INSTITUTE OF SCIENCE, NAGPUR.

(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF ZOOLOGY

Syllabus Master of Science (M.Sc.) Semester Pattern

Zoology

(ZOO/PG/2021/01)

(To Be Implemented From 2021-22)

SYLLABUS for M.Sc. Zoology
Choice Based Credit System (Semester Pattern)
Institute of Science, Nagpur (An Autonomous Institution, NAAC Acrediatated A Grade)
With effect from 2021-22

Candidates opting for this course are advised to go through the direction relating to the course "DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE, SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM), (FACULTY OF SCIENCE & TECHNOLOGY)" which is available on Institute of Science, Nagpur website.

The direction will provide details on admission criteria, rules for ATKT, scheme of examination, absorption scheme for CBS students into CBCS pattern, elective papers, foundation course papers, subject centric papers, coding pattern, pattern of question papers, practicals, distribution of marks, seminars, project work, internal assessment, calculation of SGPA and CGPA, etc.

M.Sc. (Semester Pattern)
Syllabus
Semester wise Name of Papers
Subject – Zoology

Ex. MZFS11 : M -M.Sc, Z-Zoology, F-First Year, S- Second Year, S1, 2, 3, 4- Semester 1, 2, 3, 4, 1, 2, 3, 4- Paper 1, 2, 3, 4.

Semester	Paper	Name of the Paper	Paper Code
I	I	Structure & Function of Invertebrates	**MZFS11**
	II	General Physiology	**MZFS12**
	III	Cell Biology & Genetics	**MZFS13**
	IV	Advance Reproductive Biology	**MZFS14**
	Laboratory Coursework Practical (If applicable)	Practical I- Based on Paper I & Paper II	**MZFS15PR**
		Practical II- Based on Paper III & Paper IV	**MZFS16PR**
	Seminar		**MZFS17SM**
II	I	Structure & Function of Vertebrates	**MZFS21**
	II	Comparative Endocrinology	**MZFS22**
	III	Molecular Biology & Biotechnology	**MZFS23**
	IV	Advanced Developmental Biology	**MZFS24**
	Laboratory Coursework Practical (If applicable)	Practical I- Based on Paper I & Paper II	**MZFS25PR**
		Practical II- Based on Paper III & Paper IV	**MZFS26PR**
	Seminar		**MZFS27SM**

Semester	Paper	Name of the Paper	Paper Code
III	I	Parasitology & Immunology	**MZSS31**
	II	Core I- Wild Life & Avian Biology	**MZSS32**
	Laboratory Coursework Practical (If applicable)	Practical I- Based on Paper I	**MZSS33PR**
	Seminar		**MZSS34SM**
Special Group Mammalian Reproductive Physiology	(MRP)- III	Reproductive Process in Male	**MZSS33MRP**
	(MRP)- IV	Reproductive Process in Female	**MZSS34MRP**
	Laboratory Coursework Practical (If applicable)	Based on Paper III & Paper IV	**MZSS35MRPPR**
Special Group Fish & Fisheries (FF)	(FF)-III	General Studies	**MZSS33FF**
	(FF)- IV	Applied Fisheries	**MZSS34FF**
	Laboratory Coursework Practical (If applicable)	Based on Paper III & Paper IV	**MZSS35FFPR**
Special Group Animal Physiology (AP)	(AP)- III	Physiology of Digestion and Excretion	**MZSS33AP**
	(AP)- IV	Physiology of Circulation	**MZSS34AP**
	Laboratory Coursework Practical (If applicable)	Based on Paper III & Paper IV	**MZSS35APPR**
Special Group Cell Biology (CB)	(CB)- III	Techniques in Cell Biology	**MZSS33CB**
	(CB)- IV	Genetics & Genomics	**MZSS34CB**
	Laboratory Coursework Practical (If applicable)		**MZSS35CBPR**

Semester	Paper	Name of the Paper	Paper Code
IV	I	Biotechniques, Biostatistics, Ethology, Toxicology and Bioinformatics	**MZSS41**
	II	Core II- Radiation & Chronobiology	**MZSS42**
	Laboratory Coursework Practical (If applicable)	Project Work	**MZSS43PRJT**
	Seminar		**MZSS44SM**
Special Group Mammalian Reproductive Physiology	(MRP)- III	Reproductive Endocrinology	**MZSS43MRP**
	(MRP)- IV	Reproductive Toxicology, Embryology and Fertility	**MZSS44MRP**
	Laboratory Coursework Practical (If applicable)	Based on Paper III & Paper IV	**MZSS45MRPPR**
Special Group Fish & Fisheries (FF)	(FF)-III	General Studies	**MZSS43FF**
	(FF)- IV	Fishery technology and Fish pathology	**MZSS44FF**
	Laboratory Coursework Practical (If applicable)	Based on Paper III & Paper IV	**MZSS45FFPR**
Special Group Animal Physiology (AP)	(AP)- III	Physiology of Brain, Nerve and Muscle	**MZSS43AP**
	(AP)- IV	Physiology of Respiration & Reproduction	**MZSS44AP**
	Laboratory Coursework Practical (If applicable)	Based on Paper III & Paper IV	**MZSS45APPR**
Special Group Cell Biology (CB)	(CB)- III	Molecular Cell Biology	**MZSS43CB**
	(CB)- IV	Applied Biotechnology	**MZSS44CB**
	Laboratory Coursework Practical (If applicable)		**MZSS45CBPR**

Institute of Science, Nagpur
(An Autonomous Institute of Government of Maharashtra)
Syllabus for M.Sc. Zoology (Semester with credit based Pattern) w e f 2021-22
Academic session
Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Zoology

M. Sc. Zoology Semester I											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in	Max. Marks		Total Marks	Minimum Passing Marks	
		Theory	Practical	Total			External	Internal		Th	Prac
MZFS11	Paper I**:** Structure and Function of Invertebrates	4	-	4	4	3	80	20	100	40	
MZFS12	Paper II**:** General Physiology	4	-	4	4	3	80	20	100	40	
MZFS13	Paper III: Cell Biology and Genetics	4	-	4	4	3	80	20	100	40	
MZFS14	Paper IV**:** Advanced Reproductive Biology	4	-	4	4	3	80	20	100	40	
Pract. Paper I & II – MZFS15PR	Practical**:** Based on theory Paper **I & II**	-	8	8	4	3-8*	100**	-	100		40
Pract. Paper 3 &	Practical **:** Based on	-	8	8	4	3-8*	100**	-	100		40
4-MZFS16 PR	theory Paper III & IV										
Seminar MZFS17 SM	Seminar -	2	-	2	1			25	25	10	
	TOTAL	18	16	34	25		520	105	625	170	80

M. Sc. Zoology Semester II											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in	Max. Marks		Total Marks	Minimum Passing Marks	
		Th	Pract	Total			External	Internal		Th	Pract
MZFS21	Paper I: Structure and Function of Vertebrates	4	-	4	4	3	80	20	100	40	
MZFS22	Paper II: Comparative Endocrinology	4	-	4	4	3	80	20	100	40	
MZFS23	Paper III : Molecular Biology and Biotechnology	4	-	4	4	3	80	20	100	40	
MZFS24	Paper IV : Advanced Developmental Biology	4	-	4	4	3	80	20	100	40	
Pract. MZFS25PR	Practical I: Based on theory Paper	-	8	8	4	3-8*	100**	-	100		40
Pract. MZFS26PR	Practical II: Based on theory Paper	-	8	8	4	3-8*	100**	-	100		40
Seminar MZFS27SM	Seminar -$2S_2$	2	-	2	1			25	25	10	
	TOTAL	18	16	34	25		520	105	625	170	80

M. Sc. Zoology Semester III											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credit	Examination Scheme					
		T	Pr	To		Dr	Max. Marks		To	Minimum Passing Marks	
							External	Internal		Th	Pract
MZSS31	Paper I**:** Parasitology and Immunology	4	-	4	4	3	80	20	100	40	
MZSS32	Paper **II:** Core (Subject Centric)- I Wild Life and Avian Biology	4	-	4	4	3	80	20	100	40	
MZSS33- AP FF MRP CB	Paper **III: Special Group- Paper I** • Fish and Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Cell Biology	4	-	4	4	3	80	20	100	40	

MZSS34 AP FF MRP CB	**Special Group- Paper IV** • Fish and Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Cell Biology	4	-	4	4	3	80	20	100	40	

Pract. I MZSS 35PR	Practical I**:** Based on theory of Paper I & II	-	8	8	4	3-8*	100**	-	100		40
Pract. II MZSS3	Practical **$3P_2$:** Based on theory of special papers III & IV	-	8	8	4	3-8*	100**	-	100		40
Seminar MZSS34 SM	Seminar	2	-	2	1			25	25	10	
	TOTAL	**18**	**16**	**34**	**25**		**520**	**105**	**625**	**170**	**80**

M. Sc. Zoology Semester IV											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in	Max. Marks		Total Marks	Minimum Passing Marks	
		Th	Pract	Total			Extern	Intern		Th	Pra
MZSS41	**Paper I**: Biotechnique, Biostatistics, Ethology, Toxicology and Bioinformatics	4	-	4	4	3	80	20	100	40	
MZSS42	**Paper II**: Core (Subject Centric)-II Radiation and Chronobiology	4	-	4	4	3	80	20	100	40	
MZSS43 FF AP MRP CB	**Paper III Special Group- Paper I** • Fish and Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Cell Biology	4	-	4	4	3	80	20	100	40	

MZSS44 FF AP MRP CB	**Special Group- Paper II** • Fish and Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Cell Biology										
Pract. **MZSS45**	**Practical : Based on t heory of P a p e r III and IV**	-	8	8	4	3-8*	100**	-	100		40
Project MZSS43PRJT	Project -**Pro**	-	8	8	4	3-8*	100**	-	100		40
Seminar **MZSS44SM**	Seminar- **$4S_4$**	2	-	2	1			25	25	10	
	TOTAL	**18**	**16**	**34**	**25**		**520**	**105**	**625**	**170**	**80**

Note: Th = Theory; Pr = Practical/lab, * = If required, for two days.
** = The Practical and Project shall be evaluated by both the External and Internal Examiner in therespective Department / Center / Affiliated College.

Changes in practical curriculum as per UGC Notification No. F.14-6/2014 (CPP-II) Dated 1st August 2014 (w.e.f. academic session 2015-16)Important Instructions

I. Use of animals for dissection for practical purpose in the curriculum is banned by UGC vide its notification No. F.14-6/2014 (CPP-II) dated 1st August 2014. It is now essential to use necessary alternatives to stop dissection and promote and orient students towards the knowledge component rather than skill development using ICT and available resources without disturbing natural habitat.

These digital learning devices and available resources are to be used to demonstrate the dissection of the animals and other laboratory exercises andto evaluate the students at the time of examination and to ensures compliance of the aforesaid notification.

II. Those institutions which are already having Zoology museum / Permanent Slides / Skeleton and Loose Bones of any animals should use them till they last. No new specimens/ slides or any other laboratory material procured from animal source

shall be purchased for conducting practicals mentioned here- in above. If needed, they should purchase charts/ models/ photographs or digital sources as alternatives.

III. During regular practical and practical examination, for anatomical observations, demonstration and detailed explanation of the given system of Invertebrate/ Vertebrate animal, the student will expose/ explain the given system of the animal anddraw, label and comment on it.

IV. During regular practical and practical examination, for mounting of given material and permanent stained preparation, the student is expected to describe the process and/or identify, draw, label and describe the given material.

Semester-I
Paper-I, Structure and function of Invertebrates
(Paper Code- MZFS11)

Objectives:

The course Objectives to provide students with a basic understanding of:

1. Basic concepts of classification & recent trends in biosystematics.
2. Different physiological body processes of invertebrates.
3. Larval forms of invertebrates
4. Minor Phyla

Learning outcomes-

By the end of the course, students should be able to:

1. Describe basis of taxonomy, biosystamatics &classification.
2. Colonial, syncytial & molecular theories about origin of metazoan.
3. Describe different physiological body processes of invertebrates.
4. Describe Larval forms of invertebrates
5. Describe characteristics and significance of Affinities & taxonomic position of Peripatus, Neopilina, Rotifera & Bryozoa.

Unit-I

1.1 Basic concepts of biosystematics, taxonomy and classification. Recent trends in biosystematics:Chemotaxonomy, Cytotaxonomy & Molecular taxonomy.
1.2 Ultrastructure of locomotory organs & locomotion in protozoa .
1.3 Dermal cells and skeletan of Porifera . Canal system in sponges.
1.4 Comparative account of Coelenterata & Ctenophora: Structure &Reproduction.

Unit-II

2.1 Origin of metazoan-colonial, syncytial and molecular theories.
2.2 Reproductive systemand reproduction inHelminthes.
2.3 Classification of coelomates based on coelomformation, metamerism &Symmetry.
2.4 Excretory system & excretion in Annelida.

Unit-III

3.1 Filter feeding mechanism in Invertebrates.
3.2 Organs & Mechanism ofrespiration in Arthropoda & Mollusca.
3.3 Affinities & taxonomic position of Peripatus & Neopilina.
3.4 Neuroanatomy in Gastropoda, Bivalvia and Cephalopoda.

Unit-IV

4.1 Water vascular system in Echinodermata: structure and functions.
4.2 Larval forms in Echinodermata: Metamorphosis and phylogenetic significance.
4.3 Principles of hydrostaticskeleton & Locomotion based on hydrostatic skeleton in Invertebrates
4.4 Systematic position,general organization andaffinities of Bryozoa & Rotifera

Semester-I
Paper-II, General Physiology
(Paper Code- MZFS12)

Objectives:

1. Understand and deal with all aspects of general and systemic physiology.

Course outcome:

Students completing this course will be able to:

1. Enzyme- Classification, its action and regulation.
2. Respiratory pigments- types, distribution and properties, mechanism of O_2 transport.
3. Physiology of Neurotransmitters, colour change, bioluminescence, thermoregulation, osmoregulation.
4. Molecular mechanism of hormonal action, membrane receptors and signal transduction.
5. Types of heart (myogenic and neurogenic), cardiac cycle.
6. Classification and metabolism- carbohydrates , lipids, proteins, hydromineral metabolism.
8. Cerebrospinal fluid: chemistry and functions.
9. Mechanism of reflex action, physiology of environmental stress and strain.

Unit-I

1.1 Enzyme**: Nature,** classification, mechanism ofenzyme action. Factors affectingenzyme action, regulation of enzyme activity, activators and inhibitors.

1.2 Respiratory pigments- types, distribution and properties, structure of haemoglobin and mechanism of O_2 transport.

1.3 Neurotransmitters: chemical nature, biosynthesis and mechanism of synaptic transmission.

1.4 Physiology of heart –Myogenic and neurogenic heart, pacemakers, heartvalves, cardiac cycle, electrocardiogram, bradycardia and tachycardia.

Unit-II

2.1 Bioluminescence: light producing organs- distribution in invertebrates and vertebrates, physiology and significance.

2.2 Thermoregulation in poikilotherms and homeotherms, tolerance and resistance, adaptations, aestivation and hibernation

2.3 Osmoregulation in Aquatic (Pisces and Amphibia) and terrestrial (Birds and Mammals organisms mechanism of salt and watertransport by gills and kidney.

2.4 Colour changemechanism: Chromatophoresand melanophores- structure, physiology and significance

Unit-III

3.1 Carbohydrates- classification and metabolism- glycogenesis, glycogenolysis, glycolysis, Oxidativedecarboxylation

3.2 TCA cycle, electrontransport system andoxidative phosphorylation.

3.3 Lipids- classification andmetabolism- oxidation of fatty acids, cholesterol metabolism.

3.4 Proteins- classification and metabolism- oxidative deamination, decarboxylation and Trans-amination of aminoacids, arginine- ornithine cycle.

Unit-IV

4.1 Hydromineralmetabolism-water electrolyte balance, mineral metabolismin bone

4.2 Cerebrospinal fluid: Chemistry and functions.

4.3 Mechanism of reflex action.

4.4 Physiology of environmental stress and strain- tolerance, avoidance, resistance and physiological adaptations.

Semester-I

Paper-III, Cell Biology and Genetic

(Paper Code- MZFS13)

Objectives:

1. This paper is aimed to introduce & to understand the structure and molecular basis of cellular interactions, cell communication, Mendelian genetics, human genetics, microbial genetics, cell cycle and information transfer.

Course Outcome:

On completion of the course, students are able to understand

1) the structure and function of : cell membrane ,cell organelles, microfilaments, microtubules.
2) cell division and cell cycle.
3) cell signaling , signal transduction pathways, cellular communication and cancer.
4) inheritance- Mendelian, non-Mendelian; extensions of Mendelian principles ; quantitative genetics and mutation.
5) alterations of chromosomes and their genetic implications.
6) extra chromosomal inheritance.
7) microbial genetics and human genetics.

Unit-I

1.1 Membrane structure and function – Structure of model membrane. Structure & organization of membrane lipids. Structure & organization of membrane proteins. Membrane of human red blood cell. Transport of substances through membrane- Diffusion. Facilitated diffusion. Active transport (Primary & secondary).

1.2 Structural organization and functions of cell organelles- nucleus, mitochondria, endoplasmic reticulum, Golgi complex, lysosomes and peroxisomes.

1.3 Organization of cytoskeleton- Structure and Functions of microfilaments, microtubules and intermediate filaments.

1.4 Cell division and cell cycle - phases of cell cycle, checkpoints of cell cycle, regulation of cell cycle, mitosis, meiosis.

Unit-II

2.1 Cell signaling - hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, Receptor protein- tyrosin kinase and ion channel receptors.

2.2 Signal transduction pathways, primary and secondary messenger systems, regulation of signaling pathways.

2.3 Cellular communication- Cell-cell interaction. Cell adhesion molecules (Selectins, Immunoglobulin superfamily, Cadherins). Adherens junctions and desmosomes. Tight junctions. Gap junctions.

2.4 Cellular communication- Cell – Extracellular matrix interaction. Organization and components of extracellular matrix. Interaction of cell withextracellular matrix , (Integrins, focal adhesions & hemidesmosomes.

Unit-III

3.1 Mendelian, non- Mendelian inheritance - Mono / dihybrid inheritance, types of dominance, multiple allelism.Exercises for solving genetics problems.

3.2 Extensions of Mendelian principles - codominance, incomplete dominance, gene interactions, linkage and crossing over, sex linkage, sex limited and sex influenced

characters.

3.3 Quantitative Genetics - polygenic traits and mode of inheritance, genetic and environmental factors, heritability, inbreeding and consequences, coefficient of inbreeding and consanguinity.

3.4 Mutation - types, causes and detection, mutant types- lethal, conditional,biochemical, loss of function, gain of function, germinal verses somatic mutants.

Unit-IV

4.1 Structural and numerical alterations of chromosomes - deletion, duplication, inversion, transversion, translocation, ploidy and their genetic implications.

4.2 Extra chromosomal inheritance - cytoplasmic inheritance, inheritance of mitochondrial genes, maternal inheritance.

4.3 Microbial genetics - recombination in bacteria and gene mapping, transformation, conjugation, transduction (generalized and specialized), fine structure mapping of genes.

4.4 Human genetics- pedigree analysis, Karyotypes. Genetic disorders (Huntington's disease, Phenylketonuria, Alkaptonuria, Albinism, Sickle cell anemia.

Semester-I

Paper-IV, Advanced Reproductive Biology
(Paper Code- MZFS14)

Objectives:

1. To imbibe the current knowledge pertaining to the reproductive methods & development of animal embryos of diverse taxonomic groups.
2. To introduce advance techniques in reproductive biology.

Course Outcome:

On completion of the course, students are able to understand

1. methods of reproduction in protozoa.
2. regeneration in hydra, digesia and annelid worms; morphogenesis and hormonal control.
3. mechanism of vitellogenesis and metamorphosis in insects
4. spermatogenesis, mechanism of oogenesis, cytological and molecular events of fertilization.
5. embryology- types of cleavage, blastulation, gastrulation and embryonic induction.
6. male accessory sex glands in mammals.
7. semen, sperm capacitation and decapacitation
8. pheromones and sexual behavior in mammals
9. neurohormonal control of fish reproduction and mechanism of vitellogenesis.
10. molecular induction , cryopreservation ,test-tube baby , in vitro fertilization (ivf) and its significance.

Unit-I

1.1 Various methods of asexual and sexual reproduction in Protozoa

1.2 Regeneration in *Hydra*, *Dugesia* and Annelid worms; Morphogenesis and hormonal control.

1.3 Metamorphosis in insects: Partial and complete metamorphosis, metamorphic forms- nymph, larvae and pupae.

1.4 Mechanism of vitellogenesis in insects.

Unit-II

2.1 Spermatogenesis: Process, hormonal control and ultra-structure of spermatozoa of man.

2.2 Mechanism of oogenesis: Process, biochemical events, hormonal regulation.

2.3 Cytological and molecular events of fertilization.

2.4 Types of cleavage, blastulation, gastrulation and embryonic induction.

Unit-III

3.1 Brief description of histomorphology and hormonal control of male accessory organs viz., epididymis, vas deferens, seminal vesicles, ventral prostate, bulbourethral gland and preputial gland.

3.2 Sperm maturation – morphological andbiochemical events influence of accessory organ secretions and sperm abnormalities

3.3 Sperm capacitation and decapacitation- molecular mechanism and significance.

3.4 Hormones and sexual behaviour – Selected examples of courtship and mating behaviour.Pheromones in Insects andMamma**ls.**

Unit-IV

4.1 Neurohormonal control of fish reproduction and mechanism of vitellogenesis.

4.2 Molecular induction (Morphogenetic gradients) and organizer concept.

4.3 Cryopreservation of gametes, embryo and test-tube baby.

4.4 In vitro fertilization (IVF) and its significance.

Semester I, Practical-I, Structure and Function of Invertebrates and General Physiology
Section-A

1 Study of museum specimens using already available specimens in the museum/ charts/ models/ photographs/ digital alternatives etc.

Classification upto order and comments on the specimens representing all phyla.

2 Anatomical Observations

Anatomical observations, demonstration and detailed explanation of a) D**igestive system** of Earthworm, Leech, Cockroach, Silkworm and Honey bee b) N**ervous system** of Prawn, Cockroach, Silkworm and Honey bee and c) R**eproductive system** of Earthworm, Leech, Cockroach and Honey bee with the help of ICT tools/ Models/ Charts/ Photographs etc.

3 Mounting- Whole mount preparation of plankton and/or study of permanent preparation of the following with the help of already available permanent slides/ ICT tools/ charts/ photographs etc**.**

a. Earthworm – Nerve ring, ovary, spermatheca, nephridia.
b. Leech – jaws, ciliated organ.
c. Cockroach – Mouth parts, Salivary glands, trachea.
d. Prawn –Appendages, Statocyst.
e. Protozoans- rhizopods , flagellates , ciliates (fresh water forms).
f. Porifera – Spicules and gemmules of fresh water sponges.
g. Crustaceans and rotifers - Planktonic copepodes, cladoceran, ostracoderm and rotifers.
h. Larval forms of the free living invertebrates.
i. Larval forms of parasitic invertebrates.

4 Study of permanent Invertebrate slides

a. Porifera – T.S. and L.S. of *Sycon*, gemmules, spongian fibres, spiculesCo
b. elenterata – T.S. of *Hydra* , T.S. of Sea anaemon, Ephyra larva
c. Helminths – T.S. of *Planaria*, T.S. of *Taenia* , scolex W.M., Mature , gravid proglotids , T.S. of male and female *Ascaris*, W.M of *Ankylostoma* , *Enterbios*, *Dracunculus*, *Wuchereria*
d. Annelida -T.S. of *Nereis*, T.S. of Earthworm passing through various organs, T. S. of Leech.
e. Arthropod larvae – Nauplius, Zoea, Metazoea, Megalopa, Mysis.
f. Mollusca – T.S. of foot, Veliger and Glochidium larva.
g. Echinodermata- pedicellarae, T.S. of arm of star fish, Bipinnaria, Oricularia larva.
h. Hemichordata – T.S. through collar, proboscis, trunk and branchio-genital regions. Tornaria larva.

Section-B

Physiology experiments –

a. Total leucocyte count and differential leucocyte count.
b. Total R.B.C. count.
c. Demonstration of action of salivary amylase, trypsin, pepsin.
d. Demonstration of rate of O_2 consumption in aquatic animals, under various environmental stresses.
e. Demonstration of haemoglobin concentration in normal and pathological condition.
f. Estimation of sodium, potassium and chloride in blood and excretory organs by Colorimeter or flame photometer (Source of blood: Local recognized pathology laboratory).
g. Estimation of glucose in blood by spectrophotometer or Colorimeter (Source of blood: Local recognized pathology laboratory).
h. Estimation of total blood proteins by spectrophotometer or Colorimeter (Source of blood: Local recognized pathology laboratory).
i. Estimation of cholesterol in blood by spectrophotometer or Calorimeter (Source of blood: Local recognized pathology laboratory).

Distribution of Marks:		**Marks**
1.	Anatomical observations	10
2.	Stained permanent preparation:	10
3.	Identification and comment on the spots (1-10)	30
4.	Physiology experiment (Major)	15
5.	Physiology experiment (Minor)	10
6.	Submission of stained permanent slides	05
7.	Class Record	10
8.	Viva-voce	10
	Total marks	100

Semester-I, Practical- II, Cell Biology, Genetics and Advanced Reproductive Biology

Section-A

1. Study of mitotic metaphasic chromosomes in plant material.
2. Preparation of human karyotypes by using photographs/pictures.
3. Demonstration of Barr body in human female leucocytes.
4. Demonstration of polytene chromosome in dipteran larvae with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
5. Problems on genetics based on monohybrid/dihybrid ratios, sex linked inheritance and blood groups.
6. Study of various human genetic traits.

Section-B

1 Study of meiotic chromosomes and spermatogenesis in grasshopper / r a t with the help ofalready available permanent slides/ ICT tools/ models/ charts/ photographs etc.

2 Demonstration of oogenesis in earthworm/ fish/ rat ovary with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

3 Semen analysis: physical viscosity, pH, liquefaction time, agglutination test, motility and sperm count (Source of semen: Government artificial insemination centre).

4 Sperm vitality study using suitable stains (Source of semen: Government artificial insemination centre).

5 Hypo-osmotic swelling (HOS) for the assessment of normal semen.

6 Study of vaginal smear in rat by temporary mounting (methylene blue) or by permanent stained (Haematoxylin-eosin) with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

7 Histology of male and female reproductive organs and accessory reproductive glands with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

Distribution of Marks		**Marks**
1.	Cytological preparation	20
2.	Problems on genetics (any two)	20
3.	Spermatogenesis/oogenesis/spermvitality	15
4.	Sperm count/vaginal smear/hypo-osmotic test for fertility	10
5.	Identification and comment on spots (1-5)	15
6.	Class record	10
7.	Viva-voce	10

	Total marks	100

- **Suggested Readings**

Structure and function of Invertebrates

1. Hyman L.H. The Invertebrate Vol. I, Protozoa through Ctenophora. McGraw-Hill Co., New York.
2. Barrington E.J.W. Invertebrate structure and function. Thomas Nelson and sons Ltd., London.
3. Jagerstein G. Evolution of Metazoan life cycle . Academic press, New York and London.
4. Hyman L.H. The invertebrate vol. 2 McGraw-Hill Co., New York.
5. Hyman L.H. The invertebrate vol. 8 McGraw-Hill Co., New York.
6. Barnes R.D. Invertebrate Zoology W.B. Saunders and Co., Philadelphia
7. Russet HunterW.D.D. biology of higher invertebrate The Macmillan Co. Ltd., London.
8. Backlemiccher W.N. Principles of comparative anatomy of Invertebrates Oliver and Boyed Edinberg.
9. Hadisi J. The Evolution of Metazoa. Pergamon Press, Oxford.
10. Dales R.P. Annelids, Hutchinson, London.
11. Green J. Biology of Crustacea, Wither by, London.
12. Morton J. E. Mollusca, Hutchinson, London.
13. Nichols D. Echinodermata, Hutchincon, London.

General Physiology

1. Text Book of Physiology & Biochemistry: Bell, G.E. & Davidson, J.N. & Emslie D. Smith, 1922.
2. Medical Physiology: A Wiley Medical Publication, John Wiley & Sons, New York.
3. Mineral Metabolism: Comar, C.L. & Felix Bronner (1961) Acad Press, New York & London.
4. A Text Book of General Physiology: Dayson (1964): Little Brown & Co. Boston.
5. Animal Physiology: R. Eckert & D. Randall (1983) 2nd Edn., W.H. Rexeman & Co.
6. Biochemistry & Physiology of the Cell: (2nd Edn.), M.A. Edwards & K.A. Hassall (1980) Mc. Graw Hill Co.
7. The Physiology of Cells: Cuthe F. (1968): The Macmillan Co.
8. Textbook of Medical Physiology: Guyton, A.G. (1968). 7th Edn.Saunders Pub.
9. Samson Wrights Applied Physiology: Oxford University Press.
10. Comparative Animal Physiology C.L. Prosser, W.B. Saunders & Company.
11. Animal Physiology: Mechanism & Application, R. Eckert, W.H. Freeman & Company.
12. General & Comparative Animal Physiology: W.S. Hoar.
13. Medical Physiology: W.F. Ganong (1981): 10th Edn. Lange Medical Publications.
14. Principles of Anatomy and Physiology: Tortora Grabowski, 9th Edn.John Willey &Sons.
15. Reproductive Physiology of Vertebrates: Van Tienhoven, A. (1983): 2nd Edn. Cornell Univ. Press, New York.

Cell Biology and Genetics

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 VI by Benjamin Lewis, Oxford press.
6. Gene VIII by Benjamin Lewis, Oxford press.
7. Molecular biology of Gene by Watson J. D. et. al., Benjamin publication.
8. Molecular cell Biology by Darnell J. Scientific American Books USA.
9. Molecular Biology of the Cell by Alberts B., Bray D. Lewis J., garland publishing Inc.
10. Genetics Vol. I and II by Pawar C. B., Himalaya publication.
12. Essentials of Molecular Biology by Freifelder D., narosa publication House.
13. Molecular Cell Biology by Laodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. and Darnell J., W. H. Freeman and Co.
14. The Cell: Molecular Approch by Cooper G. M.
15. Molecular Biology by Upadhay A and Upadhay K. Himalaya publication.

Advance reproductive Biology

1. Developmental Biology. 2nd Edition.Leon W. Browwer Saunders College publishing.
2. Current Topics in Developmental Biology eds. R. A. Pedersen and G. P. Schatten.
3. Principles of animal developmental biology: S. C. Goel, Himalaya Publishing House.
4. Developmental Biology, S.F. Gilbert. 4th Edn.Sinauer Associates Inc. Publishers.
5. An Introduction to Developmental Biology: D. A. Ede.
6. Principles of developmental: Paul Weiss edited by Hafner publishing company NewYork.
7. Cells into organs. 2nd Edition.The forces that shape the Embryo.John Philip Trinkaus ed. Tom Aloisi.
8. Principles of development: Lewis Wolpert et al. 1998. Oxford University Press.
9. Foundations of Embryology. B. M. Patten & B. M. Carlson. Tata McGraw Hill Publishing Company Ltd., New Delhi.
10. An Introduction to Embryology: Balinsky (1981) 5th Ed. (CBS College Publishing).
11. Embryonic and foetal development. Cambridge University Press by Austin and Short, 1982, 1994 2nd Ed.
12. Marshall's Physiology of Reproduction Longmont, Green and Co. London Vol. 1 & 2. Lamming 1984, 2000.

Semester-II
Paper-I,
Structure and
Function of Vertebrates
(Paper Code- MZFS21)

Objectives:

To understand the systematic position, functional morphology, mode of life, affinities and biodiversity of chordates.

Course Outcome:

On completion of the course, students are able to explain

1. the origin and ancestry of chordata. General organization and affinities of Cephalochordata.
2. Vertebrate's- integument , Sense organs , Autonomous nervous system,
3. Evolution of urinogenital organs & heart .
4. Comparative anatomy in vertebrates -the brain, Appendicular skeleton.
5. Organs and mechanism of respiration in Amphibia, Structure, development and metamorphosis of Amoecoetus.
6. General characters and affinities of Dipnoi.
7. General body organization and classification in Chelonia.
8. Origin of Birds.
9. Cetacia: general characters and adaptations, Evolution of Man.

Unit-I

1.1 Origin and ancestry of Chordata.

1.2 Characteristic features and affinities ofthe Urochordata & Cephalochordata.

1.3 Characteristic features of Agnatha &development of Amoecoetus larva.

1.4 General characters and affinities of Dipnoi.

Unit-II

2.1 Organs and mechanism of respiration in Pisces and Amphibia.

2.2 Vertebrate integument and its derivatives.

2.3 Jaw suspension in vertebrates.

2.4 General body organization and classification in Chelonia.

Unit-III

3.1 Evolution of kidney & Excretion inVertebrates.

3.2 Origin of Birds. Migration in birds.

3.3 Cetacia: general characters and adaptations.

3.4 Adaptive radiation in vertebrates:Aquatic, Terrestrial, Aerial, Arboreal & Fossorial.

Unit- IV

4.1 Autonomous nervous system in vertebrates: structure and functions.

4.2 Evolution of Circulatory system & heartin vertebrates.

4.3 Sense organs in vertebrates: Echolocation, Electroreception & Lateral line system in fishes.

4.4 Evolution of Man.

Semester-II
Paper-II, Comparative Endocrinology
(Paper Code- MZFS22)

Objectives:

To make the students to learn the importance and scope of comparative endocrinology, anatomy, morphology and histology of endocrine tissues of vertebrates, crustacean and insect endocrine organs and their functions as well as significance of hormones in pharmaceuticals.

Course Outcome:

On completion of the course, students are able to explain

1.Hormones and functions in Coelenterata , Helminths, & Echinodermata.
2. structure, hormones and functions of Neurosecretory system in Annelida & Mollusca.
3. Neuroendocrine system , structure and hormones, Endocrine control of metamorphosis reproduction and colour change mechanisms in crustaceans & insects.
4. structure, hormones and functions of pineal organ, hypothalamo hypophysial system, pituitary, thyroid, parathyroid ultimobranchial glands, gastro-entero-pancreatic endocrine system, adrenal gland .
5. Gonadal hormones in vertebrates and their hormonal actions, feedback mechanisms.

Unit-I

1.1 Hormones and functions in Coelentereta and Helminths.
1.2 Neurosecretory system in Annelida: structure, hormones and functions.
1.3 Neuroendocrine system in Mollusca: structure, hormones and functions.
1.4 Hormones and functions in Echinodermata.

Unit-II

2.1 Neuroendocrine system in crustacean; structure and hormones.
2.2 Endocrine control of metamorphosis, reproduction and colour change mechanisms in crustacea.
2.3 Cephalic neuroendocrine system in insects: structure and hormones.
2.4 Endocrine control of metamorphosis and reproduction in insects.

Unit-III

3.1 Pineal organ: structure, hormones and functions.
3.2 Hypothalamo hypophysial system: structure, hypothalamic nuclei, hormones and function.
3.3 Pituitary: cell types, hormones and functions.
3.4 Thyroid: Structure, hormones and function.

Unit-IV

4.1 Endocrine pancreas and gastro intestinal tract: endocrine cells, hormones and functions.
4.2 Adrenal gland: structure, hormones and functions invertebrates.
4.3 Gonadal hormones invertebrates and their hormonal action, feedback mechanisms.
4.4 Hormones as pharmaceuticals- Hormones incontraception, estrogen and cancer, Sex hormones and immune system and immune regulating hormone (IRH).

Semester-II
Paper-III, Molecular Biology and Biotechnology
(Paper Code- MZFS23)

Objectives:

1. To understand the structure and molecular basis of cellular interactions, regulation and control of genes, and information transfer.
2. To learn the tools & techniques of biotechnology & its applications in diverse fields of life sciences.

Course Outcome:

On completion of the course, students are able to explain

1. DNA- Cot ½ values, organelle genome, structure, forms. replication & regulation of replication.
2. different mechanism of DNA damage and repair .
3. prokaryotic and eukaryotic transcription ,its Regulation ,translation, post translational modifications.
4. Mobile DNA elements .
5. Antisense and ribozyme technology .
6. Isolation and sequencing of DNA, gene amplification.
7. Splicing and Cloning.
8. Hybridization techniques & microarray.
9. biotechnology- Medical, Agricultural , Industrial , Environmental & Immunobiotechnology.

Unit-I

1.1 Structure & organization of cellular genome- C-value paradox & Cot ½ value. Repetitive DNA, Structure of chromosome. Organization of chromatin fiber (Nucleosome, solenoid model, histones, non-histones). Forms of DNA. Mitochondrial DNA.

1.2 DNA replication – molecular mechanisms of prokaryotic and eukaryotic DNAreplication, regulation of replication. Structure & role of prokaryotic & eukaryotic DNA polymerase. Regulation of replication.

1.3 DNA damage- Types of DNA damage , causes and various causative agents. Repair of DNA damage – Mismatched repair. Excision repair. Recombination repair, Double strand break repair, Transcription coupled repair.

1.4 Mobile DNA elements – Transposable elements inbacteria. IS elements. Composite transposons. Bacteriophage Mu transposition. Tn transposition. SINES and LINES. Retroviruses and retroposons.

Unit-II

2.1 Transcription- prokaryotic and eukaryotic transcription, RNA polymerases, transcriptional unit, initiation, elongation, termination, transcriptional factors. Post transcription modifications.

2.2 Regulation of geneexpression- Regulatory proteins (Helix turn helix, zinc finger, homeodomain, leucine zipper). Regulation of gene expression in Prokaryotes – Lac Operon, positive & negative control. Tryptophan operon model Tryptophan attenuator.

2.3 Regulation of geneexpression in eukaryotes- Transcriptional activators. Transcriptional repressors. Gene silencing by modifications of histones & DNA. Regulation after transcription. Post-transcriptional gene regulation by RNA interference.

2.4 Translation- Prokaryotic and eukaryotic translation.Altered code in elongation.

Termination factors. Fidelity of translation. Post-translational modifications.

Unit-III

3.1 Antisense and ribozyme technology – initiation of splicing, polyadenylation, molecular mechanisms of antisense molecules, miRNA, siRNA, gene silencing.

3.2 Isolation and sequencing techniques- Isolation and sequencing of DNA, gene amplification, PCR, RAPD, RFLP, Maxam Gilbert, Sangers dideoxy method.

3.3 Splicing and Cloning – Cloning vectors for recombinant DNA technology- plasmids, cosmids, phagemids, YACS, gene replacement, restriction enzymes.

3.4 Hybridization techniques – Southern-Northern hybridization. Microarray. Fluorescent *In situ* hybridization(FISH).

Unit-IV

4.1 Medical biotechnology-Application of restriction fragment length polymorphism (RFLP) in forensic science, disease prognosis and genetic counseling.

4.2 Agricultural biotechnology- biofertilizers, bioinsecticides, biogas. Genetically modified (GM) crop.

4.3 Immunobiotechnology- Hybridoma technology and monoclonal antibodies.

4.4 Industrial and Environmental biotechnology-microbial production of fermentation products, enzymes, antibiotics, single Cell proteins and biosensors.

Semester-II
Paper-IV, Advanced Developmental Biology
(Paper Code- MZFS24)

Objectives:

1. To assimilate the current knowledge pertaining to the development of animal embryos of diverse taxonomic groups.
2. To learn about novel techniques in embryology & contraception methods.

Course Outcome:

On completion of the course, students are able to explain

1. Mammals-Implantation, Foetal membranes, Placental Hormones , Multiple ovulation and embryo transfer technology (MOET), Application of embryonic stem cells, significance. Embryonic sexing, cloning, screening for genetic disorder diagnosis (ICSI, GIFT etc.), Immunocontraception & Classical contraceptive techniques ,
2. Role of mutants and transgenics in human welfare.
3. Metamorphosis in Amphibia.
4. Regeneration in vertebrate,Apoptosis, Ageing.
5 Polymorphism in insect .
6. Cloning of animals by nuclear transfer.

Unit-I

1.1 Basic concepts of Developmental Biology: Model systems: Chick & Drosophilla. Implantation in Mammals.
1.2 Types of eggs and cleavage patterns: concepts in pattern formation, animal vegital axis, gradients, origin and specification of germ layers.
1.3 Placenta-types, structure, functions. Hormones of placenta and their functions.
1.4 Metamorphosis in Amphibia: morphogenetic and biochemical mechanism,hormonal control.

Unit-II

2.1 Regeneration in vertebrates: tail, limb, lens and retina.
2.2 Concept of growth, differential cell proliferation, shaping of organ primordia and programmed morphogenetic cell death.
2.3 Ageing- mechanism, concepts and models.
2.4 Polymorphism (caste differentiation) in insect (Termites, Honey bees and Ants).

Unit-III

3.1 Multiple ovulation and embryo transfer technology (MOET).
3.2 Application of embryonic stem cells, clinical and economic significance.
3.3 Embryonic sexing, cloning, screening for genetic disorder diagnosis (ICSI, GIFT etc.)
3.4 Cloning of animals by nuclear transfer.

Unit-IV

4.1 Immunocontraception- fertilization, inhibition and pregnancy termination.
4.2 Classical contraceptive techniques: Physical, chemical, surgical and IUCD devices.
4.3 Anti-androgen and anti-spermiogenic compounds (LDH-CY and SP-10)
4.4 Role of mutants and transgenics in human welfare.

Semester-II, Practical-I, Structure and Function of Vertebrates and Comparative Endocrinology

Section-A

1 Study of museum specimens using already available specimens in the museum/ charts/ models/ photographs/ digital alternatives etc.

Classification of vertebrates up to order and comments on the specimens representing all phyla.

2 **Anatomical Observations**

Anatomical observations, demonstration and detailed explanation of the following with the help of ICT tools/ models/ charts/ photographs etc.

a) Brain and cranial nerves- Fish/ Rat. b) Arterial and venous systems- Fish/Rat c) Urinogenital system- Fish/Rat. d) Reproductive systems- Fish/Rat. e) Internal ear in fish, Weberian ossicles in fish, accessory respiratory organs in fish.

Mounting: Study of StainedPermanent preparation of scales, ampullae of Lorenzini, otolith, striated muscles and cartilage of fish using animal wastes from local recognized fish markets or with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

2 Microtomy, Histology and Skeleton

a. Fixation, embedding, sectioning and staining of the internal organs of vertebrates (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)
b. Study of slides of internal organs of vertebrates with the help of already already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
c. Axial and appendicular skeleton of fowl and rabbit using already available skeleton/ ICT tools/ models/ charts/ photographs etc.

Section-B

1 **Microtomy** - Fixation, embedding, sectioning and staining of the endocrine gland (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)

2 **Histological study** – a) Histological slide of endocrine glands and gonadal endocrine components, EM structure of endocrine gland. b) Identification of pituitary cell type. c) Identification of α, β, γ, cells of Islets of Langerhans with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

Anatomical Observations- Anatomical observations, demonstration and detailed

explanation of the endocrine glands in a) Cockroach and b) Endocrine glands- pituitary, thyroid parathyroid, adrenal in fish/rat with the help of ICT tools/ models/ charts/ photographs etc.

Distribution of Marks		**Marks**
1.	Anatomical observations of fish/rat	15
2.	Stained permanent preparation:	10
3.	Identification and comment on the spots (1-10)	30
4.	Submission of stained permanent slides	05
5.	Anatomical observations of Endocrine glands	10
6.	Histological staining of endocrine gland	10
7.	Class Record	10
8.	Viva-voce	10

Total Marks: ----------

100

Semester-II, Practical-2P2–, Molecular Biology, Biotechnology and Developmental Biology
Section-A

1. Demonstration of glycogen/ carbohydrate- PAS reaction (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
2. Demonstration of DNA: Feulgen's reaction (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
3. Demonstration of DNA: RNA: Methyl Green- Pyronin reaction (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
4. Demonstration of Lipid: Sudan Black B staining (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
5. Demonstration of Protein: HgBP staining (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
6. Histochemical analysis of alkaline phosphatase (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
7. Histochemical analysis of acid phosphatase (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
8. Biochemical estimation of sugar: O-toluidine method (Source of blood: Local recognized pathology laboratory)
9. Biochemical estimation of protein: Lowrey's method (Source of blood: Local recognized pathology laboratory)
10. Biochemical estimation of DNA: Diphenylamine method (Source of blood: Local recognized pathology laboratory)
11. Biochemical estimation of RNA: Orcinol method (Source of blood: Local recognized pathology laboratory)To perform tests for qualitative analysis of saliva
12. To perform tests for qualitative analysis of bile
13. Demonstration of separation of amino acids by paper chromatography and TLC

Section-B

1 Study of the reproductive system in mammals with the help of ICT tools/ models/ charts/ photographs etc.
2 Study of different types of eggs on the basis of their yolk content.
3 Study of developmental stages of live eggs of Lymnea or any gastropod with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
4 Study of developmental stages of insects/ fishes with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
5 Study of developmental stages of frog with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
6 Chick embryo mounting by window method.
7 Study of developmental stages of chick through slides and whole mounts.
8 Morphological study of different types of placenta with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
9 Histological study of placenta with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
10 Sperm count from any domestic animal (Source of semen: Government artificial insemination centre).

Distribution of Marks		**Marks**
1.	Histochemical demonstration of DNA/RNA protein / carbohydrate/lipids/enzymes	20
2.	Estimation of sugar/protein/DNA/RNA/ qualitative analysis of saliva/bile	20
3.	Whole mount preparation of chick embryo/sperm count.	15
4.	Preparation of development stages of live eggs of Lymnea	10
5.	Identification and comment on spots (1-5)	15
6.	Class record	10
7.	Viva voce	10
	Total marks	100

- **Suggested Readings**

Structure and function of Vertebrates

1. Alexander R.N., 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. Kingslay J.S, Outlines of Comparative anatomy of vertebrates, Central Book Depot, Allahabad.
5. Honyelli A.R. The Chordates Cambridge University Press, London
6. Smith H.S. Evolution of Chordate structure, Hold Rinehart and Wintoin Inc. New York
7. Walter H.A. and Sayles L.D. Biology of Vertebrates Macmillan and co. New York
8. Romer A.S. Vertebrate body W.P. Sanders co., Philadelphia.
9. Young J.Z. Life of Vertebrates Oxford University Press, London.
10. Young J.Z. Life of Mammals Oxford University Press, London.
11. Colbert E.H. Evolution of Vertebrates John Wiley and sons Inc. New York.
12. Kent C.J. Comparative anatomy of Vertebrates.
13. Waterman A.J. Chordate Structure and Functions Macmillan Co. New York.
14. Montagna W. Comparative anatomy clarenden press, Oxford
15. Weichert C.K. Preach W. Elements of Chordates anatomy McGraw-Hill book co., New York.
16. Lovetrup S. The phytogeny of Vertebrates John Wiley and sons Inc., London.
17. Joysey K.A. and Kemp T.S. Vertebrate Evolution Oliver and Boyd, Edinberg.
18. Romer A.S. Vertebrate Paleontology University of Chicago Press, Chicago.
19. Newman Phylum Chordata.
20. Goodrich E.S. Structure and development of vertebrates. Dover publications Inc., New York
21. Hard disty M.W. and Potter I.C. Biology of Lampreys Academic Press Newyork
22. T.B.of Zoology Parker and Haswell W.A. Mac millon co. Ltd. London
23. The Biology of Amphibia Noble G.K. Dover Publication Inc Newyork

Comparative Endocrinology

1. General & Comparative Endocrinology: E.J.W., Barrington, Oxford, Clarendon Press.
2. Text Book of Endocrinology: R.H. Williams, W.B. Saunders.
3. Endocrine Physiology: C.R. Martin, Oxford University Press.
4. Comparative Endocrinology: A Gorbman et al, John Wiley & Sons.

5. Medical Physiology: W.F. Ganong (1981): 10th Edn. Lange Medical Publications.
6. Principles of Anatomy and Physiology: Tortora Grabowski, 9th Edn., John Willey & Sons.
7. Reproductive Physiology of Vertebrates: Van Tienhoven, A. (1983): 2nd Edn. Cornell Univ. Press, New York.
8. The Pituitary Gland: Imura, H. (1994), 2nd Edn., Comprehensive Endocrinology Revised Series Raven, New York.
9. Comparative Vertebrate Endocrinology: Bentley, P.J. (1976) Cambridge University Press, Cambridge.
10. General & Comparative Endocrinology: E.J.W., Barrington, Oxford, Clarendon Press.
11. Text Book of Endocrinology: R.H. Williams, W.B. Saunders.
12. Comparative Vertebrate Endocrinomental: Bentely, P.J. (1976) Cambridge University Press, Cambridge.
13. Invertebrate endocrinology: D. B. Tembhare, Himalaya publishing House (2012)

Molecular Biology and Biotechnology

1. Harper's Review of Biochemistry, Prentice Hall.
2. Principles of Biochemistry by Lehninger and Nelson, CBS publications and Distributors.
3. The Biochemistry "Students companion" by Allen J. Scism, Prentice Hall.
4. Fundamentals of Biochemistry by Jain J. L., S. Chand Publication.
5. Principles of Biochemistry by Zubay J. L., WM. C. Brown Publishers.
6. Principles of Biochemistry by Horton, Prentice Hall.
7. Concept of Biochemistry by Boyer R., Coel publication co.
8. Harper's Biochemistry eds.Murray, R. K. P. and Granner, D. K. Prentice Hall.
9. Biochemistry by Mathews C. K. and Van Holde K. E., Benjamin C. publishing Co.
10. Biochemistry by Garrett R. H. and Grisham C. M., Saunders College publication.
11. Cell and Molecular Biology by De Robertis- E. D. P., I. S. E. publication.
12. Molecular Biology by Turner P. C. and Mc Lennan , Viva Books Pvt. Ltd.
13. Advanced Molecular Biology by Twyman R. M., Viva Books Pvt. Ltd.
14. Molecular Biology by Freifelder D., narosa publication House.
15. Gene VI by Benjamin Lewis, Oxford press.
16. Gene VIII by Benjamin Lewis, Oxford press.
17. Molecular biology of Gene by Watson J. D. et. al., Benjamin publication.
18. Molecular cell Biology by Darnell J. Scientific American Books USA.
19. Molecular Biology of the Cell by Alberts B., Bray D. Lewis J., garland publishing Inc.
20. Genetics Vol. I and II by Pawar C. B., Himalaya publication.
21 Essentials of Molecular Biology by Freifelder D., narosa publication House.
22. Molecular Cell Biology by Laodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. and Darnell J., W. H. Freeman and Co.
23. The Cell: Molecular Approch by Cooper G. M.
24. Molecular Biology by Upadhay A and Upadhay K. Himalaya publication.

Gamete and Developmental Biology

1. Developmental Biology. 2nd Edition.Leon W. Browwer Saunders College publishing.
2. Current Topics in Developmental Biology eds. R. A. Pedersen and G. P. Schatten.
3. Principles of animal developmental biology: S. C. Goel, Himalaya Publishing House.

4. Developmental Biology, S.F. Gilbert. 4th Edn.Sinauer Associates Inc. Publishers.
5. An Introduction to Developmental Biology: D. A. Ede.
6. Principles of developmental: Paul Weiss edited by Hafner publishing company New York.
7. Cells into organs. 2nd Edition.The forces that shape the Embryo. John Philip Trinkaus ed. Tom Aloisi.
8. Principles of development: Lewis Wolpert et al. 1998. Oxford University Press.
9. Foundations of Embryology. B. M. Patten & B. M. Carlson. Tata McGraw Hill Publishing Company Ltd., New Delhi.
10. An Introduction to Embryology: Balinsky (1981) 5th Ed. (CBS College Publishing).
11. Embryonic and foetal development. Cambridge University Press by Austin and Short, 1982, 1994 2nd Ed.
12. Marshall's Physiology of Reproduction Longmont, Green and Co. London Vol. 1 &2. Lamming 1984, 2000.

Semester- III
Paper- I, Parasitology and Immunology
(Paper Code- MZSS31)

Objectives:

1. To help students gain a fundamental understanding with the diversity of animal parasites, interactions with hosts, life history, physiology, toxins & antitoxins.
2. To Understand the Structural and functional basis of immunity & immune system, the mechanism, mediators, detection and application of antigen-antibody reaction in the immune system.
3. To learn about practical aspects of immunology like transplantation & tumor immunology.

Unit I:

1.1 *Vibrio cholera and Clostridium titani*- Life cycle, mode of transmission, infection andtreatment

1.2 *Yersinia pestis and Influenza virus*- Life cycle, mode of transmission, infection and treatment

1.3 Covid 19 and H1 N1 viruses- Life cycle, mode of transmission, infection and treatment and awareness programe.

1.4 Dengue and Hepatitis- Life cycle, mode of transmission, infection and treatment

Unit II:

2.1 *Trypanosoma and Entomoeba* - Life cycle, mode of transmission, infection and treatment

2.2 *Leishmania and* Malaria- Life cycle, mode of transmission, infection and treatment

2.3 *Wuchereria* and *Trichinella* - Life cycle, mode of transmission, infection and treatment

2.4 Toxins and antitoxins

Unit III:

3.1 Immune system- innate and adaptive immunity; Antigens and antibodies and its interaction

3.2 Cells and organs of immune system; T cells and B cells - maturation, activation and differentiation, T cell receptors

3.3 Major Histocompatibility Complex (MHC)- general organization and inheritance of the MHC, MHC molecules and genes

3.4 Complement system- classical, alternative and lectin pathways, regulation of complement system, biological consequences of complement activation

Unit IV:

4.1 Cytokine receptors- properties of cytokines, cytokine receptors, cytokine secretion by TH1 and TH2 subsets; Cell mediated cytotoxic responses- effector mechanisms, leukocyte activation and migration.

4.2 Hypersensitivity reactions- types, mechanisms of type I to IV hypersensitivity reactions; Autoimmunity- Organ specific autoimmune disease and treatment

4.3 Transplantation immunology- blood antigens, transplantation rejection, graft rejection, familial grafting, tissue typing, cross matching, immunosuppression.

4.4 Tumor immunology- Types and roles of tumor antigens, immune response to tumor; Imunotechniques- RIA and ELISA

Semester-III, Practical-I, Parasitology and Immunology

Section-A

1. Study of different types of parasitic protozoan's with the help of already available permanent slides/ ICT tools/ Models/ Charts/ Photographs etc.
2. Study of different types of parasitic helminthes with the help of already available specimens, permanent slides/ ICT tools/ models/ charts/ photographs etc.
3. Study of different types of insect vectors with the help of already available specimens, permanent slides/ ICT tools/ models/ charts/ photographs etc.
4. Identification and study of various ecto and endo parasites with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
5. Study of different types of insect vectors and their mouth parts with the help of already available specimens, permanent slides/ ICT tools/ models/ charts/ photographs etc.
6. Study of life cycles of various parasites with the help of already available specimens, permanent slides/ ICT tools/ models/ charts/ photographs etc.
7. Demonstration of Gram positive and Gram negative bacteria.
8. Demonstration of immunoelectrophoresis.

Section-B

9. Immunological diagnosis of pregnancy.
10. Preparation of tissue sections of thymus, spleen, and lymph nodes. (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)
11. Agar gel diffusion.
12. Identification and study of T and B cells with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
13. Demonstration of Mast cells. (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)
14. Demonstration of ouchterlony double diffusion (ODD).

Distribution of marks		**Marks**
1.	Identification and comments on spot (1 to 10)	20
2.	Demonstration of Gram +ve (Positive), Gram –ve (Negative) bacteria.	10
3.	Antigen-antibody reaction/Agar gel diffusion/diagnosis of pregnancy	10
4.	T and B cells identification/Mast cell demonstration	15
5.	Submission of photographs of vectors	10
6.	Practical record	10
7.	Viva-voce	05
	Total marks	100

- **Suggested Readings**

Parasitology

1. Brock Biology of Microorganisms (Ed. IX) M. T. Madigan J. M. Martinko and J. Parker.Prentice Hall International Publication.
2. The Nematode Parasite in Vertebrate, W. Youle and Maplestone.
3. General Parasitology, V. A. Dogiel.
4. Helminthology, E. C. Fausy.
5. Platyhelminthes and Parasitisium, D.R.Birt.
6. Animal Parasite- O.W. Aisen
7. Parasitic Protozoa, J.P. Kreier and J.R. Baker. Allen and Unwin Press.

8. Medical and Veterinary Protozoalogy M. G. Kathering , A. James paul and V. Zaman. Churchill Livingstone.

Immunology

1. Immunology – R. C. Kuby et al.
2. Immunology - Tizzard.
3. Immunology -. Roitt, Brostoff and D. Male.
4. Microbiology- M. T. Pelzer. Jr. E. C. S. Chan and N. R. Krieg. Tata McGraw -Hill
5. Immunology - Abbas

Semester –III
Core- I Paper-II Wild Life and Avian Biology
(Paper Code- MZSS32)

Objectives:

1. Understand Nature, environment natural resources and their conservation, ecology & behaviour of different animals & pest management methods.
2. To learn techniques of avian study, bird biodiversity & breeding.

Course Outcome:

Under this paper the students will study:

1. Wild life sciences that seeks to meet the increasing demand for research and monitoring of wildlife and their habitats and provide trained biologist to further do research in wildlife conservation.
2. Student with wildlife course are also free to join different streams like in entomology, foresters, as a zoo curator, in wildlife department , as a conservationist etc.
3. Wild life sciences has also another employment area for the students like in sanctuaries, National parks, Wildlife research centres, Environmental monitoring centres etc.
4. Avian biology is a new field which allows one to pursue the fascination about birds through the study of topics like physiology, anatomy, nutrition, behaviour etc.
5. Study of avian biology has world wide job opportunities that involve domestication of pets, commercial poultry industry, research institute and bird sanctuaries and zoos.

Unit I- Wild life Ecology and Behaviour

1.1 Definition, importance of wildlife, Concept of conservation, Conservation movement in India

1.2 International conservation bodies; IUCN, UNDP, FAO, WWF, Red data book, rare and endangered animals of India.

1.3 Predatory-prey relationship, predator dynamics, optimal foraging theory: patch choice, diet choice, prey selectivity, anti-predator defenses.

1.4 Social organization in carnivores and primates.

Unit- II- Wild life Population and Pest Management

2.1 Population estimation of ungulates and carnivores: Faecal samples, Hair identification, Pug marks and census method.

2.2 Management and identification of animals by natural marking, collars, tags, branding, rings etc. Dynamic marking: beta light, radio- tracking, collars. 33

2.3 Basic Concept of forest soil dwelling arthropods, decomposer food web in forest soil, vertical distribution and aggregation of Collembola and mites.

2.4 Pests of Teak (Borers- Alcterogystia cadambae& Defoliators- Hyblaea puera) and Sal (Borers- Hoplocerambyx spinicornis and Defoliators- Lymantria mathura)

Unit- III- Avian Systematic

3.1 Morphology and morphometry of birds, methods of identification and bird diversity.

3.2 Bird study techniques: equipments, area of study, field data recording, bird photography.

3.3 Bird counting technique: sampling, bird singing techniques, use of hi-tech gadgets like GPS, CCTV, Camera and high vision equipments.

3.4 Estimation of breeding population, breeding ground mapping.

Unit- IV- Bird diversity and Breeding

4.1 Bird biodiversity hotspots in India, Bird sanctuaries in India.

4.2 Role of birds in ecosystem – pollination, seed dispersal, insect control, bird migratory routes.

4.3 Breeding biology, nesting territories, bird songs, courtship and mating.

4.4 Types of nest, nest building, nest defense and parental care.

Suggested reading :

1. Ali, S. and Ripley, S. D. 1983. Handbook of the Birds of India and Pakistan Compact Edition. Oxford Univ. Press. New Delhi.

2. Anon. 1975. Forest Pest Control. National academy of Science. NAS, Washington, D. C.

3. Bailey J. A. 1984. Principles of Wildlife Management John Wiley and Son. N.Y.

4. Beeson, C. F. C. 1941. The ecology and control of forest insects of India and neighboring countries, Govt. of India Press.

5. Brockman, O.F. 1959. Recreational use of Wildlife. McGraw Hill Book Company.

6. Daniel, J. C. 1983. The Book of Indian Reptiles, Bombay Natural History Society, Bombay.

7. Davis & Johnson. 1987. Forest Management. McGraw Hill Book Company.

8. Eisenbeis, G & Wichard, W. 1991. Atlas on the Biology of Soil Arthropods, Springer – verlak, London.

9. Elseth,B.D. & Baumgartner, K.M. 2003. Population Biology,Van Nostrand Co., New York.

10. Findley, W. P. K. 1967. Timber pests and diseases: Pregman Press.

11. Graham, S.A. and Knight, F.B. 1965. Principles of Forest Entomology, McGraw Hill book Company.

12. Harris, W.V. 1964. Termites: Their recognition and control. Longmans, London.

13. Krebs, J. R. & Davies, N. B. (1989) An Introduction to Behavioral Ecology. Oxford: Blackwell Scientific Publications.

14. Knight, P. V., 1980. Principles of forest entomology, McGraw Hill Publication.

15. Lenderen D. 1991. Modelling in behavioral ecology. Chapman & Hall London U.K.

16. Rodgers N.A & Panwar H.S 2001. Planning of wild life / Protected area Network in India. The report of wild life Institute of India, Dehradun.

17. Snodgrass, R. E. 1995. Principles of Insect Morphology. USDA.1952. Insects: The Year Book of Agriculture.

18. Staddon, J.E.R. 1983. Foraging and Behavioral Ecology. Adaptive Behavior and Learning. Cambridge University Press. 34

19. Stephens, D.W., Brown, J.S. & Ydenberg, R.C., 2007. Foraging: Behavior and Ecology. Chicago: University of Chicago Press

20. Trippense, R.E. 1953. Wildlife Management, McGraw Hill Book Co.

21. Van Tyne, J. & Berger, A. J., 1976. Fundamental Ornithology, MacMillan Publishing Co. Inc. N. Y.

22. Wallace, G. J. & Mahan H. D., 1975. An Introduction to Ornithology. MacMillan Publishing Co. Inc. N. Y.

23. West, D.C., Shugart, H.H. & Botkin, D.F., 1981,Forest Succession: Concepts and Application, Springer-verlag, New York.

24. Witter, J A & Coulson, R N, 1984, Forest entomology: ecology and management, John Wiley and Sons, U.S.A

Semester –III
Paper-III, Special Group-Fish and Fisheries -I,
General studies
(Paper Code- MZSS33FF)

Objectives:

1. This paper is aimed to introduce origin, evolution, classification & general characters of fishes.
2. To introduce the accessory respiratory organs in fishes.

Course Outcome:

After completion of this paper students will gain knowledge about:

1. Origin & evolution of fishes.
2. Classification, general characters & affinities of Elasmobranchs, Chondrichthyes, Holocephali, Actinopterrugii & Crossopterygii.
3. Classification, general characters & affinities of Dipnoi.
4. Accessory respiratory organs & mechanism of air breathing in fishes.

Unit-I

1.1 Origin and Evolution of fishes:Evolutionary classification, ostracoderms and cyclostomes, placoderms, Cartilaginous fishes,Bony fishes.

1.2 Jaw suspension and origin of paired fins in fishes.

1.3 Classification and general characters of Placoderms: Acanthodii, Coccostei, Pterychthyes, Stegoselachii, Palaeospondyli.

1.4 Affinities of ostracoderms and cyclostomes.

Unit-II

2.1 Classification and general characters of Elasmobranch/Chondrichthyes: Sharks and Rays, Holocephali

2.2 Affinities and specializedcharacters of Holocephali.

2.3 Classification and general characters of Actinopterygii/Ray finned fishes:Palaeonisciformes,Polypteriformes, Acipenseriformes, Amiiformes, Teleostea (Osteoglossomorpha, Elopomorpha, Clupeomorpha, Euteleostei)

2.4 Affinities of Crossopterygiians.

Unit-III

3.1 Dipnoi: General characters, classification, fossil Dipnoians and distribution of Dipnoians.

3.2 Specialized characters and affinities of Dipnoians, Blood vascular system of Protopterus

3.3 Respiratory system: Structure of gills in fishes, gill histology.

3.4 Blood supply of a gill and mechanism of respiration in teleosts..

Unit-IV

4.1 Accessary respiratory organs: skin, buccopharynx, alimentary canal opercular cavity, and air bladder.Origin and significance of air breathing organs.

4.2 Mechanism of air breathing, function of accessory respiratory organ.

4.3 Air bladder: Origin and evolution, types of air bladder- physostomous, physoclistous, structure of bladderwall and gas secreting complex

4.4 Blood supply to air bladder and functions of air bladder

Semester-III
Paper-IV, Special Group-Fish and Fisheries –II
Applied fisheries
(Paper Code- MZSS34FF)

Objectives:

1. To make students aware about the applications & economic importance of Fishery Science.

Course Outcome:

After studying this special paper the students will be able to:

1. Learn the various fisheries of India & breeding of Indian major carps.
2. Understand the culture of Indian & exotic fishes.
3. Know methods of culture of air breathing fishes, Crab culture, Ornamental fish culture & Culture of sea weeds and Spirulina.
4. Learn the techniques of Pearl culture: fresh water and marine pearl oysters, Prawn culture, Frog culture.

Unit-I

1.1 Fresh water fisheries of India, Riverine and Reservoir fisheries.
1.2 Estuarine and Marine fisheries of India.
1.3 Breeding of Indian major carps : i) Natural breeding, ii) Induced breeding, iii) methods of obtaining fish seed from natural resources.
1.4 Neuroendocrine control of carp reproduction.

Unit-II

2.1 Culture of Indian and exotic fishes – common carp, Composite culture, common carp culture
2.2 Monoculture, Monosex culture.
2.3 Integrated Fish farming with – Poultry, Duck, Pig and Paddy.
2.4 Sewage fed fisheries

Unit-III

3.1 Culture of air breathing fishes.
3.2 Crab culture
3.3 Ornamental fish culture: i) Oviparous, ii) Live bearers.
3.4 Culture of sea weeds and Spirulina.

Unit-IV

4.1 Pearl culture: freshwaterand marine pearl oysters,culture methods
4.2 Oyster culture: i) Species- edible ii) Culture methods.
4.3 Prawn culture (Life cycle and breeding)
4.4 Frog culture

Semester-III, Practical-II, Special Group-Fish and Fisheries

1. Identification of Commercial important fishes upon species.
2. Anatomical observations, demonstration and detailed explanation of fish in general anatomy of fish ,reproduction and urino genital system, Endocrine glands with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of cranial nerves in *Wallago* and *Labeo* with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
4. Identification of various stages of carps, spawn, fry, fingerlings of major carps with the help of already available preserved material, permanent slides/ charts/ models / photographs/ ICTtools etc.
5. Permanent preparation of various scales using wastes from recognized fish markets..
6. Estimation of dissolve oxygen in water sample.
7. Estimation of CO2 in water sample.
8. Estimation of chloride sample in water.
9. Estimation of protein in muscles/ blood of fish (Source of fish blood: Local recognized fishmarkets).
10. Determination of free fattyacids (FFAs) in fish oil .
11. Study of morphometric and meristic characteristics of fish (Source of fish: Local recognized fish markets).

Distribution of Marks:		**Marks**
1.	Anatomical observations (Major)	20
2.	Physiology Experiment	20
3.	Mounting of Scale	10
4.	Identification of fishes	30
5.	Practical Record	10
6.	Viva voce	10
	Total marks	100

Semester –III
Paper-III, Special Group-Mammalian Reproductive Physiology -I
Reproductive Process in Male
(Paper Code- MZSS33MRP)

Objectives:
To introduce students to the physiology of male reproductive system.

Course Outcome:
In this special paper the students on completion of the course, will be able to:

1. Understand the Structure , functions of Sertoli cells, Leydig cells ,Epididymis and sperm.
2. Students will understand Spermatogenesis (Molecular changes, hormonal regulation), and spermiogenesis, Sperm capacitation: molecular and biochemical changes, decapacitation.
3. Understand the Structure and function of Vas deferens, Seminal Vesicle: Structure, function and regulation, Prostate gland: Structure, function and prostatic cancer, Cowpers gland and Penis, its structure and mechanism of erection.
4. Male reproductive behaviour: Mating system, neural and hormonal control.,Pheromones: types, structure and function. and Infertility: causes and remedy.
5. Anthologically relevant diseases in advanced age.

Unit-I

1.1 Development, descent and structure of the testis.
1.2 Spermatogenesis: Molecular changes, hormonal regulation, and spermiogenesis.
1.3 Sertoli cells: Structure , functions, blood testis barrier.
1.4 Leydig cells: Structure , functions and interaction with peritubular and Sertoli cells.

Unit-II

2.1 Epididymis: Structure , organization function and anamolies.
2.2 Structure of spermatozoa and anomalies.
2.3 Sperm capacitation: molecular and biochemical changes, decapacitation.
2.4 Vas deferens: Structure and function.

Unit-III

3.1 Seminal Vesicle: Structure, function and regulation.
3.2 Prostate gland: Structural organization, function, endocrine regulation and prostatic cancer.
3.3 Cowpers gland: Structure, function and anomalies.
3.4 Penis: Structure andmechanism of erection and problems in ejaculation.

Unit-IV

4.1 Male reproductive behaviour: Mating system, neural and hormonal control.
4.2 Pheromones: types, structure and function.
4.3 Infertility in male : causes and remedy.
4.4 Andrology: reproductivehealth dysfunction in advanced age..

Semester-III

Paper-IV, Special Group-Mammalian Reproductive Physiology-II

Reproductive Process in Female

(MZSS34MRP)

Objectives:

To introduce students to the physiology of female reproductive system.

Course Outcome:

In this special paper the students on completion of the course, will be able to

1. Study the differentiation of the ovary and female genital tract, the process of folliculogenesis and its hormonal control and signalling for ovulation.
2. To understand the oestrous cycle in mammals, Menstrual cycle and Menopause in female, mechanism and hormonal control of ovulation
3. Histology and function of Corpus luteum and structure, regional differentiation and function of oviduct, uterus.
4. Understand the structure, functions of cervix and vagina, also detection of various stages of oestrous cycle by vaginal cytology, vaginal plug. Onset of puberty and delayed puberty.
5. To study the role of prostaglandins in reproduction, anatomy and growth of mammary glands and lactogenesis and galactopoiesis.

Unit- I

1.1 Differentiation of the ovary and female genital tract.
1.2 The process of folliculogenesis and its hormonal control.
1.3 Recruitment, selection, dominance of follicle and signaling for ovulation.
1.4 Follicle wall: Theca, differentiation, steroid hormone synthesis (2-gonadotropin,2- cell concept).

Unit-II

2.1 Estrous cycle in mammals.
2.2 Menstrual cycle and Menopause.
2.3 Mechanism and hormonal control of ovulation .
2.4 Corpus luteum: histogenesis, function, maintenance and luteolysis.

Unit-III

3.1 Oviduct: structure, regional differentiation and function.
3.2 Uterus: Types, abnormalities.
3.3 Cervix-structure, functions and cervical cancer.
3.4 Vagina-structure, function, detection of various stages of oestrous cycle by vaginal cytology, vaginal plug.

Unit-IV

4.1 Onset of puberty and delayed puberty.
4.2 Prostaglandins- Structure, biosynthesis, mode of action and their role in reproduction .
4.3 Anatomy and growth of mammary glands.
4.4 Lactogenesis and galactopoiesis.

Semester-III, Practical-II, Special Group-Mammalian Reproductive Physiology (MRP)

1. Demonstration of surgical operation in rat/ mice Orchidectomy or Vasectomy or Epididymoctomy with the help of ICT tools
2. Anatomical observations, demonstration and detailed explanation of the male reproductive system of rat/ mice with the help of ICT tools/ models/ charts/ photographs etc.
3. Sperm count for the assessment of fertility (Source of semen: Government artificial insemination centre).
4. Study of spermatogenesis and identification of its various stages with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
5. Estimation of fructose/ acid and alkaline phosphatase/sialic acid in reproductive tissue /semen using animal wastes fromrecognized slaughter houses/ poultry farms/AIC etc.
6. Experimental studies (histological slides for identification) of the following with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
   a. Effects of anti-androgen on testis and sex-accessory glands
   b. Effect of heavy metals on testis and sex accessory glands
7. Histology: Histological changes in male reproductive organs and sex accessories during active and inactive stage with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
8. Study of following endocrine glands with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
   a. Pituitary gland: anatomy, cell types and identification of cell types
   b. Thyroid gland: Histology of active and inactive glands, effects of antithyroid drugs
   c. Adrenal: Normal histology and effects of metapyrone and corticosteroids administration
9. Field Work: Visit to Artificial insemination centre.

Distribution of marks	**Total Marks**
1. Surgical operation	20
2. Anatomical observations	15
3. Minor experimental analysis	10
4. Biochemical estimation	20
5. Identification and comments on spots (1-5)	15
6. Practical record	10
7. Viva-voce	10
Total marks	100

Semester-III
Paper-III, Special Group-Cell Biology –I
Techniques in Cell Biology
(Paper Code- MZSS33CB)

Objectives:

To introduce students to tools & techniques in Cell Biology & its applications.

Course Outcome:

After completion of this paper the students will be able to:

1. To understand the working and applications of various microscopy techniques This will be helpful to them in R & D jobs.
2. Students will acquire knowledge of Basic principles , applications and working of various types of centrifuges, Spectroscopy and Chromatography technique used in biophysics.
3. Understand the Cell culture techniques and will learn to design and functioning of tissue culture laboratory.
4. Students will learn tissue engineering, Enzymology of recombinant DNA technology , Cloning vectors,Gene probes and Gene library – Construction
5. Understand gene cloning and its application, detecting DNA polymorphism, DNA chip technology.

Unit-I

1.1 Light Microscopy: principles, working and applications of Phase contrast, Interference, Fluorescence and Confocal microscopy. Electron Microscopy - Principles, working, applications of Scanning & transmissionelectron microscopy.

1.2 Basic principles of sedimentation , types of centrifuges, Preparative centrifugation, analytical centrifugation and applications of ultracentrifugation in cell fractionation. Cell separation by flow cytometry.

1.3 Isolation and purification of DNA, RNA & proteins. Isolation and purification, molecular weight determination & characterization of proteins.

1.4 NMR, ESR & X-Ray crystallography. Nanorobot & Nubot.

Unit-II

2.1 Principle, working and application of UV/Visible absorption spectroscopy, UV/Visible fluroscence spectroscopy, Mass spectroscopy.

2.2 Principle, working and applications of paper and thin layer chromatography, affinity chromatography, gel filtration chromatography, ion-exchange chromatography and Gas-liquid chromatography.

2.3 Cell culture techniques- Monolayer and polylayer. Design and functioning of tissue culture laboratory.

2.4 Culture media preparation and cell harvesting methods, Cell proliferation measurements, Cell viability testing, Tissue engineering.

Unit-III

3.1 Physicochemical properties of Nucleic acids. Enzymology of recombinant DNA technology- DNA modifying enzymes, restriction endonucleases, DNA ligases.

3.2 Cloning vectors – Plasmid, Lambda & M13 virus based vectors, phagemids, cosmids, YAC and BAC vectors.

3.3 Gene probes – Designing and production of gene probes for recombinant DNA technology.

3.4 Gene library – Construction of C-DNA & genomic library.

Unit-IV

4.1 Gene transformation and transfection methods for recombinabt DNA. Genetic screening methods for gene constructs.

4.2 Applications of gene cloning – Sequencing cloned DNA, *invitro* mutagenesis, PCR based mutagenesis.

4.3 Applications of gene cloning – Expression of foreign genes, production of fusion proteins, phage display techniques.

4.4 Applications of gene cloning – Identifying and analyzing mRNA, analyzing gene *in situ*, analyzing promoter protein interactions, transgenics, detecting DNA polymorphism, DNA chip technology.

Semester –III
Paper-IV, Special Group-Cell Biology-II
Genetics & Genomics
(Paper Code- MZSS34CB)

Objectives:

1. To understand the principles of genetics & interrelationship to human disorders & syndromes.
2. Achieve a working knowledge of concepts and recent discoveries in genomics. Explain how technological advances have led to conceptual advances in genomics.
3. To know key concepts of developmental genetics & population genetics.

Course Outcome:

After completion of this course, students should

1. Understand the Chromosome structure, classification ,Chromosomal mutations and Structural abnormalities of human chromosomes and related syndromes:
2. To understand Human metabolic disorders, Molecular methods of chromosome studies and applications – in situ hybridization, FISH, Genome organization
3. Understanding about Functional genomics, Molecular cytogenetic, DNA sequencing, microarray.
4. Students will understand Developmental genetics, Cell specification and determination– Role of segmentation genes,
5. To learn Population genetics, Genetic selection, Speciation and isolating mechanisms.

Unit I

1.1 Chromosome structure and classification – Human karyotyping and criteria for ideogram preparation. Chromosome banding methods, it's applications in genetics.

1.2 Chromosomal mutations, molecular mechanism of mutation. Structural abnormalities of human chromosomes and related syndromes: Deletion, Robersonian translocation, Cri-du-chat syndrome, Prader-Willi syndrome, Williams syndrome, Wolf-Herschhorn syndrome.

1.3 Human metabolic disorders: Phenylketonuria, Lesch-Nyhan syndrome, Tay-Sachs disease, Alkaptonuria, Albinism, Congenital adrenal hyperplasia, Emphysemia, Glucose-6-phosphate dehydrogenase deficiency.

1.4 Molecular methods of chromosome studies and applications – *in situ* hybridization, FISH.

Unit-II

2.1 Genome organization – Hierarchy in genome organization. Physical and genetic mapping of genome. Organelle genome – organization and expression of mitochondrial and chloroplast genome.

2.2 Detailed account of genome models of lambda phage, *E. coli*, *C. elegans*, *Drosophila* and humans.

2.3 Functional genomics – Human genome project.

2.4 Molecular cytogenetic techniques – DNA fingerprinting, automated karyotyping, chromosome painting, DNA sequencing, microarray.

Unit-III

3.1 Sex determination–Mechanism of sex determination in *Drosophila* human.and

3.2 Developmental genetics–Establishment of anterior-posterior polarity and role of maternal effect genes during development.

3.3 Cell specification and determination–Role of segmentation genes, gap genes, pair-rule genes and segment polarity genes during development. Homeobox concept in different phylogenic groups.

3.4 Cell differentiation and differential gene activity, totipotency and nuclear transfer experiment.

Unit-IV

4.1 Population genetics – Demes, gene pool, gene flow and genetic drift. Hardy-Weinberg equation and its significance in population genetics.

4.2 Genetic selection–Selection pressure, fitness and coefficient of selection, types and examples of genetic selection.

4.3 Speciation and isolating mechanisms.

4.4 Theories of organic evolution.

Semester-III, Practical-II, Special Group- Cell Biology

1 Study of structure of prokaryotic cell using lactobacilli (curd)

2 Study of structure of eukaryotic cell and cell organelles: nucleus, mitochondria, golgi apparatus, smooth endoplasmic reticulum, rough endoplasmic reticulum, liposomes, microtubules, microfilaments, ribosomes, centrioles with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

3 Study of electron micrographs of eukaryotic cell and cell organelles.

4 Study of different types of mammalian cells (tissues) with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

5 Isolation of DNA from any available material.

6 Demonstration of Mitochondria by vital staining using buccal epithelium.

7 Study of mitotic stages in onion root tips.

8 Estimation of Mitotic Index.

9 Study of meiotic stages from Tradescantia buds.

10 Study of polytene chromosome in Chironomous larva with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

11 Measurement of cell size using oculometer.

12 Study of human karyotype using photographs: normal male and female diseases conditions (classification of chromosomes according to size and position of centromere).

13 Identification and study of male and female drosophila, mutants in eye color and structure, body color, wings with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

14 Study of drosophila culture technique and life cycle of drosophila

15 Problems based on Hardy- Weinberg equation and its significance in population genetics.

16 Design and functioning of tissue culture lab

Distribution of Marks		**Marks**
1.	Isolation of DNA/ Demonstration of mitochondria	20
2.	Estimation of mitotic index/ Demonstration of meiotic stages	15
3.	Measurement of cell size by oculometer/ Problems based on Hardy-Weinberg equation	15
4.	Identification and comment on spots (1-10)	30
5.	Class record/ submissions	10
6.	Viva-voce	10
	Total marks	100

Paper-III, Special Group-Animal Physiology-I
Physiology of Digestion and Excretion
(Paper Code- MZSS33AP)

Objectives:

To understand the anatomy & physiology of digestive & excretory system.

Course Outcome:

After completing this course, students will know

1. Histology of salivary gland & other glands of digestive system.
2. Histology of intestine & intestinal glands.
3. Mechanism & physiology of digestion.
4. Functional anatomy of kidney & mechanism of urine formation.
5. Regulation of urine and body fluid concentration and volume.
6. Causes & mechanism of renal failure.

Unit-I

1.1 Histology of salivary glands, Mechanism of salivary secretion, composition and functions of saliva.

1.2 Histology of stomach, mechanism of secretion of gastric juice, composition and functions of gastric juice.

1.3 Histology of pancreas, mechanism of pancreatic secretion, composition and functions of pancreatic juice.

1.4 Histology of liver, bile secretion, its composition and functions.

Unit-II

2.1 Histology of small and large intestine, intestinal glands, itssecretion and control, intestinal bacteria.

2.2 Digestion and absorption of proteins, carbohydrates and fats in the gastrointestinal tract.

2.3 Neural and endocrineregulation of gastro intestinalmovements and secretions.

2.4 Gastrointestinal Disorders (Achalasia, Gastritis,Pancreatitis and Colitis)

Unit-III

3.1 Functional anatomy of kidney- Types and ultrastructure of Nephron, blood and nerve supply.

3.2 Mechanism of formation of urine - Ultrafiltration, tubular reabsorption, tubular secretion and its regulation.

3.3 Mechanism of concentration and dilution of urine – The Counter current system.

3.4 Normal and abnormal constituents of urine, micturition & its control.

Unit-IV

4.1.1 Regulation of urine and body fluid concentration and volume, hormonal mechanismof Antidiuratic hormone, Aldosterone and Renin – Angiotensin system in renal physiology.

4.2 Regulation of water, electrolytes and acid base, renal clearance.

4.3 Physiology of nitrogen excretion

4.4 Renal failure- Acute and chronic renal failure, renaldiuretics

Semester –III
Paper-IV, Special Group- Animal Physiology-II
Physiology of Circulation
(Paper Code- MZSS34AP)

Objectives:

1. To learn the anatomy, histology & physiology of heart & cardiac cycle.
2. To know composition, function of blood & lymph, disorders of blood.

Course Outcome:

By the end of the course, the students should be able to:

1. Understand structure & functioning of heart.
2. Cardiac cycle & cardiac failure.
3. Cellular composition and functions of blood, blood disorders.
4. Lymph – composition, formation and functions, Haemostasis, Transport of O2 & CO2 by blood.

Unit-I

1.1 Structure, properties and function of cardiac muscles.
1.2 Anatomy, histology and nerve innervation of the heart, heart valves.
1.3 Pace maker and specialized conducting fibers.
1.4 Blood pressure and factors affecting blood pressure.

Unit-II

2.1 Cardiac cycle, Electrocardiogram (ECG).
2.2 Cardiac output and itscontrol, heart sound and Cardiac murmur
2.3 Haemodynamics and Hemorrhage
2.4 Circulatory shock and cardiac failure.

Unit-III

3.1 Cellular composition and functions of blood.
3.2 Blood groups and Blood transfusion.
3.3 Anaemia and polycythemia, platelets and Blood substitute.
3.4 Pathological condition of blood glucose and lipids.

Unit-IV

4.1 Haemostasis, Cascade of biochemical reactions involvedin coagulation of blood.
4.2 Transport of O2 & CO2 by blood.
4.3 Blood disorders- Anemia, Bleeding disorder and blood cancer.
4.4 Lymph – composition, formation and functions.

Semester-III Practical-II, Special Group- Animal Physiology

I. Physiology Experiments

1 Effect of pH, temperature and incubation on human salivary amylase activity.

2 Determination of:-
a) Clotting time, bleeding time.
b) Erythrocyte sedimentation rate and c) Haemoglobin concentration.

3 Determination of protein, glucose in Urine.

4 Study of structure of RBCs in vertebrates with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

5 Determination of protein, glucose in Urine from diabetic patient.

6 Total leukocyte count and differential leukocyte count.

7 Total erythrocyte count.

II. Quantitative Analysis

1 Estimation of blood Glucose (Source of blood: Local recognized pathology laboratory)

2 Estimation of blood proteins (Source of blood: Local recognized pathology laboratory)

3 Estimation of blood triglycerides (Source of blood: Local recognized pathology laboratory)

4 Estimation of blood cholesterol (Source of blood: Local recognized pathology laboratory)

5 Estimation of blood Sodium, potassium, Calcium (Source of blood: Local recognized pathology laboratory)

6 Estimation of blood alkaline & acid phosphates (Source of blood: Local recognized pathology laboratory).

7 Blood amino-acid separation by TLC / Paper chromatography (Source of blood: Local recognized pathology laboratory).

III. Qualitative Analysis

1 Normal & abnormal constituents of human urine.

2 Blood group detection by antisera.

3 Preparation and study of Urine crystals.

4 Estimation of serum urea (Source of blood: Local recognized pathology laboratory)

5 Preparation and study of haemin crystals.

IV. Histological Study of Stomach, Liver, Small intestine, Large intestine, Pancreas, Kidney, Thyroid, Pituitary, Blood smear, Heart, T.S. Vein, T.S. Arterywith the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

Distribution of Marks:		**Marks**
1.	Physiology Experiment	20
2.	Major quantitative analysis	20
3.	Minor quantitative analysis	10
4.	Qualitative analysis	15
5.	Identification and comment on spots(1-5)	15
6.	Practical Record	10
7.	Viva-voce	10
Total marks		100

Semester-IV

Paper-I

Biotechniques, Biostatistics, Ethology, Toxicology and Bioinformatics

(Paper Code- MZSS41)

Objectives:

To introduce students to important concepts of biotechnology, ethology, toxicology & interdisciplinary subjects like biostatistics & bioinformatics.

Course Outcome:

After completion of this course, students should know:

1. To understand various sterilization techniques, media for microbial culture, inoculation Methods.
2. Animal cell & tissue culture.
3. To understand Basic principle of sedimentation and centrifugation, Chromatography, and Electrophoretic separation techniques.
4. Students will learn key concepts of Bioststistics.
5. To understand animal behaviour and Animal ethics.
6. Understand concepts & scope of toxicology.
8. Students will learn concepts scope of bioinformatics.

Unit- I

1.1 Sterilization techniques, media for microbial culture, inoculation methods

1.2 Animal cell & tissue culture- primary culture, cell lines, cell quantification, growth kinetics of cells in culture, cryopreservation of cells

1.3 Basic principle of sedimentation and centrifugation; Radioactive isotopes.

1.4 Chromatographic separation- Thin layer and gas chromatography; Electrophoretic separation techniques

Unit- II

2.1 Central tendency and dispersion- mean, mode and median with examples; Dispersion and variance.

2.2 Probability and probability distribution -Basic theory and type of probability and probability distribution with example (binomial, poison and normal distribution).

2.3 Sampling – types, standard error (SE), standard deviation (SD), significance tests - t- test, z- test, Chi square test- assumption, importance and example

2.4 Neuronal control, genetic and environmental components in development of animal behavior; Animal ethics- Introduction, concept, organizations and their functions

Unit- III

3.1 Introduction and scope of toxicology

3.2 Environmental toxicology- Classification of environmental toxicants; Pesticides, Fertilizers, Heavy and trace metals, radioactive substances, food additives, automobile emission.

3.3 Translocation of toxicants- absorption, distribution, biotransformation and excretion of toxicants

3.4 Toxicity tests- Types (Acute and Chronic), calculation of LC50 and LD 50; Antidotal thereapy- Antidotes, type of antidotes and antidotal procedure.

Unit- IV

4.1 Introduction and scope of bioinformatics - history, scope of bioinformatics in research, business and employment opportunities; Bioinformatics in India.

4.2 Sequence alignment- Pair wise sequence alignment and multiple sequence alignment.

4.3 Biological databases– Basic local alignment search tool (BLAST), and FASTA, Variants of BLAST, PSI-BLAST.

4.4 Phylogenetic analysis- Tree style, tree building methods

- **Suggested Readings**

Tissue culture and Biotechniques

1. Animal cell culture – A practical approach, (III Edition) Ed. John R. W. Masters. IRLPress.
2. *In vtro*-cultivation of animal cell, biotechnology by open learning (BIOTOL), Butterworth Heinemann Ltd. Linaere house, Jordan Hill Oxford.
3. Introduction to instrumental analysis, Robert Broun, McGraw Hill International Edition.
4. A Biologist Guide to Principle and Techniques of Practical Biochemistry K. Wilson and K.H. Goulding ELBS Edition.
5. Molecular Cell Biology, J. Darnel, H. Lodish and D. Baltimore. W. H. Freeman and Company New York.
6. DNA Techniques by Alcamo.
7. Insect Cell Culturing Engineering, Ed. M. F. A. Goosen, A.J. Daugulis and P.Faulkner.
8. Biotechnlogy - B. D. Sings.
9. Biophysical Chemistry – Upadhyay, Upadhyay and Nath.

Toxicology

1. Animal Clinical Chemistry: A Primer for Toxicologists. G.O. Evans (Ed.) ISBN: 0748403515, Taylor & Francis, 1996.
2. Animal Models in Toxicology. S.C. Gad & C.P. Chengelis (Eds.), ISBN: 0824784561, Marcel Deker, 1992.
3. Annual Reviews of Pharmacology & Toxicology, ISBN: 0824304373, 1997
4. Basic Toxicology: Fundamentals, Target Organ & Risk Assessment. F.C. Lu, ISBN: 1560323809, Taylor & Francis, 1996.
5. Casarett & Doull's Toxicology: The Basic Science of Poisons. C.D. Klaassen (Ed), ISBN: 0071054766, McGraw-Hill, 1996.
6. Comprehensive Toxicology. I. Sipes, C.A. McQueen & A. Gandolfi (Eds.), ISBN: 0080423019, Elsevier Science, 1997.
7. General & Applied Toxicology. B. Ballantyne, T. Mars & P. Turner (Eds), Vol I & II, ISBN: 0333498011, Macmillon/Stockton Press, 1993.
8. Loomi's Essentials of Toxicology, T.A. Loomis & A.W. Hayes, ISBN: 0124556256, Academic Pess, 1996.
9. Encyclopaedia of Toxicology, Chemical and Concepts, P. Wexler, ISBN: 012227220-X, Academic Press, 1998.
10. Dictionary of Toxicology. E. Hogson, J.E. Chambers & R.B. Mailman, ISBN: 1561592161, Groves ic, 1997.

Biostatistics

1. Biostatistics-Arora and Malhan
2. Biostatistics- Jasraj and Gurudeep Raj
3. Biostatistics- P. Ramkrishan
4. Methods in Biostatistics-Mahajan

Bioinformatics

1. Mount W. 2004. Bioinformatics and sequence genome analysis 2nd Editon CBS Pub. New Delhi.
2. Bergman, N. H. Comparative Genomics. Humana Press Inc. Part of Springer Science+BusinessMedia, 2007.
3. Baxevanis, A. D. Ouellate, B. F. F. 2009. Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
4. Campbell A. M. and Heyer, L. J. 2007. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings.
5. Des Higgins and Willie Taylor 2000. Bioinformatics: Sequence, structure and databanks. Oxford University Press.
6. Rashidi H. H. and Buehler 2002. Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.
7. Gibas Cynthia and Jambeck P. 2001. Developing Bioinformatics Computer Skills: Shroff Publishersand Distributors Pvt. Ltd. (O'Reilly), Mumbai.

Semester –IV
Core Paper II
Radiation and Chronobiology
(Paper Code- MZSS42)

Objectives:

To understand key concepts, scope & significance of radiation biology & chronobiology.

Course Outcome:

After completing this course, students will learn about :

1. Radiation Biology(Definition, scope , Classification , and significance of radiation).
2. Principles of radiation dosimetry, direct and indirect effects. Radiations lesions in DNA, radiobiological effect on cell.
3. Effect of Radiation on Human Health
4. To understand effect of Radiation in the developing embryo and fetus, radiation induced heritable diseases.
5. To study Circadian cycle, Concept of central and peripheral clock system,Circadian pacemaker system in invertebrates with particular reference to Drosophila ,rodents.
6. Biological clock ,Centers of biological clock – Supra chiasmatic nuclei, pineal gland and optic lobes. Depression and sleep disorders.
7. Chronopharmacology, chronomedicine, chronotherapy.

Unit- I: Radiation Biology

1.1. Definition, scope and significance of radiation biology.

1.2. General classification of radiation. Ionizing radiation, linear energy transfer, radiation dose and units.

1.3. Principles of radiation dosimetry, direct and indirect effects. Radiations lesions in DNA, radiobiological effect on cell.

1.4. Radiation sensitizers and protectors.

Unit II: Effect of Radiation on Human Health

2.1. Health consequences after total body irradiation from radiation accidents.

2.2. Long term radiation risks from low radiations doses.

2.3. Radiation induced cancer.

2.4. Radiation effects in the developing embryo and fetus, radiation induced heritable diseases.

Unit- III: Circadian cycle

3.1. Organization of circadian system in multicellular animals.

3.2. Concept of central and peripheral clock system.

3.3. Circadian pacemaker system in invertebrates with particular reference to Drosophila.

3.4. Circadian pacemaker system with particular reference to rodents.

Unit- IV: Biological clock

4.1. Centers of biological clock – Supra chiasmatic nuclei, pineal gland and optic lobes.

4.2. The relevance of biological clock for human welfare- clock function and dysfunction.

4.3. Depression and sleep disorders.

4.4. Chronopharmacology, chronomedicine, chronotherapy

Suggested Readings:

1. Kumar, V. 2002. Biological Rhythms, Narosa Publishing House, Delhi/ Springer-Verlag, Germany
2. Dunlap, J. C., Loros, J. J. & DeCoursey, P. J. 2004. Chronobiology Biological Timekeeping, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
3. Fliedner, T. M., Friesecke, I. & Beyrer, K., 2001. Medical management of radiation accidents– manual on the acute radiation syndrome.British Institute of Radiology Supplement. 52
4. Kramer, K. & Merrow, G. 2013. Handbook of Experimental Pharmacology, Circadian Clocks, Springer, London.
5. Hall, E. J, Giaccia A. J. 2006. Radiobiology for the radiologist, Philadelphia, Pa: Lippincott Williams & Wilkins.
6. Saunders, D.S., Steel, C.G.H., Afopoulou X. & Lewis, R.D. 2002. Insect Clocks, Barens and Noble Inc., New York, USA.
7. International Commission on Radiological Protection, 2003: Biological effects after prenatal irradiation (embryo and foetus), ICRP publication.
8. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, 2006: Low dose extrapolation of radiation-related cancer risk, ICRP publication.
9.Foster, R. & Kreitzman, L. 2014. Rhythms of Life, The Biological Clocks that Control the Daily Lives of Every Living Thing by, Profile Books Ltd.

Semester –IV
Paper-III, Special Group-Fish and Fisheries-I
General studies
(Paper Code- MZSS43FF)

Objectives:

1. To understand structure & physiology of important organs in fishes.
2. To understand the mechanism & factors responsible for migration in fishes.

Course Outcome:

After completion of this course, students will learn about

1. Structure & physiology of alimentary canal, Structure of kidney, osmoregulation in fishes.
2. Chemoreceptors, migration in fishes.
3. Structure & physiology of male & female reproductive systems in fishes.
4. Structure, hormones and functions of pituitary gland, thyroid and other glands, Hypothalamo-hypophysial system in fishes.
5. Structure and functions of Pancreatic islets and Pineal organ.

Unit-I

1.1 Structure of alimentary canal in teleosts; feeding habits, histology of different parts
1.2 Modification of alimentary canal in relation to feeding habits, digestion and absorption of food.
1.3 Structure of kidney in teleosts: Head kidney and trunk kidney, histology, blood supply
1.4 Osmoregulation in Freshwater forms, Marine forms, Rays and Skates, Diadromous fishes.

Unit-II

2.1 Chaemoreceptors: Structure of olfactory organs, structure of olfactory epithelium, olfactory bulb and tract.
2.2 Structure and functions of taste buds.
2.3 Migration in fishes: Types- Anadromous, Catadromous, Amphidromous, factors responsible for migration , periodicity of migration.
2.4 Role of hormones in migration, Orientation and Navigation during migration.

Unit-III

3.1 Structure of male reproductive system
3.2 Mechanism of spermatogenesis and its hormonal control
3.3 Structure of female reproductive system
3.4 Oogenesis, egg development, hormonal control of oogenesis

Unit-IV

4.1 Structure, hormones and functions of pituitary gland in fishes
4.2 Structure, hormones and functions of other thyroid and other glands.
4.3 Hypothalamo-hypophysial system in fishes.
4.4 Structure and functions of Pancreatic islets and Pineal organ..

Semester –IV
Paper-IV, Special Group-Fish and Fisheries -II
Fishery technology and Fish pathology
(Paper Code- MZSS44FF)

Objectives:

To comprehend the key concepts of Fishery technology and Fish pathology.

Course Outcome:

After completion of this course, students will learn about

1. Construction and maintenance of fish farm, gear and crafts in inland water, Indian fishery legislation and their importance, Water pollution and its effect on fisheries.
2. Plankton study, culture of zooplankton, manufacture and maintenance of aquarium, hybridization technique.
3. Fish marketing.
4. Sex determination, sex reversal and chromosome manipulation in fishes.
5. Fish conservation.
6. Spoilage and methods of preservation of fish, Fish products and by-products
7. Fish pathology, fish diseases and its control.

Unit-I

1.1 Construction and maintenance of fish farm.
1.2 Gear and crafts in inland water.
1.3 Indian fishery legislation and their importance.
1.4 Water pollution and fisheries

Unit-II

2.1 Plankton in relation to fish production,
2.2 Culture of zooplankton (Daphnia, Artemia, Monia)
2.3 Manufacture and maintenance of Aquarium
2.4 Hybridization and transgenic fish

Unit-III

3.1 Fish marketing: Marketing practices, marketing channels and systems
3.2 Domestic and export marketing.
3.3 Sex determination, sex reversal and chromosome manipulation in fishes.
3.4 Fish conservation: In- situ and Ex-situ,cryopreservation technique and its applications.

Unit-IV

4.1 Spoilage and methods of preservation of fish.
i. Refrigeration and freezing, ii. Freeze Drying, iii. Canning, iv. Drying, v. Salting, vi. Smoking.
4.2 Fish products and by-products: i. Fish body oil, ii. Fish liver oil, iii. Fish meal, iv. Isinglass, v. Hydrolyzed protein (fish flour), vi. Fish glue, vii. Fish manure
4.3 Fish pathology: i) Signs of sickness and effects on fish, ii) Pathological procedure for diagnosis of fish diseases
4.4 Fish diseases and its control:
a) Viral diseases, b) Bacterial diseases, c) Fungal diseases, d) Protozoan diseases

Semester- IV, Practical-4P$_1$, Special Group-Fish and Fisheries

1 Study of eyestalk ablation in prawns with the help of ICT tools/ charts/ models / photographs etc.
2 Study of RBC count in fish blood (Source of fish blood**:** Local recognizedfish markets).
3 Study of WBC count in fish blood (Source of fish blood**:** Local recognized fish markets).
4 Determination of peroxide value (PV) in fish oil.
5 Quantitative estimation of zooplankton.
6 Permanent mounting ofzooplankton.
7 Study of permanent histological slides of various fish organs & endocrine glands with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
8 Study of skeletal system of *Wallago* &*Labeo* with the help of already available skeleton/ ICT tools/ charts/ models / photographs etc.
9 Study of Weberrian ossicles in *Labeo rohita,Tor tor* and *Wallago attu* with the help of already availableskletion/ICT tools/ charts/ models/ photographs etc.
10 Study of accessory respiratory organs in *Channa, Anabas,Heteropneustes andClarias* with the help of already preserved material/ ICT tools/ charts/ models/ photographs etc.
11 Assessment of maturity of gonads using already available preserved specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.

Distribution of Marks:	**Marks**
1. Anatomical observations(Major)	20
2. PhysiologyExperiment	20
3. Mounting of zooplankton	10
4. Identification of spots	30
5. Viva voce	10
6. Practical Record	10
-Total marks	100
· **Project work**	100

(80 marks project evaluation including viva +20 marks Internal assessment)

- **Suggested Readings:**

1. Fish Physiology Vol. 1 to 13: Hoar H.S. & Randall (Eds.) (1964-1994) Academic press London, New York.
2. The physiology of fishes Vol. 1&2: Brown M.E.(1957) Academic press, New York.
3. Natural history of fishes & systematic of fresh water fishes:P Datta Munshi, J.S. & Shrivastva, M.P.(1988): Narendra pub. House, Delhi.
4. Air breathing fishes of India- Their structure, function and life history: Dutta Munshi, J. S., Hunghes G.M. (1992) .Oxford and JBH publication Co. New Delhi.
5. The freshwater fishes of India, Pakistan, Bangladesh, Burma and Shri Lanka Handbook: Jayaram, K.C. (1981): Zoological Survey of India, Calcutta.
6. Fish migration: Jones, F.R. S. (1968), E.Arnold, London
7. Aquaculture, Bardach, Ryther and Mc Lamy
8. Marine fisheries: D. K. Dal, K. V. Rao
9. Ichthyology: Lagler, K. F., Bardach, J. and Miller, R.(1977) John Wileys and sons.
10. Fish Endocrinology: Matty, A. J. (1985), Chapman and Hall, London.
11. An aid to the identification of common commercial fishes of India and Pakistan: Mishra K. S. (1982).
12. Aquaculture: The farming and husbandry of freshwater and marine organism: Bardach, J.E. (1974). Narendra Publication House, New Delhi.
13. Handbook of breeding of Indian Major Carps by pituitary hormone injection: Chonder, S. L. (1970). Satish book enterprises, Agra.
14. Diseases of fish: Duijin, C:Van Inr. (1973), life books London.
15. Fish and fisheries of India: Jhingran , V. G. (1985). Hindustan Publication Company, New Delhi.
16. Prawns and prawn fisheries of India: Kurian, C.V. and Sebastian, V. O. (19876) . Hindustan Publication Company, New Delhi.
17. The Sea food Industry: Martin, R. E.(1990). Narendra Publication House, New Delhi.
18. Ecological effects of water, applied limnology and pollutant effect: Welch, E. B. (1992).
19. A compemendium of aquaculture technologies: Sinha, V.R. P.(1993). Oxford and JBH publication Co. New Delhi.

Semester-IV

Paper-III, Special Group-Mammalian Reproductive Physiology-I

Reproductive Endocrinology

(Paper Code- MZSS43MRP)

Objectives:

To understand the anatomy, cytoarchitecture, secretions & regulation of endocrine glands & its role in reproduction.

Course Outcome:

After completion of this course, students will learn about

1. Anatomy, cytoarchitecture of Hypothalamus , Neurotransmitters and Feedback regulatory Mechanism.
2. Anatomy and cytology of Pituitary Gland and its hormones.
3. Hypothalamo – hypophyseal testis axis, Thyroid -gonad axis and Hypothalamo- hypophyseal adrenal-gonad axis.
4. Biosynthesis, mode of action, transport and function of oestrogen, testosterone, progesterone & inhibin.

Unit-I

1.1 Hypothalamus – Anatomy, cytoarchitecture.
1.2 Releasing and release inhibiting hormones.
1.3 Feedback regulatory mechanism
1.4 Neurotransmitters and neural signals.

Unit-II

2.1 Adenohypophysis: Anatomy, cytology.
2.2 Neurohypophysis: Anatomy, cytology.
2.3 Gonadotrophic hormones: structure, mechanism of secretion and function.
2.4 Oxytocin- Structure,regulation and its role inreproduction..

Unit-III

3.1 Hypothalamo – hypophyseal testis axis
3.2 Hypothalamo – hypophyseal ovarian axis.Physiology of inhibin-biosynthesis, mode of action and functions.
3.3 Hypothalamo- hypophyseal adrenal-gonad axis..
3.4 Hypothalamo- hypophyseal thyroid-gonad axis..

Unit- IV

4.1 The Androgen: Biosynthesis,mode of action, transport and functions of testosterone
4.2 The oestrogen: Biosynthesis, mode of action, transport and functions.
4.3 The progesterone: Biosynthesis, mode of action, transport and function.
4.4 Physiology of inhibin- biosynthesis, mode of action and functions

Semester-IV

Paper-IV, Special Group-Mammalian Reproductive Physiology-II

Reproductive Toxicology, Embryology and Fertility

(Paper Code- MZSS44MRP)

Objective:

To understand the key elements of Reproductive Toxicology, Embryology and Fertility.

Course Outcome:

After completion of this course, students will learn about

1. Students will learn chemical toxicants and testicular toxicity, induction of gonadal toxicity in Females and interruption of pregnancy by pesticides.
2. Implantation of mammalian blastocyst, chorio–allantoicplacenta, foetal membranes.
3. Intrauterine and intra cervical devices (IUDS and IUCDS), medicated and non medicated IUD's, pregnancy vaccine, recent advances in female contraception.
4. Vasectomy and reversible vas occlusion, antagonist, anti-androgen and anti-spermiogenic compounds.

Unit-I

1.1 Chemical toxicants and Testicular toxicity.
1.2 Impact of environmental and occupational factors onreproductive health.
1.3 Induction of gonadal toxicityby heavy metals in females
1.4 Teratogen and pregnancy.

Unit-II

2.1 Preimplantation developmentof mammalian embryo and its regulation.
2.2 Placental role in foetal programming.
2.3 Foetal membranes – Development, structure, function of chorion, amnion, allantois, yolk sac.
2.4 Onset and endocrine control of parturition.

Unit-III

3.1 Intrauterine and intra cervical devices (IUDS and IUCDS) medicated and non-medicated IUD's, Long acting steroidal contraceptives.
3.2 Surgical sterilization and medical termination of pregnancy (MTP).
3.3 Pregnancy vaccine (anti-HCG, Antizona vaccine, immunization with FSH).
3.4 Recent advances in female contraception (inhibin, prostagladin, hormone analogues, subdermal implants).

Unit- IV

4.1 Vasectomy and reversible vas occlusion.
4.2 LH-RH antagonist, estrogen antagonist, GnRH antagonist.
4.3 Anti-androgen and anti-spermiogenic compounds (LDH-Cy and Sp-10), Inhibin.
4.4 Antibodies for acrosomal enzymes and sperm surface proteins.

Semester-IV, Practical-4 P_1, Special Group-Mammalian Reproductive Physiology

1 Demonstration of surgical operation in rat/ mice Ovariectomy or Hysterectomy or Unilateral adrenalectomy with the help of ICT tools/ Charts/ Models / Photographs etc.

2 Anatomical observations, demonstration and detailed explanation of the female reproductive system of rat or mice with the help of ICT tools/ models/ charts/ photographs etc.

3 Vaginal smear: Vaginal cytology with relation to estrous cycle with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.

4 a. Pregnancy detection testfrom urine.

b. Quantitative estimation of oestrogen from urine.

5 Study of histochemical localization of proteins in rat/ mouse thyroid by Mercury-Bromophenol blue method with the help of already available permanent slides/ ICT tools/charts/ models/ photographs etc.

6. Study of histochemical localization of lipids in rat / mouse ovary by Sudan Black–B method (Propylene glycol method)/ carbohydrates by periodic acid Schiff's reagent / DNA by Feulgen with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.

7. Experimental (histological slides for identification) study of the following with the helpof already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
a) Effects of some female antifertility drugs on ovary and adrenal gland

8. Histology: (Identification of slides) Histological changes in female reproductive organs during different phases of oestrous cycle in continuous and seasonal breeder with the helpof already available permanent slides/ ICT tools/ charts/ models/ photographs etc.

9. Embryology: Study of various stages of development of mammalian egg, development offoetal membranes, different types of placenta, progestational changes in uterus with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.

10. Field work: Visit to laboratory for embryo transfer and family planning clinics.

Distribution of marks		**Marks**
1.	Surgical operation	20
2.	Anatomical observations	20
3.	Vaginal smear and oestrous cycle stages	10
4.	Experimental analysis	15
5.	Identification and comment on spots	15
6.	Practical Record	10
7.	Viva voce	10
	Total marks	100

- **Project work** 100

(80 marks project evaluation including viva + 20 marks Internal assessment)

- **Suggested Readings**

1. A textbook of in vitro fertilization and assisted reproduction edited by P.R. Brinsden and P. A. Rainsbur Jaypee brothers 1992.
2. Advances in Reproductive Physiology, Vol. 1 to 6: Mclaren, (1968). Logos Press Ltd., London.
3. Advances in Reproductive Toxicology eds. S. C. Joshi and A. S. Ansari Pointer publishers.
4. Andrology. 2nd Edition Male Reproductive health and dysfunction (Eds. E. Nieschlag & H.M. Behre) 2000.
5. Biochemistry of Mammalian Reproduction: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & sons, New York.The Ovary.Vol. I, II & III: Zuckerman, S, (1962). Academic Press, London.
6. Biology of Gestation: Assalye, N.S. (1968). Academic Press, London.
7. Biology of ovarian follicles in mammals (1985). S. S. Guraya Springer-Verlag.
8. Comparative cellular and molecular biology of testis in vertebrates (Trends in endocrine, paracrine and autocrine regulation of structure of functions) (2001) S.S. Guraya, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta.
9. Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C. Haldar, Narosa Publishing House (1998).
10. Contraceptive Technology Past, Present and Future: Das. R.P. (1989). N.I.H.F.W. New Delhi.
11. Control of ovulation: Crighton, D.B., Haynes, N.B. Foxcroft, G.R. & G.E. Lamming (1978). Butterworths, London.
12. Encylopedia of Reproduction Vol. I, II, III, IV eds. Ernst Knobil and J.D. Neill (1998).
13. Endocrinology and metabolism. 4th edition 2001. Philip Felig & Lowrence A. Frohmon McGraw Hill Inc. Medical Publishing Division.
14. Endocrinology. Vol. 1 to 3: L.J. Degroot et al. (1989). W.B. Saundors Co. Philadelphia.
15. General Endocrinolgoy: Turner, C.D. & J.T. Bagnara (1990) W.B. Saunders Co., & Toppan Co., Philadelphia, London & Tokyo.
16. Hormonal Control of Lactation: Cowie, A.T. Forryth, I.A. and I. Hart (1980). Springer-Verlag, Berlin & New York.
17. Mammalian Oviduct: Hafez, E.S., and R.J. Blandu. The University of Chicago Press, Chicago, London.
18. Marshall's Physiology of Reproduction. 4th Edition Vol. 3 Pregnancy and Lactation Part I, II, III edited by G.E. Lamming, Champan and Hall.
19. Ovarian Cycle of Mammals: Perry, J.S. Oliver and Boyd, Edinburgh.
20. Patterns of Reproduction: Asdell, S.A. (1964). Constable and Co. London.
21. Physiology of Lactation: Smith, Vearch, Constable & Co., London.
22. Postgraduate Reproductive endocrinology. 4th Edition. 1997. R. Rajan Jaypee brothers. Medical Publishers (P) Ltd.
23. Practice of fertility control, Choudhary S. K. Churchill and Livingstone.
24. Progress in Reproductive Biology, Vol. 4. The pineal and reproduction: Reiter, R.J. Series Ed. P.O. Hubinant, Karger, Basel. Paris, London (latest edition).
25. Reproduction in Mammals Series: 1 to 6: Austin, C.R. and R. V. Short (1984 & 1994),
    Cambridge University Press, Cambridge.

26. Reproductive Endocrinology: Ref. No. 1, Vol. 3 Hormones in Reproduction.
27. Seasonal Patterns of Stress, immune function and disease R.J. Nelson, G.E. Demas, S.L. Klein, L.J. Kriegsfeld. 2002. Cambridge Univ. Press.
28. Shaw's textbook of Gynaecology eds. V. G. Padubidri and S. N. Daftary. 2000.
29. The Biology of Blastocyst: Blandau, R.J. (1971). The University of Chicago Press, Chicago & London.
30. The Prostaglandins Vol. I & II: Ramwell, P.W. (1974). Prenum Press, New York and London.
31. The Testis Vol. 1 to 4: Jhonson, A.D. and W. R., Gomes.
32. Vertebrate Foetal Membrances: Mossman, H.W. (1989). Rutgress Press Ltd.
33. WHO laboratory manual for the examination of human semen and sperm – cervical mucus interaction. 4th Edition Cambridge Univ. Press. 2000.

Semester –IV
Paper-III, Special Group-Cell Biology-I
Molecular Cell Biology
(Paper Code- MZSS43CB)

Objectives:

To comprehend the key features of Molecular cytology.

Course Outcome:

After completion of this course, students will learn about

1. Prebiological chemical evolution and proto cells.
2. Cytoskeleton, principles of cell-cell interactions and adhesion, cell-matrix interactions and Adhesions.
3. Protein structure, Ramchandran plot, molecular chaperons and heat shock proteins.
4. Protein synthesis in eukaryotes, transport of proteins across nuclear membrane.
5. DNA binding proteins.
6. Types of cancer, proto-oncogenes and viral oncogenes, mechanism of oncogene activation, tumor markers and tumor suppressor genes.
7. Model organisms for molecular studies
8. Cell senescence and apoptosis.
9. Somatic cell hybridization and chromosome mapping, cell fusion and applications.
10. Protein and tissue engineering.

Unit-I

1.1 Prebiological chemical evolution and proto cells.
1.2 Receptors.
1.3 Cytoskeleton – Microtubules & microfilaments – Structure and dynamics.
1.4 Cell-cell interactions and adhesion. Adhesion molecules involved.
Cell-matrix interactions and adhesions. Adhesion molecules involved. Proteins of extracellular matrix. Types of junctions.

Unit-II

2.1 Protein structure – Primary, secondary, tertiary and quaternary, Domains and motifs, Protein folding, Ramchandran plot.
2.2 Molecular chaperons and heat shock proteins. Prion structure and functions.
2.3 Protein synthesis in eukaryotes. Up take into ER, Modifications in ER, Protein sorting in Golgi apparatus, Transport of proteins across nuclear membrane. Lysosomal assembly and functions.
2.4 DNA binding proteins – Leucine zipper, zinc finger, helix turn helix, beta barrel and OB fold.

Unit-III

3.1 Origin, epidemiology, causes and types of cancer.
3.2 Cytogenetical properties of normal and abnormal cells.
3.3 Proto-oncogenes and viral oncogenes, Mechanism of oncogene activation.
3.4 Tumor markers and tumor suppressor genes.

Unit-IV

4.1 Model organisms for molecular studies –Importance of *Drosophila melanogaster*, *C. elegans*, *S. cerevisae*, zebra fish studies.

4.2 Cell senescence and apoptosis.

4.3 Protein engineering

4.4 Tissue engineering.

Semester –IV
Paper-IV, Special Group-Cell Biology-II
Applied Biotechnology
(Paper Code- MZSS44CB)

Objectives:

To comprehend the key features of biotechnology & its applications various fields.

Course Outcome:

After completion of this course, students will learn about

1. Marker assisted improvement of crop, recent developments in drug delivery, Nanobiotechnology and biological warfare.
2. Biology, cause, diagnosis and treatment of various diseases like hepatitis, Parkinson's disease, diabetes and cystic fibrosis.
3. Properties of stem cells,types of stem cells, haemopoisis, Stem cell disorders. Stem cell therapy, Stem cell and cancer, Stem cell research in India.
4. Stem cells and tissue engineering, ethical, legal and social implications (ELSI) of Stem cell technology.
5. World Trade Organization and trade related intellectual property rights (TRIPS), Intellectual property rights – Patents and patent documentation.

Unit-I

1.1 Marker assisted improvement of crop. Genetically modified food and future implications.

1.2 DNA and ribosomes as drug targets–Recent developments in drug delivery System, Ion channels as drug target, Drug metabolism.

1.3 Nanobiotechnology – Molecular motors, DNA hybridization control using ion Crystal antennae.

1.4 Bio-safety and bioethical considerations on biotechnology, biological warfare.

Unit-II

2.1 Biology, cause, diagnosis and treatment of influenza and hepatitis.

2.2 Biology, cause, diagnosis and treatment of Parkinson's disease.

2.3 Biology, cause, diagnosis and treatment of diabetes.

2.4 Biology, cause, diagnosis and treatment of cystic fibrosis.

Unit-III

3.1 Properties of stem cells. Types of stem cells – Embryonic, umbilical, adult.

3.2 Haemopoietic stem cells and formation of blood cells. Bone marrow transplantations.

3.3 Stem cell disorders. Stem cell therapy, Stem cell and cancer, Stem cell research in India.

3.4 Stem cells and tissue engineering, ethical, legal and social implications (ELSI) of Stem cell technology.

Unit-IV

1.1. World Trade Organization and trade related intellectual property rights (TRIPS).

1.2. Intellectual property rights – Patents and patent documentation.

1.3. Patent search methods & tools for patent search.

1.4. Indian patent laws and recent amendments, examples of patents in India & abroad.

Semester –IV Practical-4P1, Special Group-Cell Biology

1 Measurement of maximum absorption of colored solutions & verification of Beer-Lambert's law.
2 Biochemical estimation of blood cholesterol (Source of blood: Local recognized pathology laboratory)
3 Biochemical estimation of blood glucose (Source of blood: Local recognized pathology laboratory)
4 Biochemical estimation of acid phosphatase (Source of blood: Local recognized pathology laboratory)
5 Biochemical estimation of alkaline phosphatase (Source of blood: Local recognized pathology laboratory)
6 Isolation of lymphocytes.
7 Comparison of RBC and WBC in different group of vertebrates with the help of already available permanent slides/ ICT tools/ Charts/ Photographs etc.
8 Media preparation for prokaryotic cell culture.
9 Different methods of sterilization (Dry, wet and UV sterilization).
10 Gram staining of micro-organisms.
11 Bacterial motility under microscope.
12 Preparation of neem extract as an antimicrobial agent.
13 Separation of amino acids by paper chromatography.
14 Separation of amino acids/ lipids by thin layer chromatography.
15 Uses and functioning of different types of microscopes.
16 Study of metaphase chromosomes from rat bone marrow with the help of already available permanent slides/ ICT tools/ charts/ models etc.
17 Study of G banding of metaphase chromosome with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
18 Study of C banding with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
19 Study of histology of normal tissue and cancerous tissue with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
20 Demonstration of tools used for patent search and patent filing system.

Distribution of marks		**Marks**
1.	Biochemical estimation of alkaline/acid phosphatase/ Cholesterol/ glucose	20
2.	Separation of amino acids/ lipids by paper/ thin layer Chromatography	20
3.	Isolation of lymphocytes/ Gram staining of micro-organisms/Bacterial motility	20
4.	Identification and comment on spots (1-5)	20
5.	Class record/ submissions	10
6.	Viva-voce	10

Total marks **100**

- **Project work** 100

(80 marks project evaluation including viva + 20 marks Internal assessment)

- **Suggested Readings**

1. The cell theory, QAMS: Vol. 89,96,1948-55,Bakar.
2. Synthetic activity of polythene chromosomes: Berendes (Int. Rev. Cytol. vol. 35, 1973)
3. The Nucleolus in the cell Metabolism: Bimstiel, Ann. Rev. Plant Physical vol.l1 1967.
4. Elements of cytology: Cohen.
5. The nucleic Acid: Chargaff & Davidson.
6. The Bio-chemistry of DNA: Davidson.
7. Cell Biology- De Reoberts.
8. The cell-Biology: Dowbwn Haper.
9. Cell Biology: C. B. Powar.
10. DNA & Chromosomes, D.Praw.
11. Mitochondria structure & function: Ernster & Drahota.
12. Nuclear Envelope: Franke.
13. The structure of cell membrane: Fox.
14. Energy& Mitochondria: Green & H Baum.
15. Biological membrane: structure & function: Harrison & Lunt.
16. Studies in basic Genetics & Molecular Biology: Hayes & Wiley.
17. Cell Biology: Johan Paul.
18. The Mitochondria: Loghinger.
19. Hand book of Molecular Cytology: Lirna-de-Paria.
20. Cell structure & function: Loewy& Siskevit P.
21. Structure & function of biological membranes: Roth Field.
22. Molecular Genetics: Stent.
23. Cytogenetic: SwansonJ, Yount Yodyrdan Metz & W.J.
24. The molecular basic of membrane function: Yodyrdan.
25. Molecular Biology of Gene: W. Son.
26. The Chromosomes: White.
27. The Nuclear Envelope, Its ultra structure & functional Significance: Wisctinitzers, S.
28. Tissue Culture methods & Application: Kruse, P. F. Jr. Academic Press, M. KS Pattesrson, New York, San Francisco, London, 1973.
29. Tissue culture technique:2nd Ed. Cameron G. Academic press, N. Y.
30. Laboratory Techniquesin Biology & Medicine, Earle W.R
31. An Introduction to cell and tissue culture: Free, W. F. Burgess, Minneapolis.
32. Genes VI: Lwein, Benjamin(1997), Oxford University press, New York
33. Genetics: 3rd Ed., Stansfield W.D.(1991), Schaum's outline series, McGraw Hill Inc. New York.
34. Genetics in Medicine: Thompson M. W., Mcinnes RR& HF. Willard (1991),W. D. Saunders Co. Philadelphia.
35. A first course in Recombinant DNA Technology: Micklos D.A & G.A Freyer (1990), Cold Spring Harbor Lab. Press.
36. Scientific American Books: Watson, J.D., Gilman, M. Witnowski,I.& M. Zoller (1992), Distributed by W. H. Freeman & Co., New York.
37. Genetics, Weaver: RF. & P.W. Hedrick,(1989), Wnc Brown Publishers, Dubuque, TOWA (USA).
38. Gene Regulation: A Eukaryotic Perspective, Latchrnan, Davin (1990), Un win

Hyman, London.
39. Gene Cloning: Brown.
40. Biotechonolgy: Higgins.
41. Essentials of Cytology: C.B. Powar (1996), Himalaya Pub. House, Bombay.
42. Cell Biology: David E. Sadava (1993), Jones & Bartlett Pub. Boston (London).
43. Biotechnology: Current Progress, Paul, N. Cherernisenoff & L.M. Ferrante (1991), A technomic Pub. Co., Lancaster, U.S.A
44. Microbial Genetics, David Freifelder (1987), NAROSA Pub. House, (India).
45. Molecular Biology: David Freifelder (1987), NAROSA Pub. House, Delhi, India
46. Molecular Cell Biology, Lodish *et. al.,* (2007), W.H. Freeman and Company, New York, USA.
47. Molecular Biology of the cell, Alberts *et. al.,* (2008), Graceland Science, Taylor & Francis Group, New York, USA.
48. Cell Physiology Source Book: A Molecular approach, Sperelakis, (2001), Academic Press, New York, USA.
49. Principles of Genome Analysis and Genomics, Primrose, S.B. and Twyman R.M., (7^{th} Ed., 2006), Blackwell Publishing Company, Malden, USA
50. Genomes 3, Brown, T. A., Garland Science Publishing, London, UK.
51. Bioinformatics: sequence and Genome Analysis, Mount, D.W., Cold Spring
52. Harbor Laboratory Press, New York, USA.

Semester –IV
Paper-III, Special Group-Animal Physiology-I
Physiology of Brain, Nerve and Muscle
(Paper Code- MZSS43AP)

Objectives:

To comprehend the key features of physiology of Brain, Nerve and Muscle

Course Outcome:

After completion of this course, students will learn about

1. Anatomy of brain & physiology of learning, memory and sleep.
2. Types, ultrastructure and functional properties, bioelectrical properties of neurons.
3. Biosynthesis, storage and release of neurotransmitters & neuropeptides.
4. Receptor physiology.
5. Disorders of nervous system.
6. Ultrastructure and Properties of skeletal muscle, molecular mechanism of muscle contraction, ultrastructure of neuromuscular Junction.
7. Neuromuscular disorders:Types, causes and treatment.

Unit-I

1.1 Morphological differentiation of mammalian brain
1.2 Brain stem
1.3 Cerebellum
1.4 Physiology of learning, memory and sleep.

Unit-II

2.1 Types, ultrastructure and functional properties of neurons.
2.2 Ultrastructure of synapse and molecular mechanism of synaptic transmission.
2.3 Bioelectrical properties of neurons- neuronal excitability, resting membrane potential- Nearnst equation, sodium and potassium pump, propagationof nerve impulses, generation of action potential.
2.4 Neurotrophins and Growth factor affecting the neuronal growth

Unit III

3.1 Biosynthesis, storage and release of neurotransmitters:Acetylcholine , GABA, Epinephrine, Nor-epinephrine , Serotonin.
3.2 Neuropeptides- oxitocin, vasopression, thyrotropin releasing hormone, cholecystokinin
3.3 Receptor physiology- Mechanoreception, photoreception, phonoreception, chemoreception
3.4 Disorders of nervous system: Alzheimer's disease, Parkinson's disease.

Unit-IV

4.1 Ultrastructure and Properties of skeletal muscle.
4.2 Molecular mechanism of muscle contraction- muscle proteins, Calcium receptors, Calmodulin, Calcium pump, sliding filament theory chemistry and role of ATP inmuscle contraction.
4.3 Ultrastructure of Neuromuscular Junction.
4.4 Neuromuscular Disorders:Types, causes and treatment.

Semester –IV
Paper-IV, Special Group-Animal Physiology-II
Physiology of Respiration and Reproduction
(Paper Code- MZSS44AP)

Objectives:

To understand the key elements of physiology of respiration & reproduction.

Course Outcome:

After completion of this course, students will learn about

1. Physiological anatomy of respiratory system, mechanism of respiration, transport of respiratory gases by blood, lung volumes and capacities.
2. Neural and chemical regulation of respiration, artificial respiration, infectious respiratory diseases.
3. Male & female reproductive systems, menstrual cycle, andropause & menopause.
4. Pregnancy- Fertilization, hormonal regulation of pregnancy.
5. Physiology of lactation
6. Ovarian and testicular steroid hormones and therephysiological role.
7. Causes of infertility in male and female. *In vitro* fertilization (IVF).

Unit I

1.1 Physiological anatomy of respiratory system.

1.2 Mechanism of respiration – Mechanism of breathing and the exchange of respiratory gases at pulmonary surface.

1.3 Transport of respiratory gases by blood- Transport of O2 and CO2, O2 and CO2 dissociation curve.

1.4 Lung volumes and capacities, partial pressure of gases.

Unit II

2.1 Neural and chemical regulation of respiration

2.2 Hypoxia, Cyanosis.

2.3 Artificial respiration and Oxygen therapy

2.4 Infectious respiratorydiseases (COVID-19, SARS,SWINE FLUE)

Unit III

3.1 Male reproductive system- Spermatogenesis, Sertoli cell, Leydig cell and hormonal control of spermatogenessis.

3.2 Female reproductive system- Oogenesis, Follicular cells, Corpus luteum and hormonal control ofoogenesis

3.3 Menstrual cycle- Mechanism, hormonalregulation and abnormalities.

3.4 Andropause and Menopause- causes,symptoms and treatments.

Unit IV

4.1 Pregnancy- Fertilization, implantation of embryo and parturition, Hormonalregulation of pregnancy.

4.2 Physiology of lactation- Development of the Breasts, mechanism of lactation, composition of milk. Lactation and menstrual cycle.

4.3 Ovarian and testicular steroid hormones and therephysiological role.

4.4 Causes of infertility in male and female. *In vitro* fertilization (IVF).

Semester-IV, Practical-4P$_1$, Special Group- Animal Physiology

I. Physiology Experiments

1. Study of Electrocardiograph (ECG) under different physiological conditions with the help of ICT tools/ charts/ models / photographs etc.
2. Body size and oxygen consumption in aquatic animals.
3. Effect of pH, temperature on oxygen and carbon dioxide concentration in pond water.
4. Biochemical estimation of tissue cholesterol (Source of tissue**:** Local recognized fish markets/ slaughter houses/ poultry farms etc.)
5. Measuring of heart beat under different physiological condition.
6. Study of nerve cells and neurosecretry cells of cockroach with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
7. Estimation of SGOT/SGPT from blood sample (Source of blood**:** Local recognized pathology laboratory)

II. Quantitative Analysis

1. Muscle & Liver glycogen (Source of muscle/ liver: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
2. Determination of fructose in seminal vesicle/ semen (Source of semen: Government artificial insemination centre)
3. Separation of protein by SDS-PAGE
4. Determination of semen constituents (Source of semen: Government artificial insemination centre)
5. Estimation of percentage quantity of lactose in milk in vertebrates.

III. Qualitative Analysis

1. Estimation of lactate dehydrogenase (Source of blood: Local recognized pathology laboratory).
2. Estimation of RNA and DNA (Source of blood: Local recognized pathology laboratory).
3. Histochemical localization of a dehydrogenase (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
4. Histochemical localization of Carbohydrate (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
5. Histochemical localization of Glycogen (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
6. Histochemical localization of lipid (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
7. Histochemical localization of protein (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)

IV. Histological Study of Brain, Testis, Ovary, Thyroid, Adrenal, Corpus luteum in ovary, Leydig cells in testis, T. S. Muscle fiber, T. S. Spinal cord, Cerebellum & cerebrum, Nerve fiber, Lung with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

Distribution of Marks:			**Marks**
1.	Physiology Experiment		20
2.	Major quantitative analysis		20
3.	Minor quantitative analysis		10
4.	Qualitative analysis	15	
5.	Identification and comment on spots(1-5)	15	
6.	Practical Record	10	
7.	Viva-voce	10	
		Total marks	100

- **Project work** 100

(80 marks project evaluation including viva + 20 marks Internal assessment)