Analytical Techniques. Pragatiprakashan, Meerut. 36
8.Hoope, W.. 1983. Biophysics. Springer Verlag, Berlin.
9.Lehninger, A.L.1971. Bioenergetics.

Web Resources

https://bit.ly/2XGFuML
http://www.life.uiuc.edu/molbio/geldigest/electro.html
http://users.stat.ufl.edu/~winner/sta6934/st4170_int.pdf

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Understands and gains basic idea on the biophysical concepts of diffusion and osmosis	**K2,K3**
CO2	Outlines the structure of the biomembranes and identifies their role in cell mediated transport mechanism	**K2,K3**
CO3	Distinguish between the first and second law of thermodynamics and identifies their application in bioenergetics processes	**K3,K4,K5**
CO4	Explains the biophysical concepts of radiation and summarizes the radiation effects on biomolecules	**K2,K3, K5**
CO5	Evaluates the importance of radioisotopes in nuclear medicine and its application	**K5,K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	3	2	3	2
CO2	2	2	2	3	2	3
CO3	3	3	2	3	2	3
CO4	2	2	3	3	2	3
CO5	3	3	2	2	3	2
Total of CO-PSO mapping	**13**	**12**	**12**	**13**	**12**	**13**
Average of CO-PSO mapping	**2.6**	**2.4**	**2.4**	**2.6**	**2.4**	**2.6**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

THIRD SEMESTER

ANY ONE TO BE CHOSEN

1. MOLECULAR AND HUMAN ENDOCRINOLOGY

2. MOLECULAR DEVELOPMENTAL BIOLOGY

THIRD SEMESTER				
Course code		**22PCAZE3A**		
Name of the course		**MOLECULAR AND HUMAN ENDOCRINOLOGY**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC-III	**Elective**	**4**	**4**	**25 + 75=100**

Course Objectives

- Gains knowledge to classify the hormones based on chemical nature and their mechanism of action
- Acquire knowledge of different pathways related to cell signalling and post receptor events
- Understands the integrated neural network between the hypothalamus and hypopophysial axis.
- Understand about the structural architecture, histological details of different endocrine glands, their physiological function and regulation of biochemical pathways
- Provides the basis of understanding their disorders and abnormal function of endocrine glands

UNIT I: **Chemical nature of hormones and mechanism of hormone action (12 hrs)**

Classification of hormones based on chemical nature. Hormonal feedback - Negative and positive feed back mechanisms through endocrine axis. Types of cell signalling (paracrine, autocrine and endocrine).

Signal transduction mechanisms- Mechanism of hormone action- Mechanism of action of peptide hormones - Membrane receptors, G-proteins and control of adenylate cyclase, PLC signaling pathways. Second messengers - Cyclic AMP cascade, DAG, Ca^{2+}, calmodulin activation- MAP kinase pathways. Mechanism of action of Steroid hormones.

UNIT II : **Hypothalamo-hypophysial system** **(12 hrs)**

Hypothalamic hormones- localization, chemistry and actions
Hypophysial hormones - Neurohypophysial and Adenohypophysial hormones: Chemistry and physiological roles. Pro-opiomelanocortin family of hormones (ACTH, MSH, β-LPH and β-endorphin). Disorders with reference to Gigantism, Acromegaly, Diabetes insipidus

UNIT III: Thyroid, Parathyroid and Pancreas **(12 hrs)**

Thyroid gland - Biosynthesis of thyroid hormones, Control of secretion and Biological functions – Disorders- Hypothyroidism, Hyperthyroidism
Parathyroid gland- Role of parathormone, calcitonin and vitamin D in calcium homeostasis
Endocrine pancreas- Chemistry of insulin. Physiological actions of insulin and glucagon, Diabetes mellitus

UNIT IV: Adrenal gland **(12 hrs)**

Adrenal cortex: Structure, Hormone secretion, Biosynthesis and Control of mineralocorticoid and glucocorticoid secretions. Physiological roles of glucocorticoids and mineralocorticoids
Adrenal medulla: Catecholamine biosynthesis, release and its physiological role.
Disorders with reference to Addisons disease and Cushing's syndrome

UNIT V: Testis and Ovary **(12 hrs)**

Testis: Organization and Hormone secretion – Chemical structure of testosterone. Physiological role of androgens
Ovary: Structure - Hormone secretion- Chemical structure of estrogens. Physiological role of estrogen, progesterone and relaxin. Hormonal control of ovulation in humans. . Hormones of placenta and pregnancy and their biological role

Text Books :

1. Hadley: Endocrinology, Prentice Hall. International Edition. 2000
2. Brooks And Marshall: Essentials Of Endocrinology, Blackwell Science. 1995

Reference Books:

1.Norris: Vertebrate Endocrinology (2nd Ed). Lea & Febriger. 1997
2.Turner And Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984
3.Larson: Williams Text Book Of Endocrinology, 10th Edition. W. B. Saunders Company, Philadelphia. 2002

Web Resources

https://www.cellsignal.com/contents/science/cst-pathways/science-pathways
https://archive.org/details/endocrinology00hadl/page/n5/mode/1up
https://www.toppr.com/guides/biology/chemical-coordination-and-integration/mechanism-of-hormone-action/

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Classifies hormones based on chemical nature and interprets the cell signalling mechanism based on hormone binding to cell surface receptors and nuclear receptors	**K2,K5**
CO2	Identifies the integration of the hypothalamus and hypophysis. List the biological functions of various anterior and posterior pituitary hormones and explains the causes of classical dysfunction of pituitary	**K1, K2,K5**
CO3	Compiles endocrine interaction towards physiological functions and related disorders of the thyroid, parathyroid and pancreatic glands	**K1,K2**
CO4	Assess the importance and coordination of adrenal cortex and adrenal medulla, distinguishes the difference between the regions of the adrenal, identifies the biological functions of the hormone secretions for normal function and dysfunction	**K1,K2,K3**
CO5	Understand and recalls the structural organization of reproductive organs the testis and ovary, identifies the reproductive cells involved in synthesizing hormones and analyse the normal levels of hormones that regulate reproductive functions and other physiological processes in human males and females	**K2, K3, K4**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	3	3	2	-
CO2	3	-	3	3	2	1
CO3	3	3	3	3	2	1
CO4	3	2	3	3	2	1
CO5	3	2	3	3	3	2
Total of CO-PSO mapping	**15**	**08**	**15**	**15**	**11**	**05**
Average of CO-PSO mapping	**3**	**1.6**	**3**	**3**	**2.2**	**1**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

THIRD SEMESTER				
Course code		**22PCAZE3B**		
Name of the course		**MOLECULAR DEVELOPMENTAL BIOLOGY**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC- III	**Elective**	**4**	**4**	**25 + 75=100**

Course Objectives

- Understands the regulation and interaction genes and cytoplasmic determinants and early development of embryonic structural and cellular organization in an organism
- Enhances the knowledge developmental pattern formation .
- Understands the intricate mechanisms of cellular behaviour during developmental process
- Understands and emphasize the roles of genes in controlling neurogenesis
- Understands the key signal transduction pathways
- Realize that very similar mechanisms are used in very diverse organisms; and development is controlled through molecular changes resulting in variation in the expression and function of gene networks

UNIT I: Axis and Pattern formation in animals (12 hrs)

Genomic equivalence and cytoplasmic determinants (cleavage, mid-blastula transition, gastrulation) - Axis and pattern formation in animals Early development of model organisms. Early development and axis specification in *Caenorhabditis elegans*, drosophila and amphibia

UNIT II: Genes in development (12 hrs)

Major Classes of Developmental Genes . Anterior-posterior, Dorsal-ventral and left right patterning in drosophila (maternal effect genes, zygotic genes, gap genes, pair rule genes, segment polarity genes, homeotic selector genes, realisator genes), anterior-posterior patterning in amphibia

UNIT III: Molecular basis of cell interactions (12 hrs)

Cellular interactions in development Hox code hypothesis..Nieuwkoop centre and mesodermal polarity. Molecular basis of mesoderm induction. Transcription factors induced in the organizer

UNIT IV: Role of genes in Neural induction (12 hrs)

Neural induction, regional specificity of induction, genetic specificity of induction (paracrine factors - hedgehog family, wnt family, tgf, bmp).Gene – phene relationship, autophene, allophene and pleiotrophy; teratogenic agents (retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals)

UNIT V: Receptor Biology and Signal transduction (12 hrs)

Surface receptors and signal transduction pathway - RTK pathway, SMAD pathway,WNT pathway, hedgehog pathway and cell death pathway.

Text Books :

1. Balinsky, B.I.2004. An Introduction To Embryology. W.B.Saundersco.,Philadelphia. Berril, N.J. 1979. Developmental Biology.Tata Mcgraw-Hill Pub.Co.Ltd.,New Delhi.
2. Gilbert, S.F. 2006. Developmental Biology (9thedn).Sinauer Associates Inc., Publishers, Masachusettes, USA

Reference Books:

1. Hopper, A.F. And Hart ,N.H.1985. Foundations of Animal Development. Oxford University Press, Oxford.

2. Lewis Wolpert. 2007. Principles of Development. Oxford University Press.Oxford Saunders, J.W.1982. Developmental Biology- Patterns, Principles And Problems. Macmillan Publishing Co.,New York.

3. Subramanian, T. 2002. Developmental Biology.Alpha Science Intetnational Ltd.,New Delhi

4.Sunstard,D.P., Simmons, M. J. And J.B Jenkins.1997. Principles of Genetics. John Wiley And Sons, New York.

5.Wolpert L. And C. Tickle. 2011. Principles Of Development.(4^{th} edn). Oxford University Press, Oxford, UK

Web Resources

https://www.ncbi.nlm.nih.gov/books/NBK10052/
https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html
https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/dvdy.20468
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293490/

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	To relate the factors that contribute to the early developmental process of axis specification in animals	**K1**
CO2	Outlinethe role of genes in patternformation and its molecularperspectives	**K2**
CO3	Identifies cell interaction process influencing embryonic development**.**	**K3**
CO4	Interpretthe roleof induction process and explain the importance of morphogens during developmental process	**K2,K5**
CO5	To correlate the involvement of specific cell surface receptors and mechanism of signaltransduction pathways encountered during developmental process	**K2**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2		1	1
CO2	2	3	1	2		1
CO3	3	3	2	1	2	1
CO4	3	2	3	2	2	
CO5	3	3	2	2	1	
Total of CO-PSO mapping	**14**	**13**	**10**	**07**	**06**	
Average of CO-PSO mapping	**2.8**	**2.6**	**2**	**1.4**	**1.2**	**0.6**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FOURTH SEMESTER

Elective IV and V

ANY TWO ELECTIVES TO BE CHOSEN

1.Research Methodology

2. Aquaculture

3.Human Genetics

4. Bio-Oceanography

FOURTH SEMESTER				
Course Code		**22PDAZE4A**		
Name of the course		**RESEARCH METHODOLOGY**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC-IV	**Elective**	**4**	**5**	**25 + 75=100**

Course Objectives

- Understand the concept of research and different types of research in the context of biology
- Develop competence on data collection and process of scientific documentation
- Develop laboratory experiment related skills and gains basic knowledge on qualitative research techniques
- Gains basic awareness of data analysis-and hypothesis testing procedures
- Evaluate the different methods of scientific writing and reporting and to analyze the ethical aspects of research

UNIT I: Concept and Types of Research (15 hrs)

Concepts of research - meaning, objectives, motivation and approaches- Characteristics of research, Types of research (descriptive/analytical, applied/ fundamental, quantitative/qualitative, conceptual/ empirical)

Research formulation- Features of good research design,

UNIT II: Identification of Research problem and Experimentation (15 hrs)

Defining and formulating the research problem- Development of a research plan Basic principles –Informal and formal experimental design. Sample designs- Characteristics and different types of sample design. Data collection techniques.Hypothesis- Null and alternate hypothesis, testing the hypothesis –Theory and principle

UNIT III: Literature review and Information resources (15 hrs)

Literature review - Importance of literature reviewing in defining a problem, identifying gap areas from literature review- Formulation of hypothesis.Sources of information - primary and secondary sources. Library-books, journals, periodicals, reference sources, Abstracting and indexing sources, reviews, monographs..Internet - Search engines, online libraries (Scopus. Medline, PubMed, Science direct), e-books, e-encyclopaedia, institutional websites

UNIT IV: Scientific documentation and Presentation techniques (15 hrs)

Scientific writing- characteristics. Logical format for writing thesis and papers. Essential features of abstract, introduction, review of literature, materials, methods, and discussion. Effective illustration- table and figures. Reference styles- Harvard and Vancouver systems.Project proposal writing, Research report writing (research articles, oral communications). Presentation techniques - Assignment, seminar, debate, workshop, colloquium, conference. Computer aided techniques for data presentation, data analysis, statistical techniques

UNIT V: Laboratory safety, Animal Ethics and IPR (15 hrs)

Safety and precaution - ISO standards for laboratory safety, laboratory protocols. Laboratory animal use - Care and Welfare, Animal house maintenance Extension studies : Lab to field, extension communication and extension tools. Bioethics: Working with man and animals - consent - animal ethical committees and constitution. Intellectual Property Rights (IPR) - copy right, designs, patents, trademarks, Geographical Indications(GI).

Text Books :

1. N.Gurumani 2006- Research Methodology for Biological sciences- MJP publishers- TamilNadu Book House- Chennai
2. Palanichamy, S and Shanmugavelu, M. (1991) Principles of Biophysics. Palani Paramount Publication, T. N.
3. Research Methodology Methods and Statistical Techniques- Santosh Gupta.
4. Research Methodology Methods and Techniques- C.R. Kothari.
5. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons

Reference Books:

1.Ahuja,V.K. 2010. Law Of Copy Rights And Neighbouring Rights : National And International Perspectives..Lexis Nexis- Butterworths Wadhwa, Nagpur Ahuja,V.K. 2007.
2.Law Relating To Intellectual Property Rights. Lexis Nexis-Butterworths Wadhwa, Nagpur. Anitha Goel.2010
3.Scientific Research Methodology. Narosa Publishing House, New Delhi Finney ,D.J. 1980.
4.WHO.2011. Laboratory Quality Standards And Their Implementation. WHO Regional Office. New Delhi.

Web Resources

https://research-methodology.net

https://www.researchgate.net

https://socialresearchmethods.net

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Understand and gains knowledge on concept and types of research	**K1, K2, K5, K6**
CO2	Applies knowledge to identify research problem, create an experimental research design and integrate the bioanalytical techniques and statistical methods to validate research investigations	**K2, K3, K4, K5**
CO3	Understand the methods to compile literature and information needed for research	**K1, K2, K5, K6**
CO4	Obtain information on scientific methods, scientific writing, relevant to research, publishing and presentation strategies	**K2, K3, K4, K6**
CO5	To understand the safety guidelines in laboratory, the need for patenting, piracy and bioethics	**K1, K3, K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	2	2	2	1
CO2	3	3	3	2	2	2
CO3	2	3	3	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	2	2	3
Total of CO-PSO mapping	**13**	**14**	**14**	**11**	**11**	**11**
Average of CO-PSO mapping	**2.6**	**2.8**	**2.8**	**2.2**	**2.2**	**2.2**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FOURTH SEMESTER				
Course code		**22PDAZE4B**		
Name of the course		**HUMAN GENETICS**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC- IV	**Elective**	**4**	**5**	**25 + 75=100**

Course Objectives

- To gain an indepth understanding on chromosomal karyotyping
- To unravel the mechanisms that controls pattern of inheritance
- To gain understanding on the genetic disorders
- To gain intensive and indepth knowledge genes and environment
- Develop an understanding of how cells work in healthy and diseased states and to give a health forecast by analyzing the genetic database
- To highlight the importance and need genetic counseling, prenatal diagnosis of genetic diseases and therapeutic measures

Unit – I : Human Chromosomes and Karyotyping (15 hrs)

Human chromosomes: preparation of human Chromosome complement; Banding techniques; Karyotype preparation; classification; application. Chromosome mapping; cytological maps; cloning and gene arrangement.

Unit – II : **Inheritance(15 hrs)**

Human genome project; Social ethical and legal implications. Modes of inheritance; Pedigree charts; construction of pedigree charts for autosomal dominant and recessive traits, sex linked recessive traits and Y linked trait. Gene therapy, Cancer and genes; protocogenes, oncogenes; BRAC genes.

Unit – III Genetic Disorders (15 hrs)

Common genetic disorders: Metabolic blocks in phenylalanine metabolism albinism. Genetic cause, diagnosis and treatment of the following disorders – thalassemia and sickle cell anemia, Haemophilia, muscular dystrophy, Diabetes and hypertension. G6PD and favism – Primaquine sensitivity. Congenital defects – Critical period in fetal development - chromosome anomalies and spontaneous absorption.

Unit – IVGenes and Environment(15 hrs)

Genes and mental illness; Schizophrenia and psychosis, self-multilation and Lesh Nyhan syndrome. Immunogenetics: Antibody diversity; histocompatiblity; HLA genes. Heritability and Environment: Twin studies and impact of environmental factors on heredity. DNA polymorphism – DNA profiling and applications. Dermatoglyphics and genetic analysis.

Unit – V : **(15 hrs)**

Genetic counseling – Determining risk; consanguinity; Teratogen; age 35 threshold; strategies – Prenatal diagnosis: Ultrasound scanning; Amniocentesis; Chronic villus sampling; AFP Test; Triple test; genetic screening; options available. Management of genetic disorders: Therapeutic measures;

Text Books :

Cummings, M. R. (2012). Human Heredity – Principles and issues.(10th ed.) Canada: Thomson Brooks/Cole
Gardener A and Daves T. (2012). Human Genetics. (2nd ed.). New Delhi: Viva Books.
Hartl, D. L. (2013). *Essential Genetics* & Genomics. (7th ed.). USA: Jones & Bartlett Learning.
Kelly, E. B. (2013). *Encyclopaedia of Human Genetics & Diseases. Volumes I & II.* Connecticut: Greenwood Publishing House.
Klug, W. S., Cummings, M. and Spencer, C. (2018). *Concepts of Genetics*.(12th ed.). New Jersey: Pearson Education

Reference Books:

1.Edlin.G. (1984) Human Genetics, Jones and Bartlett publishers, Boston. Reference Books
2.Elane Mangae and Mangae (1993), Human genetics. Freeman and company.
3.Ricki. L. (1994) Human Genetics. WCB Publishers.
4.Sam Singer (1985) Human Genetics, Freeman and Company, New York.
5.Ursula Good enough (1985) Genetics. Holt Reinhart and Winstan New York

Web Resources

www.ncbs.res.in
www.omim.org

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Develop an understanding to discover the karyotyping of chromosomes	**K4,K5**
CO2	Demonstrateand gains abilityto construct pedigree charts and study patterns of inheritance	**K3,K4**
CO3	Findsout thevarious metabolicdisordersand identify thetherapiesforitsmanagement, outlines the genes related tocancer.	**K2,K3,K4**
CO4	Identifies genes involved in controlling mental health and immune health	**K3,K4**
CO5	Understands the need for geneticcounselling and developtoolsto diagnose prenatal genetic abnormalities	**K4,K5,K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	2
CO2	2	3	2	3	2	3
CO3	3	2	3	2	3	3
CO4	2	2	3		2	2
CO5	3	2	2	3	2	3
Total of CO-PSO mapping	**13**	**12**	**12**	**11**	**12**	**13**
Average of CO-PSO mapping	**2.6**	**2.4**	**2.4**	**2.2**	**2.4**	**2.6**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FOURTH SEMESTER				
Course code		**22PDAZE5A**		
Name of the course		**AQUACULTURE**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC- V	**Elective**	**4**	**5**	**25 + 75=100**

Course Objectives:

- To study the fishery resources of the world.
- Understand the culture techniques of prawn, pearl and fish.
- To emphasize on economically important fishes and their nutritive value.
- To study the different culture methods, preservation techniques and fishery management.

UNIT I: Aquaculture and Aquaculture farms (15 hrs)

Importance of aquaculture- Present status, prospects and scope in India. Fresh water aquaculture- Brackishwater aquaculture- Mariculture - Metahaline culture in India. Types of fish culture – Types of fish ponds for culture practice. Topography, site selection – water quality - soil condition and quality – structure and construction design and layout - inlet and outlet. Water quality management for aquaculture. Control of parasites, predators and weeds in culture ponds. Fish farm implements - Secchi disc - aerator - pH meter - tools for hypophysation - feeding trays.

UNIT II: Fish seed and feed production, Hatchery techniques for freshwater organisms. (15 hrs)

Procurement of seed from natural resources- collection methods and segregation. Hatchery technology for major carps and freshwater prawn. Artificial seed production –Breeding under control conditions, induced breeding technique, larval rearing, packing and transportation- Commercial substitute for pituitary extracts. Classification of fish feed- Artificial feeds- Types, Feed - formulation - feeding methods. Live feed- Microalgae, Rotifer, *Artemia* and their culture.

UNIT III: Brackish water aquaculture and Mariculture (15 hrs)

Shrimp hatchery technology – Hatchery design, brood stock management, spawning, larval rearing, algal culture, packing and transportation. Shrimp culture technology – Culture operations (water quality, feed and health management) - harvesting, preservation and marketing.

Brackish water fish culture. Edible and Pearl oyster culture - pearl production.Crab culture. Economic importance of Lobster, sea urchin and sea cucumber - their by-products. Types of seaweeds - species and methods of culture – by-products.

UNIT IV : Fish Diseases and Management (15 hrs)

Fish and shrimp diseases and health management – infectious diseases - Bacterial, Fungal, Viral, Protozoan; Non-infectious - environmental and nutritional diseases. Diseases diagnosis, prevention and control measures.

UNIT V: Fishing crafts and gears andFisheries marketing (15 hrs)

Different types of crafts and gears for fishing , Preservation and processing of fish. By products of fish industry & their utility, Fisheries economics and marketing. Fisheries management and extension. Central aquaculture research organizations- CMFRI, CIBA, CIFRI, CIFA, CIFE, CIFT,MPEDA and its activities

Text Books :

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

Reference Books:

1. Das M. C. and Patnaik, P. N. (1994) Brackish water culture. Palani paramount Publications, Palani, T. N.
2. Day, F (1958). Fishes of India , VoL I and Vol. II. William Sawson and Sons Ltd., London.
3. Jhingran, C. G. (1981). Fish and Fisheries of India. Hindustan Publishing Co., India.
4. Maheswari. K. (1983) Common fish disease and their control. Institute of Fisheries Education, Powarkads (M.P).
5. Michael, B. N. and Singholka, B.(1985). Freshwater Prawn Farming: A manual of culture of *Macrobrachium rosenbergii*. Daya publishing House, New Delhi.
6. Paul Raj S. (Ed.) (1995). Shrimp farming techniques, problems and solutions. Palani Paramount Publications, Palani, T. N.

Web Resources

http://fishcount.org.uk/farmed-fish-welfare/development-of-intensive-fish-farming

http://www.fao.org/fileadmin/templates/SEC/docs/Fishery/cage/3DAAPM_en.pdf

https://www.tandfonline.com/doi/abs/10.1080/10641262.2010.535046

http://animal-world.com/encyclo/fresh/information/Diseases.htm

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	To develop knowledge on the fish farm and their maintenance.	**K5,K6**
CO2	Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques	**K4,K6**
CO3	To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval culture.	**K3,K5,K6**
CO4	Identifies the different fishes diseases, diagnosis and their management strategies	**K3.K4**
CO5	Analyses the various fishing crafts and gears and develops knowledge on fish marketing modalities	**K4,K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	2
CO2	2	3	3	2	3	3
CO3	3	3	2	3	3	3
CO4	2	2	3	2	2	2
CO5	3	3	2	3	3	3
Total of CO-PSO mapping	**13**	**14**	**12**	**13**	**14**	**13**
Average of CO-PSO mapping	**2.6**	**2.8**	**2.4**	**2.6**	**2.8**	**2.6**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low

2 – Medium

3 – High

0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

FOURTH SEMESTER				
Course code		**22PDAZE5B**		
Name of the course		**BIO-OCEANOGRAPHY**		
Course No	Course Category Core / Elective / EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC- V	**Elective**	**4**	**5**	**25 + 75=100**

Course Objectives

- To explore the life of organisms inhabiting the marine ecosystem
- Understands the physical properties and chemistry of sea water
- Gains knowledge on the adaptations of organisms inhabiting the intertidal habitat
- Understands the primary biotic divisions of the sea and the distribution of organisms
- Perceives idea on the marine microbes and suggests methods for coastal zone management

UNIT I: Physical Oceanography (15 hrs)

Physical oceanography - Physical properties: light, temperature, salinity, density and pressure distribution in the oceans - Thermal and optical properties of sea water - Water masses - currents: general characteristics, effects of fields of pressure, gravity and mass - Relative currents, wind currents, upwelling and sinking - Tides: tide-producing forces and tide characteristics - Circulation patterns and currents in the Indian ocean - Major currents of the world oceans - Ocean-land-atmospheric interactions: monsoons, cyclones, anticyclones - Oceanography – remote sensing techniques

UNIT II: Chemical Oceanography (15 hrs)

Chemical oceanography - Chemistry of the sea water constancy of the composition of sea water - Salinity and chlorinity, pH and carbon dioxide systems in the sea water - Chemistry of the land-locked seas and estuaries - Distribution of gases in the sea - Distribution of nutrients and their cycles – Eutrophication - Dissolved and particulate organic matter in the sea: its chemical nature and properties

UNIT III: Marine Ecology (15 hrs)

Marine ecology - The shore environment - Physico-chemical and biological factors of intertidal zone - Distribution of life on rocky shores, sandy shores and muddy shores - Zonation and adaptation of organisms in the intertidal habitats - Zoogeography of the marine environment with special reference to the indo-west pacific - Coral reef ecology: special features of coral reef habitats and distribution of coral reef organisms - Mangrove systems: special features of mangrove habitats and distribution of plants and animals in mangrove ecosystems - Benthos: distribution of shallow water benthic organisms - Distribution and adaptation of deep-sea benthic organisms - Hadal fauna - Marine animal associations: commensalisms symbiosis and parasitism

UNIT IV : Biological Ocaenography (15 hrs)

Biological oceanography - The sea as a biological environment: classification of marine environment - General characters of the populations of the primary biotic divisions (plankton, nekton and benthos) - Introduction of plankton; general classification and composition of plankton - Floating mechanism of plankton - Plankton in relation to fisheries; general account. - distribution of plankton in space and time, horizontal distribution; neritic and oceanic plankton; geographical distribution - Indicator species - Vertical distribution of plankton, vertical migration ; seasonal changes in plankton - Nutrition in marine organisms

UNIT V : Marine Microbiology and Coastal zone Management (15 hrs)

Marine microbiology - Marine bacteria: general account of their role in the economy of the sea. Coastal zone management - Coastal resources i.e. finish, shellfish and non-living resources and their management - Impact of dredging, mining and pollution on coastal habitats and their management methods - Remote sensing application in coastal zone management - Coastal zone regulations

Text Books

1. Angel, M.V.Biological Oceanography, Methuen, 1975
2. Friendrich, H., Marine Biology Sidgwick & Jackson, 1969.
3. Ekman, S., Zoogeography Of The Sea, Sidgwick & Jackson, 1953.
4. Parsons, T.R. Takahashi, M. And B. Hargrave, Biological Oceanographic Processes

Reference Books

1. Tait, R.V.,Elements of Marine Ecology, 2nd Edition, Butterworths, 1972.
2. King, C.A.H., Introduction to Physical and Biological Oceanography, Elbs Ltd., London, 1975.
3. J.R.Clark, Integrated Management of Coastal Zones, Fao Fish Tech, Rep. Paper 327, 1992.
4. R.W.G. Carter, Coastal Environment, Academic Press, 1989.
5. Ekman S., Zoogeography of the Sea, Sidgwick and Jackson, 1977.
6. Kinne O. (Ed), Marine Ecology Vol. I To V.John Wiley and Sons, 1980-1985

Web Resources

www.life.bio.sunysb.edu/marinebio
www.worldoceanobservatory.org/content/online-resources-marine-biology

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Identifies the physical , thermal and optical properties of an ocean	**K1, K2**
CO2	Outlines the chemistry of sea water and organic matter in sea	**K2, K3, K4**
CO3	Explain the marine ecological zones of the ocean , examines the special features of coral reefs and mangroves	**K1, K2, K4**
CO4	Classifies the marine environment and identifies the marine organisms inhabiting the biotic divisions	**K2, K4, K5**
CO5	Interprets the microbes of the marine environment and selects methods for the management of coastal zones	**K3, K4, K5**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2	2	2
CO2	2	3	3	2	2	2
CO3	3	3	3	2	2	2
CO4	2	2	3	2	3	2
CO5	2	3	3	2	2	2
Total of CO –PSO mapping	**12**	**14**	**14**	**10**	**11**	**10**
Average of CO-PSO mapping	**2.4**	**2.8**	**2.8**	**2**	**2.2**	**2**

Level of Correlation between PSO's and CO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

EXTRA DISCIPLINE COURSES

SECOND SEMESTER				
Course code		**22PBAZD1**		
Name of the course		**BIOSTATISTICS AND BIOINFORMATICS**		
Course No	Course Category Core / Elective /EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
EDC - I	**Extra Discipline Course**	**4**	**3**	**25 + 75=100**

Course Objectives

- Know the applications and limitations of different bioinformatics and statistical methods.
- Know basic concepts of data representations, descriptive and inferential statistics.
- To understand hypothesis testing, correlation and regression analysis for experimental data
- Acquire knowledge of various databases of proteins, nucleic acids
- understand the characteristics and categories of structural databases and to work with some important bioinformatics data analysis tools

UNIT I: Data representation, Descriptive and inferential statistics (9 hrs)

Collection and representation of data- Graphical and diagrammatic representation of data

Measure of central tendency- Arithmetic mean - computation for (ungrouped , discrete and continuous frequency distributions) – median and mode. Measures of dispersion- Standard deviation –Computations and Interpretations. Standard errors (SE of the mean) computation- Coefficient of variation. Theoretical Probability distribution- Normal, Poisson, Binomial distribution- Applications (computation required)

UNIT II: Hypothesis testing and Test for significance (9 hrs)

Hypothesis testing - Null hypothesis - level of significance - degrees of freedom - types I and II errors. Test of significance: Chi-square test for goodness of fit, homogeneity and association between attributes (problem relating to Genetics, patterns of distribution etc. to be worked out). Student's 't' test- Applications- Test of significance T-tests (one sample t-test, two sample t-test, paired t-test).ANOVA- One way - Principle and applications , F test for comparing variance.

UNIT III: Correlation and Regression (9 hrs)

Correlation: Definition and types - simple, multiple, partial, linear, nonlinear, mutual, cause and effect, etc. Uses of scatter diagram and correlation graph (correlation between two variables). Computation of Karl Pearson's Co-efficient of correlation - testing its significance - Interpretation. Rank Correlation

Regression analysis: derivation of regression equations between two variables- regression coefficient - construction of regression lines - properties - applications

UNIT IV –Biological databases and Bioinformatic tools (9 hrs)

Introduction and Scope of Bioinformatics - Information networks in bioinformatics- Biological databases – Nucleic acid databases (GENBANK, EMBL, DDBJ) - Protein sequence data bases (PIR, TrEMBL, SWISS PROT, UniPROT), Bioinformatic tools - Homology and similarity search tools - BLAST, FASTA, CLUSTAL W - phylogenetic tool - PHYLIP. Sequence alignment - Global and local alignment - pair wise and multiple sequence alignment

UNIT V-Protein structure, **Molecular phylogenetics and Biomolecular visualization tools (9 hrs)**

Primary, Secondary, Tertiary and Quartenary structure of proteins. Conformation of proteins (Ramachandran plot, domains, motif and folds). Stability of proteins
Protein structural databases - MMDB, FSSP, SCOP and CATH.
Molecular phylogenetics- Construction of phylogenetic trees.
Biomolecular structural visualization tools -RASMOL, SWISS PDB viewer. Data base submission - Data Retrieval systems- Locus Link, SRS, PubMed, Entrez

Text Books :

1.Introductory Statistics For Biology. 3rd Edition (1979) R. E. Parker, Publisher-Edward Arnold Ltd. Statistics And Experimental Design 2nd Edition (1980). G. M. Clarke. Publisher-Edward Arnold Ltd.
2.Research Methodology Methods And Statistical Techniques- Santosh Gupta.
3.S.C. Rastogi, Mendiratta, P. Rastogi. 2005. Bioinformatics: Method & Applications. Genomics, Proteomiocs & Drug Discovery. Prentice Hall Of India, New Delhi.
4.Veerakumari L., 2006. Protein Sequencing In Bio Informatics Bioinstrumentation, MJP Publ. Chennai

Reference Books:

1.Biostatistical Analysis. 5th Edition (2008). J. H. Zar. Publisher-Pearson Education Inc. And Dorling Kindersley Publishing Inc.

2.Statistical Methods. 6th Edition (1967). G. W. Snedecor And W. G. Cochran. Publisher-Oxford Andibh Publishing Co.

3.Atwood And Parry-Smith. 2001. Introduction To Bioinformatics. Pearson Education Asia, New Delhi. Baxevanis and Ouellette.
4.Bioinformatics - A Practical Guide To The Analysis Of Genes And Proteins, Wiley, New York. Mount, 2001.
5.Bioinformatics: Sequence And Genome Analysis. Cold Sprint Harbour Laboratory Press, New York
6.Pevsner, J. (2009). Bioinformatics And Functional Genomics. Ii Edition. John Wiley & Sons

Web Resources

https://www.roseindia.net/bioinformatics/bioinformatics_resources.shtml
https://www.od.baumedicine.com/biostatistics

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Demonstrates,analyze andmeasurethedescriptive statisticsanddevelops skillsindiagrammaticrepresentations of statistical data	**K2,K3, K4,**
CO2	Describe statistical methods and probability distributions, Analyze the importance of probability and student's - t-Test,Evaluatethe statisticalproblem using chi-square andF-test. and to applystatistics andfindsolutioninsolvingresearch problems	**K1.K2,K4,K5**
CO3	Relate,organizeandexamine thecorrelation and regressionanalysesamongvariousdata	**K2.K3,K4**
CO4	Explore the biological databases, retrieve and visualize biological data stored in the databases and to describe the data meaningfully using bioinformatics tools	**K4,K6**
CO5	Analyze the properties of gene and protein sequences and deduce their functions, structure and evolutionary relationships , Make phylogenetic predictions or prediction of structure of proteins and nucleic acids	**K2,K3,K4 ,K6**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	2	2
Total of CO –PSO mapping	**15**	**15**	**15**	**15**	**11**	**11**
Average of CO-PSO mapping	**3**	**3**	**3**	**3**	**2.2**	**2.2**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low
2 – Medium
3 – High
0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75

THIRD SEMESTER				
Course code		**22PCAZD2**		
Name of the course		**MICROBIOLOGY**		
Course No	Course Category Core / Elective /EDC	No of Credits	No of hrs /week	Total marks (Int+Ext)
EDC - II	**Extra Discipline Course**	**4**	**3**	**25 + 75=100**

Course Objectives

- To understand the basic structure and characteristics of microbes
- To identify the sterilization techniques , media preparation and process of bacterial culture
- To understand the role of microbes in environment and agriculture
- Describe the mechanisms for transmission, virulence and pathogenicity in pathogenic micro-organism
- To analyze the microbes in food production

UNIT I: Classification and structure of microbes (9 hrs)

Contributions of scientists to microbiology- Seven Kingdom Classification- Classification of microbes (bacteria, fungi and viruses). Ultra structure of bacteria- Cell wall of Gram positive and Gram negative bacteria. Ultrastructural details of Fungi , Yeast and Viruses (plant and animal viruses) - Viriods and Prions.

UNIT II: Bacterial culture and Growth (9 hrs)

Sterilization techniques , Types of culture media - Methods of bacterial culture (broth, plate, slant and stab). Pure culture techniques (Serial dilution, streak plate, pour plate and spread plate) – Maintenance of bacterial culture - Identification of bacterial and fungal strains (cytological staining methods).

Microbial growth - Growth curve and Exponential growth. Batch, fed batch, continous and synchronous growth. Factors influencing bacterial growth

UNIT III: Microbial interactions in environment and agriculture (9 hrs)

Microbial ecology-. Microbes and nutrient cycles. Applications of soil beneficial microbes in agriculture – Role of Biopesticides , Bioinsecticides and Biofertilizers.

Biofuels- Biogas Production and applications . Biomining- Bioleaching, Microbial enhancement of oil recovery - Role of Biopolymers

Nitrogenfixingbacteria- symbioticandasymbiotic- MechanismofNitrogen fixation. Biological control- NPV,BT.Biocomposting methods

UNIT IV: Medical microbiology (9 hrs)

Studyofcausativeorganisms, symptoms,modesoftransmissionandcontrol.
Viraldiseses- Polio,HIV,HepatitisA ,B and C, MERS,SARS -Covid 19
Bacterial diseases- Whooping cough, Diphtheria,Tuberculosis,Leprosy, Typhoid,Cholera,Gonorrhea, syphilis.
Antibiotics- Production of antibiotics - Antimicrobial agents and mode of action - Antimicrobial chemotherapy.

UNIT V : Food and Diary microbiology (9 hrs)

Microbes in food - Role of microbes in food probiotics - Dairy and non-dairy products - Fermented foods and alcoholic beverages.

Factorsinfluencingspoilage–Methodsofdetection ofspoilage, Prevention of food spoilage.- Principles offoodpreservation. Natural food preservatives

Text Books :

1. Arora,D.R. And Arora,B. 2008. Text Book of Microbiology. CBS Publishers and Distributers, New Delhi
2. Chakraborty, P. A.2009. Text Book of Microbiology. New Central Book, Agency.New Delhi
3. Harma and Kanika.2009.Manual of Microbiology Tools and Techniques. Ane Books Pvt. Ltd. New Delhi

Reference Books:

1.Ingraham, J. L. And Ingraham, C. A. 2000. Microbiology (2^{nd} edn). Brooks/Cole-Thomson Learning, ,USA
2.Laning, M Prescot. John,P. Harley Aand Donald A Klein. 2008. Microbiology (7^{th} edn). Mcgraw Hill International, , USA
3.Talaro, Park.,Kathelee, N And Talaro, Arthur. 2002. Foundations of Microbiology. Mcgraw Hill Higher Education,NY
4.Wheelis, Mark. 2010. Principles of Modern Microbiology. Jones And Bartlett Publishers,NY,USA

Web Resources

http://archives.microbeworld.org/microbes/
http://www.bioedonline.org/
http://www.biologydiscussion.com/microorganisms/classification-of-microorganism-microbiology/64847

Methodology of Teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students

CO code	Course Outcomes	K-levels
CO1	Describe the structure of different kinds of bacteria and viruses and explain concepts relating to their growth and multiplication.	**K1, K2,K3**
CO2	Demonstrates the sterilization techniques, media preparation and types of bacterial culture , interprets the bacterial growth curve	**K2,K5**
CO3	Discovers the microbial interaction in environment and agriculture	**K4**
CO4	Identify causative organisms of some important diseases, their mode of transmission,control measures and treatment of the diseases	**K3**
CO5	Applies knowledge to identify useful and harmful microbes in food processing and dairy industry	**K3**

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	2	1
CO2	3	3	3	3	1	2
CO3	3	3	3	3	2	1
CO4	3	3	3	3	1	1
CO5	3	3	3	2	2	3
Total of CO –PSO mapping	**15**	**15**	**15**	**13**	**08**	**09**
Average of CO-PSO mapping	**3**	**3**	**3**	**2.6**	**1.6**	**1.8**

Level of Correlation between PSO's and CO's

(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value

1 – Low

2 – Medium

3 – High

0– No Correlation

BLOOM TAXONOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1,K2, K3,K4,K5	B (INTERNAL CHOICE) EITHER (a) OR (B)	5 x 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4, K5,K6	C (Answer any three question from five questions)	3 X 10	One questions from each unit	30
				75