INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

(To be implemented from 2024 -25)

Teaching and Examination Schemes Two Year M.Sc. (of four semesters) programme

M.Sc. Zoology Semester-I

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Biotechnology**	M-ZO111T	6.0	4	--	--	4	3	60	40	50
		Paper 2: **Biotechniques & Biostatistics**	M-ZO112T		4	--	--	4	3	60	40	50
2	DSE	Elective1:**Animal Physiology-I (Physiology of Digestion & Excretion)** Elective2**:Fish & Fisheries-I (Fish Biology)** Elective3:**Mammalian Reproductive Physiology-I (Reproductive process in Male)**	M-ZO113T M-ZO114T M-ZO115T		4	--	--	4	3	60	40	50
3	DSE /DSC	Lab (Based on Paper 1+2+Elective)	M-ZO116P		--	--	12	6	6 - 8	180	120	150
4	RM	Research Methodology	M-ZO117T		4	--	--	4	3	60	40	50
					16	--	12	22		420	280	--

M.Sc. Zoology Semester-II

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	DSC	Paper 1: **Biodiversity & Conservation**	M-ZO121T	6.0	4	--	--	4	3	60	40	50
		Paper 2: **Microtechnique**	M-ZO122T		4	--	--	4	3	60	40	50
2	DSE	Elective1:**Animal Physiology-II (Physiology of Circulation)** Elective2**:Fish & Fisheries-II (Applied Fisheries)** Elective3:**Mammalian Reproductive Physiology-II (Reproductive process in Female)**	M-ZO123T M-ZO124T M-ZO125T		4	--	--	4	3	60	40	50
3	DSE /DSC	Lab (Based on Paper 1+2+Elective)	M-ZO126P		--	--	12	6	6 - 8	180	120	150
4	OJT / FP	Internship / Apprenticeship / Field Project (Related to DSC)			--	--	8	4	--	--	200	100
					12	--	20	22		340	310	
Cumulative Credits for : PG Diploma in Major Subject Core = 28 Electives = 8 RM = 4 OJT / FP = 4								44				
Exit option: PG Diploma after First Year PG Degree :- Cumulative Credits required for PG Diploma (After First Year Degree) = 44												

M.Sc. Zoology Semester-III

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	DSC	Paper 1: **Endocrinology**	M-ZO231T	6.5	4	--	--	4	3	60	40	50
		Paper 2: **Evolution and animal Behaviour**	M-ZO232T		4	--	--	4	3	60	40	50
2	DSE	Elective Elective1:**Animal Physiology-III (Physiology of Brain, Nerve & Muscle)** Elective2**:Fish & Fisheries-III (Fish Biology)** Elective3:**Reproductive Physiology-III (Reproductive process Endocrinology)**	M-ZO233T M-ZO234T M-ZO235T		4	--	--	4	3	60	40	50
3	DSE /DSC	Lab (Based on Paper 1+2+Elective)	M-ZO236P		--	--	12	6	6 - 8	180	120	150
4	RP	Research Project / Dissertation (Core)			--	--	8	4	--	--	200	100
					12	--	20	22		360	440	--

M.Sc. Zoology Semester-IV

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1: **Developmental Biology**	M-ZO241T	6.5	4	--	--	4	3	60	40	50
		Paper 2: **Parasitology and Toxicology**	M-ZO242T		4	--	--	4	3	60	40	50
2	DSE	Elective Elective1:**Animal Physiology-IV (Physiology of Respiration & eproduction)** Elective2**:Fish & Fisheries-IV (Fishery technology & Fish Pathology)** Elective3:**Reproductive Physiology-IV (Reproductive Toxicology, Embryology & Fertility))**	M-ZO243T M-ZO244T M-ZO245T		4	--	--	4	3	60	40	50
3	DSE /DSC	Lab (Based on Paper 1+2+Elective)	M-ZO246P		--	--	8	4	6 - 8	120	80	100
3	OJT	Research Project / Dissertation (Core)			--	--	12	6	--	--	300	150
					12	--	24	22		300	500	--
Cumulative Credits for PG in Major Subject (One Year PG Degree) = 26 Electives = 8 RP = 10								44				
Cumulative Credits for PG in Major Subject (Two Year PG Degree) = 54 Electives = 16 RM = 4 OJT / FP = 4 RP = 10								88				
Cumulative Credits required for PG in Major Subject (One Year PG Degree) = 44 Cumulative Credits required for PG in Major Subject (Two Year PG Degree) = 88												

Table 8: Table showing total marks in theory and Practical semester wise

Semester	Theory	Practical	Total Marks
1	400	300	700
II	300	500	800
III	300	500	800
IV	300	600	900
For Honors	1300	1900	2200

Total Credits:

Cumulative Credits required for PG in Major Subject (One Year PG Degree) = 44

Cumulative Credits required for PG in Major Subject (Two Year PG Degree) = 88

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M. Sc. Semester-I Zoology

Course category: DSC

Course code: M-ZO111T

Paper–I: Biotechnology

Total Credits: 4 Hours: 60

Course objectives:

1) To study biotechnological methods such as gene cloning, recombinant technology, animal cell culture and stem cell culture.
2) To make students aware about vectors, primary cell line, viability and cytotoxicity
3) To study applications of biotechnology

Course outcomes:

1) Students will be able to understand concept of gene cloning and cell culture
2) They will be with required knowledge of biotechnological applications, advantages and disadvantages
3) They will come to know about bioaccumulation and biomagnifications of toxicants and sources of energy

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Unit-I

1.1. Introduction to Biotechnology: Definition, Applications, Advantages and disadvantages.

1.2. Gene cloning: Basic steps of gene cloning- amplification and/or heterologous gene expression, Expression of cloned genes: General features of an expression vector. Expression of a eukaryotic gene in prokaryotes.

1.3. Recombinant technology: Polymerase chain reaction, designing of primers for PCR.

1.4. Vectors: concept, types of vectors (plasmids, phage, virus), Essential qualities that a vector must possess. Types of vectors: pBR322, cosmids, lambdaphage, Transformation and Transfection.

Unit-II

2.1. Animal Cell Culture: Equipments and materials for animal cell culture technology. Various systems of tissue culture, their distinguishing features, advantages and limitations.

2.2. Culture medium: natural media, synthetic media, sera. Introduction to balanced salt solutions and simple growth medium.

2.3. Characteristics of cells in culture: Contact inhibition, anchorage dependence, cell-cell communication etc.; Cell senescence; cell and tissue response to trophic factors.

2.4. Primary Culture: Behavior of cells, properties, utility. Explantculture; suspension culture,

Unit-III

3.1. Established cell line cultures: Definition of cell lines, maintenance and management; cell adaptation.

3.2. Measurement of viability and cytotoxicity. Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

3.3. Scaling up of animal cell culture. Cell transformation.
3.4. Stem cell cultures, embryonic stem cells and their applications. Somatic cell genetics.

Unit-IV

4.1. Insulin, Somatostatin, production of human proteins and drugs, recombinant vaccines, production of transgenic animals, human gene therapy.
4.2. Xenobiotic and recalcitrant compounds. Bioaccumulation and biomagnification. Assessment of water andwaste water quality: Concept of COD, DO and BOD. Indicators of faecal pollution and MPN and MF technique for coliforms. Significance and principal of IMViC.
4.3. Energy & Biofuels: Non-conventional or renewable sources of energy, Energy from Biomass, Biofertilizers, Biopestisides, Biosensors and biochips, Biofilters, Biofuel cells.
4.4. Bioinformatics: Basic concepts, databases, applications.

M. Sc. Semester-I Zoology

Course category: DSC

Course code: M-ZO112T

Paper–II: Biotechniques and Biostatistics

Total Credits: 4 Hours: 60

Course objectives:

1) To study various microbial, cell culture and cryotechniques.
2) To study molecular separation, isotope techniques, centrifugation methods.
3) To know about biostatistical applications in biology.
4) To represent the data by table, diagrams and graphs.

Courseoutcomes:

1) Students will be able to handle microbial culture, centrifugation, colorimetry or spectrophotometry operations.
2) By taking random samples they will be able to generate statistical data for estimation
3) They will be able to compute biological data by using various statistical methods.

Unit-I

1.1. Design and functioning of tissue culture laboratory
1.2. Microbial techniques: Sterilization methods, media preparation for microbial culture, inoculation methods and growth monitoring.
1.3. Cell culture techniques: Animal cell & tissue culture-primary culture, celllines, cell quantification, growth kinetics of cells in culture, cryopreservation of cells
1.4. Cryotechniques: Cryopreservation of cells, tissues and organs, cryotechniques for microscopy, Freeze drying techniques, lyophilization.

Unit-II

2.1. Basic principle of sedimentation and centrifugation, centrifugation methods
2.2. Basic Principle and Application of Colorimetry and Spectrophotometry, Beer-Lambert's Law.
2.3. Radioactive isotopes and mass isotope techniques in biology, sample preparation for radioactive counting. Autoradiography, Metabolic labeling.

2.4. Separation techniques in biology: Molecular separation by chromatography, electrophoresis, cell separation by flow cytometry.

Unit-III

3.1. Introduction to biostatistics: definition, scope, sources of data, collection of data,

3.2. Sampling theory and Sampling methods: non probability (convenience, purposive & quota) and probability or random (simple, stratified, systematic, cluster & multistage) sampling methods.

3.3. Representation of data by Frequency distribution table, diagrams (simple bar, component bar, multiple bar & pie) and graphs (histogram, frequency polygon, frequency curve & ogive curves).

3.4. Measures of Central tendency-mean, mode and median; Measures of Dispersion- range, mean deviation, variance and standard deviation. Standard error (SE).

Unit-IV

4.1. Correlation and regression: scatter diagram, simple correlation, simple linear regression, multiple linear regression

4.2. Probability and probability distribution: Basic concepts and types of probability and probability distributions- binomial, Poisson and normal distribution.

4.3. Hypothesis testing- Steps, significance tests: z-test, t-test, Chi square test and F- test (Analysis of variance-ANOVA)

4.4. Basic Experimental designs: basic principles, commonly used basic designs- CRD, RBD & LSD

References for Biotechnology:

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References for Biotechniques and Biostatistics:

Biotechniques-

1. Boyer, R. (2000) Modern Experimental Biochemistry (3rd edition) Benjamin-Cummings.
2. Pearse, A.G.E. (1980-1993) Histochemistry - Theoretical and applied, Volume I-III, Churchill-Livingstones.
3. Plummer, D. (2017) An Introduction to Practical Biochemistry (3rd edition) McGraw Hill.
4. Wilson, K. and Walker, J. (2010) Experimental Biochemistry, Cambridge.

Biostatistics-

1. Banergee, P. K. (2013). Introduction to Biostatistics- A textbook of Biometry. S. Chand & Company Ltd. New Delhi.
2. Rao. K. S. (2010). Biostatistics for Health and Life Sciences. Himalayta Publishing House, New Delhi.
3. Jasra P. K. and Gurdeep Raj (2000). Biostatistics. KRISHNA Prakashan Media 9P) Ltd. Meerut, U. P.
4. Dutta N. K. (2002). Fundamentals of Biostatistics- Practical Approach. Kanishka Publishers & Distributors, New Delhi.

M. Sc. Semester-I Zoology

Course category: DSE

Course code: M-ZO113T

Paper–Elective1: Animal Physiology-I (Physiology of Digestion & Excretion)

Total Credits: 4 Hours: 60

Course objectives:

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

Courseoutcomes:

After completing this course, students will know-

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

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, its secretion and control, intestinal bacteria.

2.2. Neural and endocrine regulation of gastrointestinal movements and secretions.

2.3. Gastrointestinal hormones- Synthesis, chemical structure and functions**.**
2.4. Digestion and absorption of proteins, carbohydrates and fats in the gastrointestinal tract.

Unit-III
3.1. Functional anatomy of kidney.
3.2. Mechanism of formation of urine.
3.3. Normal and abnormal constituents of urine.
3.4. Mechanism of concentration and dilution of urine– The Counter current system.

Unit-IV
4.1. Regulation of urine and body fluid concentration and volume, hormonal mechanism of 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.

M. Sc. Semester-I Zoology

Course category: DSE

LAB Elective1: Animal Physiology-I (Physiology of Digestion & Excretion)

Practicals:

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.

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 cholesterol (Source of blood: Local recognized pathology laboratory)
4 Estimation of blood Sodium, potassium, Calcium (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.

IV. Histological Study of Stomach, Liver, Small intestine, Large intestine, Pancreas, Kidney, with the help of already available permanent slides /ICT tools/ charts/ photographs etc.

REFERENCES:

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2. Gerald Karp: "Cell Biology" McGraw Hill Kogakusha Ltd.
3. Darnell, Loddish, Baktimore: "Molecular Cell Biology" Scientific American Books.
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11. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
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14. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
15. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
16. Philip Carew Withers (1992): Comparative animal physiology SaundersCollege Pub.,

M. Sc. Semester-I Zoology

Course category: DSE

Course code: M-ZO114T

Paper–Elective2: Fish and Fisheries-I (Fish Biology)

Total Credits: 4 Hours: 60

Course objectives:

1) To study the origin, evolution, classification, and general characters of fishes.
2) To know the accessory respiratory organs in fishes.

Courseoutcomes:

After completion of this course students will gain the knowledge about:

1) Origin and evolution of fishes.
2) Classification, general characters and affinities of Elasmobranchs, Chondrichthyes, Holocephali, Actinopterygii and Crossopterygii.
3) Classification, general characters and affinities of Dipnoi.
4) Accessory respiratory organs and 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.
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 specialized characters 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 Crossopterygians.

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 gillsin fishes, gillhistology
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 of and significance of air breathing organs.
4.2. Mechanism of air breathing, function of accessory respiratory organ.
4.3. Airbladder: Origin and evolution, types of air bladder-physostomous, physoclistous, structure of bladder wall and gas secreting complex.
4.4. Blood supply to air bladder and functions of air bladder

M. Sc. Semester-I Zoology
Course category: DSE
LAB Elective2: Fish and Fisheries-I (Fish Biology)

Practicals:

1. Identification of commercially important fishes up to species.
2. Anatomical observations, demonstration and detailed explanation of general anatomy of fish, urino-genital system and Endocrine glands with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of cranial nervesin *Wallago* and *Labeo* with the help of already available permanents lides/ ICTtools/ models/ charts/ photographs etc.
4. Identification of various developmental stages of carps- spawn, fry and fingerlings of major carps with the help of already available preserved material, permanent slides/ charts/ models / photographs/ ICT tools etc.
5. Study of morphometric and meristic characteristics of fish (Source of fish blood: Local recognized fish markets).

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M. Sc. Semester-I Zoology

Course category: DSE

Course code: M-ZO115T

Paper–Elective3: Mammalian Reproductive Physiology-I

(Reproductive Process in Male)

Total Credits: 4 Hours: 60

Course objectives:

To introduce students to the physiology of male reproductive system.

Courseoutcomes:

Students on completion of this course, will be able to:

1) Understand the structure, functions of Sertoli cells, Leydig cells , Epididymis and sperm.

2) Students will understand Spermatogenesis and spermiogenesis, Sperm capacitation, decapacitation.

3) Understand the structure and function of vas deferens, seminal vesicle, prostate gland, Cowper's gland and Penis.

4) Male reproductive behavior.

5) Infertility causes and remedy

Unit-I

1.1. Development, descent and structure of the testis.

1.2.Spermatogenesis: Molecular changes, hormonal regulation, and spermiogenesis.

1.3. Sertolicells: Structure, functions, blood testis barrier.

1.4. Leydig cells: Structure, functions and interaction with peritubular and Sertoli cells.

Unit-II

2.1. Epididymis: Structure and function.

2.2. Structure of spermatozoa and anomalies.

2.3. Sperm capacitation: molecular and biochemical changes, decapacitation.

2.4. Vasdeferens: Structur eand function.

Unit-III

3.1. Seminal Vesicle: Structure, function and regulation.

3.2. Prostategland: Structure, function and prostatic cancer.

3.3. Cowpers gland: Structure, function and anomalies.

3.4. Penis: Structure and mechanism of erection.

Unit-IV

4.1. Male reproductive behaviour: Mating system, neural and hormonal control.

4.2. Pheromones:types, structure and function.

4.3. Infertility: causes and remedy.

4.4. Andrologically relevant diseases inadvancedage.

M. Sc. Semester-I Zoology

Course category: DSE

LAB Elective3: Mammalian Reproductive Physiology-I

(Reproductive Process in Male)

Practicals:

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/ sialic acid in reproductive tissue using animal wastes from recognized slaughter houses /poultry farm setc.
6. Experimental studies (histological slides for identification) of the following with the help of already available permanents lides/ ICT tools/ models/ charts/ photographs etc.
   a. Effects of castration and androgen replacement on sex accessory glands
   b. Effects of anti-androgen on testis and sex-accessory glands
   c. Effect of anti-cancer drugs on testis and sex-accessory glands, different duration and different regimen studies
   d. 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 anti thyroid drugs
   c. Adrenal: Normal histology and effects of meta pyrone and cortico steroids administration
9. Field Work:Visit to Artificial insemination centre and submission of report.

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M. Sc. Semester-I Zoology

Course category: DSC/DSE

Course code: M-ZO116P

LAB: (Based on Paper-I + II + Elective)

Total Credits: 6 Hours: 30

Course objectives:

1) To design the biotechnological laboratory.
2) To perform the experiments on microbial culture, cell culture and molecular separation techniques.
3) To represent the data by diagram and graphs by using computer.

Courseoutcomes:

1) Students can perform their practical work related to techniques in biology independently.
2) They will be liable to analyse the biostatistical data at their own.
3) They will understand and apply various significance tests.

Section A: Biotechnology

1) Preparation of animal cell culture media.
2) Immobilization of cells/ enzymes

3) Antigen–antibody reaction– determination of Blood group
4) Agarosegel electrophoresis of tissue extract.
5) Estimation of proteins by Lowry's and Bradford method.
6) Demonstration of technique of PCR Demonstration of DNA: Feulgen's reaction (Source of tissue: Animal wastes from local recognized slaughterhouses/ poultry forms/ fish markets etc.)
7) Demonstration of DNA: RNA: Methyl Green- Pyronin reaction (Source of tissue: Animal wastes from local recognizeds laughter houses/ poultry forms /fish markets etc.)
8) Histochemical analysis of alkaline phosphatase (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms /fish markets etc.)
9) Histochemical analysis of acid phosphatase (Source of tissue: Animal wastes from local recognizeds laughter houses/ poultry forms/ fish markets etc.)
10) Demonstration of separation of amino acids by paper chromatography and TLC
11) Computer aided statistic alanalysis
12) Computer presentation of statistical data, charts and diagrams

Section B: Biotechiques and Biostatistics

Biotechniques-

1) Section cutting of tissue by using freezing microtome.
2) Preparation of media and cultivation of microorganisms.
3) Observation of various microbial colonies on culture plates
4) Demonstration of Gram positive and Gram-negative bacteria.
5) Bacterial motility test by hanging drop method.

Biostatistics-

1) Representation of given data by frequency distribution table
2) Calculation of mean, mode and median from given data
3) Calculation of range, mean deviation, sample variance, standard deviation and standard error from given data.
4) Representation of given data by diagrams
5) Representation of given data by graphs
6) Numerical problems on binomial,Poisson and normal distribution.
7) Numerical problems on z- test, t- test, Chi square test and F- test

Scheme of Marking for Practical Examination:

Distribution of Marks: **Max. Marks: 180**

1. Demonstration of electrophoresis of tissue extract/ Paper chromatography 25
2. Antigen-antibody reaction/ Estmation of proteins by Lowry's method 25
3. Statistical analysis of given data/ Representation of given data by diagrams & graphs 25
4. Demonstration of Gram positive and negative bacteria 25
5. Experiment from elective paper 25
6. Experiment from elective paper 15
7. Certified practical record 30
8. Viva voce 10

M. Sc. Semester-I Zoology

Course category: RM

Course code: M-ZO117T

Paper: Research Methodology

Total Credits: 4 Hours: 60

Course objectives:

1) To familiarize students with basics of research and research process
2) To provide an introduction to research methods and report writings
3) To give insight into various kinds of research design and sampling

Course outcomes:

At the end of the course the students will be able to:

1) Understand the concept of research and different types of research in the context of biology.
2) Have basic awareness of data analysis and hypothesis testing procedures.
3) Develop laboratory experiment related skills.
4) Have basic knowledge on qualitative research techniques.
5) Develop competence on process of scientific documentation.
6) Analyze the ethical aspects of research.
7) Evaluate the different methods of scientific writing and reporting.

Unit-I

1.1. Research Methodology: meaning and objectives of research, types of research, research process, problems encountered by researchers in India.
1.2. Defining Research Problem: definition, selecting the problem, necessity of defining the problem, techniques involved in defining a problem.
1.3. Research Design: meaning, features of good design, various concepts relating to research design, different research designs.
1.4. Experimental Designs: concepts, basic principles of experimental designs, important experimental designs and their uses.

Unit-II

2.1. Sampling: definition, sampling theory, types of sampling, concept of standard error, sample size and its determination.
2.2. Analysis of Data: types of analysis, role of statistics in research, correlation concept and types, coefficient of correlation, regression concept and types, time series analysis-components, methods of measuring trend.
2.3. Hypothesis Testing: meaning of hypothesis, basic concepts of hypothesis testing, procedure for hypothesis testing.
2.4. Tests of Hypothesis (Tests of Significance): parametric and nonparametric tests, important parametric tests: z-test, t-test, chi-square test and F-test.

Unit-III

3.1. Analysis of Variance (ANOVA): meaning, basic principle of ANOVA, Techniques of analysis of variance, working procedure or steps for ANOVA.
3.2. Probability: definition, basic concepts, theorems of probability, important theoretical distributions and their applications.
3.3. Measures of central location, objectives and types of averages, Measures of variation or variability.
3.4. Analysis of frequencies, graphical representation of ungrouped and grouped data, advantages of graphical representation.

Unit-IV

4.1. Interpretation and Report Writing: precautions for correct interpretation, significance of report writing, different steps in writing report, types of reports, oral presentation, set rules and precautions for writing reports.

4.2. Computers in Research: classification and generations of computers, important applications of computers in research, basics of word processing software-MS Office, internet, mail and file transfer protocol (FTP).

4.3. Intellectual Property Rights (IPR): intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights.

4.4. Ethics in research: ethical issues, ethical committees, CPCSEA guidelines for animals use in research, Plagiarism- definition, different forms, consequences, unintentional plagiarism.

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INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)
(To be implemented from 2024-25)
M. Sc. Semester-II Zoology
Course category: DSC
Course code: M-ZO121T
Paper–I: Biodiversity and Conservation

Total Credits: 4 Hours: 60

Course objectives:
1) To orient students about rich heritage of Biodiversity of India and make them understand significance of its conservation.
2) To generate qualified students who can directly get jobs in the allied fields of Biodiversity, Conservation and Wildlife Management.
3) To generate a team of postgraduates who can take up jobs related to the environment in educational institutions.
4) To create awareness about Biodiversity and Nature Conservation.

Course outcomes:
Students would appreciate treasure of Biodiversity, its importance and hence would contribute their best for its conservation.

UNIT I
1.1. Biodiversity: Definition, Concept, Types and Values.
1.2. Indian Biodiversity: Zones of Faunal distribution, Major protected areas & their importance.
1.3. Natural History of Fauna of India- Major flora & Fauna Natural History of Western Ghats - Major Fauna Methods of recording Natural History of a place. Resident, Migrant, Vagrant species
1.4. Global Biodiversity: Major Biodiversity areas of the world and Biodiversity Hot Spots

UNIT II
1.1 Human –wildlife interactions: Conservation Vsprotection; Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions.
2.2. Role of Government and NGOs in controlling human-wildlife interactionsSocio-economicissuesrelatedtohuman-wildlife interactions
2.3. Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves Single species / single habitat-based conservation programmes (e.g. Project tiger)
2.4. Ex-situ & in-situ conservation. Conservation Breeding (e.g.Vulture, Pygmy hog, Gharial etc.)

UNIT III

3.1. Role of NGOs in conservation: International NGOs; UNEP, GEF, WCS, Bird Life International Important NGOs in India & their contributions WWF, ATREE, BNHS, WTI, Kalpavriksha etc.

3.2. Molecular Techniques – Genomics (General concepts & applications): Extraction of DNA from samples PCR & RTPCR DNA sequencing DNA fingerprinting Southern Blotting and its applications

3.3. Molecular Techniques – Proteomics (General concepts & applications) Extraction & Evaluation of Proteins, Protein Fingerprinting (e.g.Venomproteins, Plantproteins) Western Blotting and its applications

3.4. Analysis of Animal tracks & signs (General concepts): Tracking Large mammals Studying & analyzing Animal Tracks & signs

UNIT IV

4.1. Management of Protected areas: Principles of wildlife management, Wildlife management techniques

4.2. People's participation in managing protected areas: Integrating Local Community in conservation (e.g. Kaziranga, Eagle's Nest).

4.3. Wildlife Tradeand Laws: Wildlife protection Act of India CITES, TRAFFIC, RED Data Book, Measures to control poaching & wildlife trade

4.4. Regulations & Acts related to protected areas: General concepts of Private forests, Reserve forests, Sanctuaries, National Parks,Wildlife reserves, Coastal Regulation Zone, Protected Areas Network

M. Sc. Semester-II Zoology
Course category: DSC
Course code: M-ZO122T
Paper–II: Microtechnique

Total Credits: 4 Hours:60

Course objectives:

1) To study the process of microtechnique for organ histology of animals.

Courseoutcomes:

After completion of this course, students will-

1) Perform microtechnique process independently.
2) Able to work in pathological laboratory
3) Know the idea about histological structure

Unit-I

1.1. Introduction and importance of microtechnique.

1.2. Collection and preparation of material.

1.3. Laboratory procedures for the use of collected material.

1.4. Fixation and fixatives: Formalin, acetone, Carnoy's fluid, Bouin's fluid,

Unit-II

2.1. Washing and dehydration of material, preparation of alcoholic grades
2.2. Clearing and clearing agents: Xylol, benzene, clove and cedar wood oil
2.3. Wax embedding, block making and trimming of block.
2.4. Microtomes-Rocking, Rotary and Freezing microtomes

Unit-III

3.1. Section cutting, Honing and stropping of knife,
3.2. Affixing, processing and spreading sections; labeling slides.
3.3. Difficulties encountered during section cutting- their causes and remedies
3.4. Dehydration of sections for staining

Unit-IV

4.1. Staining: Principles of staining, types of stains, vital staining, H-E staining
4.2. Histochemical techniques for carbohydrates (PAS), proteins (bromophenol blue) and lipids (Sudan black-B).
4.3. Mounting agents: types; DPX, Canada balsam
4.4. Camera lucida drawing

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M. Sc. Semester-II Zoology
Course category: DSE
Course code: M-ZO123T
Paper–Elective1: Animal Physiology-II (Physiology of Circulation)

Total Credits: 2 Hours: 30

Course objectives:
1) To learn the anatomy, histology and physiology of heart and cardiac cycle.
2) To know composition, function of blood and lymph, disorders of blood.

Courseoutcomes: By the end of the course, the students should be able to:
1) Understand structure and functioning of heart.
2) Cardiac cycle and cardiac failure.
3) Cellular composition and functions of blood, blood disorders.
4) Lymph – composition, formation and functions, Haemostasis.

Unit-I
1.1. Types of heart (Myogenic and Neurogenic).
1.2. Anatomy, histology and nerve innervations of the heart, heart valves.
1.3. Pacemaker 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, heart sound.
2.3. Haemodynamics.
2.4. Cardiac Failure.

Unit-III
3.1. Cellular composition and functions of blood.
3.2. Blood groups and Blood transfusion.
3.3. Blood sugars–Causes and control of hypoglycemia and hyperglycemia
3.4. Blood lipids-Causes and control of hypolipidimia and hyperlipidimia

Unit-IV
4.1. Plasmaproteins- Albumins, globulins.
4.2. Haemostasis, Cascade of biochemical reactions in valves in coagulation of blood.
4.3. Transport of O_2 & CO_2 by blood.
4.4. Lymph–composition, formation and functions.

M. Sc. Semester-II Zoology
Course category: DSE
LAB Elective1: Animal Physiology-II (Physiology of Circulation)

Total Credits: 2 Hours:30

Practicals:

I. Physiology Experiments

1 Study of structure of RBCs invertebrates with the help of already available permanent slides/ ICT tools/ models /charts/ photographs etc.
2 Determination of protein, glucose in Urine from diabetic patient.
3 Total leukocyte count and differential leukocyte count.
4 Total erythrocyte count.

II. QuantitativeAnalysis

1 Estimation of blood triglycerides (Source of blood: Local recognized pathology laboratory)
2 Estimation of blood alkaline & acid phosphates (Source of blood: Local recognized pathology laboratory).
3 Blood amino-acid separation by TLC Paper chromatography (Source of blood: Local recognized pathology laboratory).

III. QualitativeAnalysis

1 Estimation of serum urea (Source of blood: Local recognized pathology laboratory)
2 Preparation and study of haemin crystals.

IV. Histological Study of Thyroid, Pituitary, Blood smear, Heart, T.S. Vein, T.S. Arterywith the help of alreadyavailablepermanentslides/ICTtools/charts/photographsetc.

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M. Sc. Semester-II Zoology
Course category: DSE
Course code: M-ZO124T
Paper–Elective2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 2 Hours: 30

Course objectives:
1) To make students aware about the applications and economic importance of Fishery Science.

Courseoutcomes: After studying this course the students will be able to:
1) Learn the various fisheries of India and breeding of carps.
2) Understand the culture of Indian and exotic fishes.
3) Know the methods of culture of air breathing fishes, crab, ornamental fishes, sea weeds and Spirulina.
4) Learn the techniques of pearl culture, 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– 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. Troutculture
3.3. Ornamental fish culture: i) Oviparous, ii) Live bearers.
3.4. Culture of sea weeds and Spirulina.

Unit-IV
4.1. Pearlculture: fresh water and marine pearl oysters, culture methods.
4.2. Crabculture.
4.3. Prawn culture (Life cycle and breeding)
4.4. Frog culture

M. Sc. Semester-II Zoology
Course category: DSE
LAB Elective2: Fish and Fisheries-II (Applied Fisheries)

Total Credits: 2 Hours: 30

Practicals:

1. Permanent preparation of various scales using wastes from recognized fish markets.
2. Estimation of dissolve oxygen in water sample.
3. Estimation of CO_2 in water sample.
4. Estimation of chloride in water sample.
5. Estimation of protein in muscles / blood of fish (Source of fish blood: Local recognized fish markets).
6. Determination of free fatty acids (FFAs) in fish oil.

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M. Sc. Semester-II Zoology
Course category: DSE
Course code: M-ZO125T
Paper–Elective3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 2 Hours: 30

Course objectives:
To introduce students to the physiology of female reproductive system.

Courseoutcomes: Students on completion of this course will be able to:
1) Study the ovary and female genital tract, the process of folliculogenesis.
2) Understand the oestrous cycle in mammals, menstrual cycle and menopause in female.
3) Study the histology and function of corpus luteum and structure of oviduct, uterus.
4) Understand the structure, functions of cervix and vagina.
4) Study the role of prostaglandins in reproduction, anatomy and growth of mammary glands.

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-cellconcept).

Unit-II
2.1. Estrous cycle in mammals.
2.2. Menstrual cycle and Menopause.
2.3. Mechanism and hormonal control of ovulation.
2.4. Corpusluteum: 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.
3.4. Vagina- structure, function, detection of various stages of oestrous cycle by vaginalcytology, vaginalplug.

Unit-IV
4.1. Onset of puberty and delayed puberty.
4.2. Prostaglandins and their role in reproduction.
4.3. Anatomy and growth of mammary glands.
4.4. Lactogenesis and galactopoiesis.

M. Sc. Semester-II Zoology
Course category: DSE
LAB Elective3: Mammalian Reproductive Physiology-II
(Reproductive Process in Female)

Total Credits: 2 Hours: 30

Practicals:

1. Demonstration of surgical operation in rat/ mice Ovariectomy or Tubectomy with the help of ICT tools
2. Anatomical observations, demonstration and detailed explanation of the female reproductive system of rat/ mice with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of Oogenesis and identification of its various stages with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
4. Experimental studies (histological slides for identification) of the following with the help of already available permanent slides /ICT tools/ models /charts/ photographs etc.
   a. Effect of anti-cancer drugs on ovary
   b. Effect of heavy metals on ovary
5. Histology: Histological changes in female reproductive organs and sex accessories duringactive and inactive stage with the help of already available permanent slides/ ICT tools /models/ charts/ photographs etc.
6. Study of following organs with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
   a. Uterus: anatomy, cell types and identification of estrous types
   b. Mammary glands: Histology of active and inactive glands

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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.
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6. Biology of Gestation: Assalye ,N.S.(1968). Academic Press, London.
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26. Reproductive Endocrinology: Ref. No.1,Vol. 3 Hormones in Reproduction.
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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: J honson, A.D. and W. R., Gomes.
32. Vertebrate Foetal Membrances: Mossman, H.W. (1989). Rutgress Press Ltd.
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M. Sc. Semester-II Zoology
Course category: DSC/DSE
Course code: M-ZO126P
LAB: (Based on Paper-I + II + Elective)

Total Credits: 6 Hours: 30

Practicals:

Section A: Biodiversity and Conservation

1. Field visits to nearby Zoo, Museum, Forest, Nursery, Aquaria or any other relevant site must be arranged. The report of these visits to be submitted.
2. Adaptations in animals: use pictures or photographs with suitable labels.
3. Application of transacts and quadrants in Simulated pictures/ photographic sheets for data collection. Record & tabulate the data.
4. 4. Using a suitable hand-held camera photograph wild animals, birds and insects to record diagnostic features and Take 5"X 7" prints on photo papers.
5. Collect matured leaves (minimum hundred for a class) from two different plants (e.g. Mango tree & False Ashoka). Measure and record the length (in cm.) along the midrib using a flexible thread. Tabulate the data, make frequency polygon, apply "t" test to the data and comment on the significance of the deference in leaf length between the two plant species.
6. Using photographs/ paintings/ coloured drawings identify and study ecological role of characteristic animal species (major representative species only) of various Biomes.
7. Study of animal architecture (photographs/ diagram/ abandoned specimen); Hive of honeybee, nest of paper wasp, nest of potter wasp, Mount of termite, Nests of Weaver Bird and tailor bird.
8. On a geographic map of India locate & demarcate major sanctuaries/ national parks.

Section B: Microtechnique

1. Collection and fixation of tissue
2. Washing, dehydration and clearing of tissue
3. Wax embedding and block making
4. Trimming of block, section cutting and spreading of sections on slides
5. Double staining by Haematoxylin and Eosin, permanent preparation of slides
6. Vital staining of mitochondria
7. Histochemical demonstration of carbohydrates, proteins and lipids
8. Camera lucida drawing

Scheme of Marking for Practical Examination:

Distribution of Marks	**Max. Marks: 180**
1. Numerical problem on t-test	20
2. Study of vegetation by Quadrat method	20
3. Permanent preparation of H-E staining	20
4. Histochemical demonstration of carbohydrates/ proteins/ lipids	20
5. Experiment from elective paper	15
6. Experiment from elective paper	15
7. Identification and comment on spots (1 to 10)	30
8. Submission of certified practical record and stained slides	30
9. Viva voce	10

INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

(To be implemented from 2024-25)

M. Sc. Semester-III Zoology

Course category: DSC

Course code: M-ZO231T

Paper–I: Endocrinology

Total Credits: 4 Hours: 60

Course objectives:

1) To familiarize students with basics of endocrine system.
2) To discuss the hormones and the mechanisms of hormone action.
3) To discuss the hormonal regulation.
4) To discuss common diseases associated with endocrine system dysfunction.

Course outcomes:

At the end of the course the students will be able to:

1) Understand the structure and functions of endocrine glands.
2) Understand the physiological mechanisms of hormone actions.
3) To study the role of hormones in growth, development, metabolism and reproduction.
4) Understand various disorders of endocrine glands.
5) Students should be able to apply this knowledge to clinical scenarios and patient care.

Unit-I

1.1 Introduction to Endocrine System; General properties;classificationand chemistry of hormones.

1.2 Functional interactions of hormones: Hormone action at cellular level, genetic level. Hormones in Biological Clock;hormones and homeostasis, feedback system.

1.3 Hypothalamo-hypophysial system: Structure, hypothalamic nuclei, hormones and function.

1.4 Pituitary gland: Morphology, Histology, cell types, hormones and functions. Pituitary hormones disorders (Acromegaly, Diabetes insipidus).

Unit-II

2.1 Pineal gland: Morphology, Histology, cell types, hormones and functions.

2.2 Melatonin function: Melatonin as an anti-oxidant; Adverse effects of Melatonin: Melatonin and depressive disorders; Melatonin and cancer; Melatonin and endocrine disorders; Jet-lag and sleep disturbance.

2.3 Thymus gland: Morphology, Histology, hormones and functions.

2.4 Thyroidand Parathyroid gland: Morphology, Histology, hormones and functions. Thyroid hormone disorders (Hashimoto's disease, Grave's disease). Parathyroid hormones and disorders(hyperparathyroidism and hypoparathyroidism)

Unit-III

3.1 Adrenal gland: Morphology, Histology, hormones and function. Adrenal gland hormones and disorders(Addison's disease, Cushing's syndrome)

3.2 Hormonal regulation of Growth and Reproduction; Gonadal Hormones during Sex Differentiation in Vertebrates.

3.3 Endocrinehistophysiology of testis and ovary in human: Hormones of testis and ovary; their actions and feedback mechanisms.

3.4 Histophysiology of endocrine placenta and placental hormones;HCG, prostaglandins.

Unit-IV

4.1 Role of Hormones in digestion:Gastrointestinal hormones and their functions; gastrin, CCK, motilin, secretin, somatostatin, ghrelin, bombesin, and gastrin-releasing peptide. Hormonal regulation of carbohydrate, Lipid and Protein metabolism.

4.2 Pancreatic endocrine system; Structure and functions of Islets of Langerhans; Diabetes: Diabetes Type I, Diabetes Type II, Diabetic Kidney Problems, Diabetes and Pregnancy, Diabetic Nerve Problems, Autoimmune diabetes.

4.3 Hormones released by heart and kidneys with secondary endocrine function.

4.4 Histophysiologies of Urohypophysis and Corpuscles of Staninus in fishes.

M. Sc. Semester-III Zoology
Course category: DSC
Course code: M-ZO232T
Paper–II: Evolution and Animal Behaviour

Total Credits: 4 Hours: 60

Course objectives:

1. To give insight into the origin of life and the related evolutionary processes.
2. To understand the evolutionary significance.
3. To understand the concept and mechanisms of evolution.
4. To study the various phyletic evolution and adaptive radiation.
5. To explain the natural behaviour patterns.
6. To learn the theoretical and practical techniques used to study animal behaviour.
7. To develop skills, concepts and experience to understand all aspects of animal behaviour.

Course outcomes:

After successfully completing this course, the students will be able to:

1. Acquire an in-depth knowledge on the diversity and relationships in animal world.
2. Develop a holistic appreciation on the phylogeny and adaptations in animals.
3. Enable the students to understand the evolution of universe and life.
4. Understanding on the process and theories in evolutionary biology.
5. Develop an interest in the debates and discussion taking place in the field of evolutionary biology.

Unit-I

1.1 Evolution- concept, theories and evidences of organic evolution

1.2 Origin of life- history, theories of origin of life on earth

1.3 Variation- definition, types of variation

1.4 Mutations- definition, mutation theory

Unit-II

2.1 Isolation- definition, isolating mechanisms, species concept and modes of speciation

2.2 Natural selection theory: modern perspective; Population as a unit of evolution- gene frequencies in Mendelian population, Hardy-Weinberg law, genetic drift.

2.3 Patterns of evolution- Macroevolution (adaptive radiation), microevolution and megaevolution

2.4 Concept of origin and evolution of horse and man

Unit-III

3.1 Animal Behaviour: - Definition, objectives and significance. Neural and Hormonal control of behaviour.

3.2 Patterns of behaviour: - Innate and Learned behaviour, concept of Fixed Action Patterns (FAP), concept of sign or key stimulus, Innate releasing Mechanism, concept of Learning, Imprinting, concept of evolution of behaviour.

3.3 Communication in animals: Auditory, visual, olfactory and tactile.

3.4 Social behavior: Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness. An over view of Sociality in animal systems. Social organization in honey bees and termites.

Unit-IV

4.1 Sexual behavior: Courtship, mating systems, sexual isolation, sexual selection- Intrasexual selection (male rivalry), Intersexual selection (female choice), Sexual conflict in parental care.

4.2 Orientation in Animals: - Kinesis, Types of Kinesis, Taxes, Types of taxes, Echolocation, Language of honey bees.

4.3 Biological rhythms: - occurrence and significance, circadian, circannual, circatidan, circalunar, circasyzygic Clocks (with examples) .

4.4 Parental care in animals

REFERENCES:

References for Endocrinology:

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2. TurnerC. D.: General Endocrinology.
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4. Gorbman A. and BernH.A.: General and Comparative Endocrinology.
5. Bancroft, J.D. and Stevens A: Theory and practical histological techniques.
6. Laufer H.and DownerR.C. H.: Endocrinology of selected vertebrate types.

References for Evolution and Animal Behaviour:

Books Recommended for Evolution:

1. Dobzhansky: Evolution (1976, Surjeet Publ.
2. Freeman and Herron: Evolutionary Analysis (1998, Prentice Hall)
3. Hedrick: Genetics of populations (2005, Jones and Bartlett Publ Inc)
4. Hartl and Clark: Principles of Population Genetics (1989 & 1997, Sinauer)
5. Kimura: The Neutral Theory of Molecular Evolution (1984, Cambridge)
6. Li Wen-Hsiung and Dan Graur: Fundamentals of Molecular Evolution (1991, Sinauer)
7. Mayr: Animal Species and Evolution (1966, Belknap Press)
8. Ridley: Evolution (1993, Blackwell)
9. White: Modes of Speciation (1978, Freeman)
10. Rastogi B.B., (2018). Organic Evolution, MedTech; 3rd edition.
11. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
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14. Colbert, E. H.; Morales, M. & Minkoff, E. I. (2001). Evolution of the Vertebrates, Science.
15. Moody, P. A. (2002). Introduction to Evolution, Kalyani Pub.
16. Dobzhansky, T, Ayala, F. J, Stebbins G. L. and Valentine, J. W. (1979). Evolution, Surjeet Pub.

Books Recommended for Animal Behaviour:

1. Slater & Halliday: Behaviour and Evolution (1st ed 1994, Cambridge Univ. Press)
2. Prasad S. – Animal Behaviour. CBS 2004
3. Mathur R. – Animal Behaviour. Rastogi 2002
4. John A (2009) Animal Behaviour.9th edition, Sinauer Associate Inc., USA.
5. Vinod Kumar (2002) Biological Rhythms: Narosa Publishing House, Delhi/ Springer-Verlag, Germany.
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9. Sherman, P. W. and Alcock, J. (2013) Exploring Animal Behaviour (6th edition) Sinauer

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11. Kumar, V. (2002). Biological Rhythms: Narosa Publishing House, Delhi/ Springer – Verlag, Germany.

M. Sc. Semester-III Zoology
Course category: DSE
Course code: M-ZO233T
Paper–Elective1: Animal Physiology-III (Physiology of Brain, Nerve and Muscle)

Total Credits: 4 Hours: 60

Course objectives:

To comprehend the key features of physiology of brain, nerve and muscle.

Course outcomes:

After completion of this course, students will learn about:

1. Anatomy of brain and physiology of learning, memory and sleep.
2. Types, ultrastructure and functional properties of neurons.
3. Biosynthesis and release of neurotransmitters and neuropeptides.
5. Disorders of nervous system.
6. Ultrastructure and properties of skeletal muscle.

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 and functional properties of neurons
2.2 Ultrastructure of neuron
2.3 Ultrastructure of synapse and molecular mechanism of synaptic transmission
2.4 Bioelectrical properties of neurons- neuronal excitability, resting membrane potential- Nearnst equation, sodium and potassium pump, propagation of nerve impulses, generation of action potential.

Unit-III

3.1 Biosynthesis, storage and release of neurotransmitters: Acetylcholine, GABA, Epinephrine, Nor-epinephrine, Serotonin.
3.2 Neuropeptides- oxytocin, vasopressin, 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 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 in muscle contraction.
4.3 Properties of muscle (twitch, tetanus, summation, tonus, all or none principlefatigue), muscular disorders.
4.4 Ultrastructure of Neuromuscular Junction.

M. Sc. Semester-III Zoology
Course category: DSE
DSE LAB Elective1:
Animal Physiology-III (Physiology of Brain, Nerve and Muscle)

Total Credits: 4 Hours: 30

Practicals:

I. Physiology Experiments

1. Study of Electrocardiograph (ECG) under different physiological conditions with the help of ICT tools/ charts/ models / photographs etc.
2. Measuring of heart beat under different physiological condition.
3. Study of nerve cells and neurosecretry cells of cockroach with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.

II. Quantitative Analysis

1. Muscle & Liver glycogen (Source of muscle/ liver: Local recognized fish markets/slaughter houses/ poultry farms etc.)
2. Separation of protein by SDS-PAGE

IV. 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.)

V. Histological Study of - Brain, T. S. Muscle fiber, T. S. Spinal cord, Cerebellum, Cerebrum and Nerve fiber with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

REFERENCES:

1. A. G. Giese: "Cell Physiology" (3rd Ed) Saunders, Toppan
2. Gerald Karp: "Cell Biology" McGraw Hill Kogakusha Ltd.
3. Darnell, Loddish, Baktimore: "Molecular Cell Biology" Scientific American Books.
4. C. A. Keil, E. Neil & E.N. Joeb (1982): "Samson Wright, Applied Physiology" Oxford Univ. Press.
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6. W. A. Hoar (1982): "General & Comparative Animal Physiology 3rd Ed." Prentice Hall Inc.
7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
8. C. Ladd Prosser Ed. (1991): "Neural & Integrative Animal Physiology" "Comparative Animal Physiology", 4th Ed. Wileg – Liss Publ.
10. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.
11. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed.Cambridge Univ. Press.
12. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
13. P. W. Hochachka & G. M. Somero (1973): "Strategies of Biochemical Adaptation".
14. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
15. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
16. Philip Carew Withers (1992): Comparative animal physiology Saunders College Pub.,

M. Sc. Semester-III Zoology
Course category: DSE
Course code: M-ZO234T
Paper–Elective2: Fish and Fisheries-III (Fish Biology)

Total Credits: 4 Hours: 60

Course objectives:

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

Course outcomes:

After completion of this course, students will learn about:

1. Structure and physiology of alimentary canal, structure of kidney, osmoregulation in fishes.
2. Chemoreceptors, migration in fishes.
3. Structure and physiology of male and 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 thyroid and adrenal glands.
4.3 Hypothalamo-hypophysial system in fishes.
4.4 Structure and functions of pancreatic islets and pineal organ.

M. Sc. Semester-III Zoology
Course category: DSE
DSE LAB Elective2: Fish and Fisheries-III (Fish Biology)

Total Credits: 4 Hours: 30

Practicals:

1. Study of eyestalk ablation in prawn 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. Permanent mounting of zooplankton.
4. Study of permanent histological slides of various fish organs and endocrine glands with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
5. Study of skeletal system of *Wallago* &*Labeo* with the help of already available skeleton/ ICT tools/ charts/ models / photographs etc.

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M. Sc. Semester-III Zoology
Course category: DSE
Course code: M-ZO235T
Paper–Elective 3:
Mammalian Reproductive Physiology-III (Reproductive Endocrinology)

Total Credits: 4 Hours: 60

Course objectives:

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

Course outcomes:

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 and inhibin.

Unit-I

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

Unit-II

2.1 Adenohypophysis: Anatomy, cytology.
2.2 Neurohypophysis: Anatomy, cytology.
2.3 Gonadotrophic hormones: structure, mechanism of secretion and function.
2.4 Anatomy and hormones of pars intermedia.

Unit-III

3.1 Hypothalamo – hypophyseal testis axis
3.2 The Androgen: Biosynthesis, mode of action, transport and functions of testosterone.
3.3 Physiology of inhibin-biosynthesis, mode of action and functions
3.4 Hypothalamo – hypophyseal thyroid-gonad axis.

Unit-IV

4.1 Hypothalamo – hypophyseal ovarian axis.
4.2 The oestrogen: Biosynthesis, mode of action, transport and functions.
4.3 The progesterone: Biosynthesis, mode of action, transport and function.
4.3 Hypothalamo- hypophyseal adrenal-gonad axis

M. Sc. Semester-III Zoology
Course category: DSE
DSE LAB Elective 3:
Mammalian Reproductive Physiology-III (Reproductive Endocrinology)

Total Credits: 4 Hours: 30

Practicals:

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. Pregnancy detection test.
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.

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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.
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22. The Testis Vol. 1 to 4: Johnson, A. D. and W. R., Gomes.
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37. Physiology of Lactation: Smith, Vearch, Constable & Co., London.
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M. Sc. Semester-III Zoology
Course category: DSC/DSE
Course code: M-ZO236P
LAB: (Based on Paper-I+II+Elective)

Total Credits: 6 Hours: 30

Practicals:

Section A: Endocrinology

1. Histology: Pituitary gland, Thyroid gland, Parathyroid gland, Adrenal gland, Pineal gland, Thymus gland, Pancreas (Permanent slides/ ICT)
2. In situ demonstration of endocrine glands in rat. (ICT)
3. Study of Endocrine disorders: Acromegaly, Diabetes insipid, Hashimoto's disease, Grave's disease, hyperparathyroidism, hypoparathyroidism, Addison's disease, Cushing's syndrome.
4. Histological techniques: preparation of permanent slides for histological structure of endocrine glands. (at least 5 be submitted)
5. Effect of thyroxin on oxygen consumption in fish.
6. Effect of insulin on blood glucose levels in fish.

Section B: Evolution and Animal Behaviour:

1. Demonstration of phototaxis phenomenon in earthworm or housefly.
2. Demonstration of geotaxis phenomenon in earthworm or houseflies.
3. Demonstration of chemotaxis phenomenon in *Paramecium*.
4. Demonstration of thiogmotactic behaviour in two beetles.
5. Study of the biological rhythms of eclosion behavior in *Drosophila melanogaster*.
6. Adaptational study of animals (invertebrates and vertebrates)
7. Study of social patterns of behavior.
8. Study of fossils from models / pictures.

Scheme of Marking for Practical Examination:

Distribution of Marks:	**Marks: 180**
1. Identification and comment on spots (1 to 10)	30
2. Anatomical observation and explanation of various endocrine glands in rat	20
3. Experiment on animal behavior	20
4. Experiment on animal behavior	20
5. Experiment from elective paper	20
6. Experiment from elective paper	20
7. Submission of slides of endocrine glands	10
8. Submission of certified practical record	30
9. Viva voce	10

INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

(To be implemented from 2024-25)

M. Sc. Semester-IV Zoology

Course category: DSC

Course code: M-ZO241T

Paper–I: Developmental Biology

Total Credits: 4 Hours: 60

Course 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 and contraception methods.

Course outcomes:

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.
2. Embryonic sexing, cloning, screening for genetic disorder diagnosis (ICSI, GIFT etc.), immunocontraception and classical contraceptive techniques.
3. Role of mutants and transgenics in human welfare.
4. Metamorphosis in Amphibia, Regeneration in vertebrate, polymorphism in insect.
5. Cloning of animals by nuclear transfer.

Unit-I

1.1 Basic concepts of Developmental Biology: Model sysems- Chick and Drosophila, 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 Concepts of growth, differential cell proliferation, shaping of organ primordial and programmed morphogenetic cell death.

2.3 Ageing- mechanism, concepts and models.

2.4 Polymorphism (caste differentiation) in insects- 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.

M. Sc. Semester-IV Zoology
Course category: DSC
Course code: M-ZO242T
Paper–II: Parasitology and Toxicology

Total Credits: 4 Hours: 60

Course objectives:

1. To inculcate knowledge about parasitic infectious diseases.
2. To impart knowledge on protozoan, helminthes and microbes parasitology.
3. Course on toxicology is focused on theoretical and applied knowledge on the effects of chemical substances on human health.
4. The students will also get introduced to the toxicological analysis and the signs and symptoms of important toxic syndromes.
5. The students will also study the basic toxicokinetic principles and metabolic systems to elucidate mechanisms of toxicity induced by xenobiotic compounds.

Course outcomes:

After completing this course the students will be able to:

1. Understand the common parasitic diseases and life threatening conditions caused by parasites.
2. Apply knowledge to study the common parasitic diseases and life threatening conditions caused by helminthes as regards etiology and life cycle of parasites of medical importance.
3. Analyze the common diseases caused by bacteria and viruses of medical interest as regards etiology, pathogenesis.
4. Understand mechanisms of systemic and organ toxicity induced by xenobiotics.
5. Learn how to analyze and interpret complex data sets in toxicological research.

Unit-I

1.1 *Clostridium titani* and *Vibrio cholerae*: Morphology, growth characteristics, mode of infection, pathogenecity and clinical signs, disease diagnosis and treatment.
1.2 *Salmonella typhi* and *Yersinia pistis* : Morphology, growth characteristics, mode of infection, pathogenecity and clinical signs, disease diagnosis and treatment.
1.3 Influenza virus and Corona virus SARS-CoV-2: Morphology, growth characteristics, mode of infection, pathogenecity and clinical signs, disease diagnosis and treatment.
1.4 Hepatitis virus and Dengue virus: Morphology, growth characteristics, mode of infection, pathogenecity and clinical signs, disease diagnosis and treatment.

Unit-II

2.1 *Entamoeba* and *Trypanosoma*: Structure, Life cycle, mode of infection, pathogenecity and symptoms, disease diagnosis and treatment.
2.2 *Leishmania* and *Plasmodium*: Structure, Life cycle, mode of infection, pathogenecity and symptoms, disease diagnosis and treatment.
2.3 *Giardia* and *Trichomonas*: Structure, Life cycle, mode of infection, pathogenecity and symptoms, disease diagnosis and treatment.
2.4 *Trichinella* and *Wuchereria*: Structure, Life cycle, mode of infection, pathogenecity and

symptoms, disease diagnosis and treatment.

Unit-III

3.1 Basic concepts and scope of toxicology

3.2 Environmental toxicology: Classification of environmental toxicants, toxicants contaminating or present in food, atmosphere and hydrosphere.

3.3 Toxicants of public health hazard: Toxic chemicals- Pesticides, Heavy metals, Fertilizers Food additives, Automobile emissions, Radioactive substances.

3.4 Translocation of toxicants: Absorption, distribution, biotransformation and excretion of toxicants.

Unit-IV

4.1 Mechanism of action of toxicants: Theory of toxicant-receptor interaction and mechanism of action of DDT and Pyrethroides.

4.2 Toxic effects: Bioaccumulation and biomagnifications of xenobiotics, Basis of toxic effects in biological systems.

4.3 Antidotal therapy: Types of antidotes and antidotal procedures

4.4 Toxicity tests: Types of toxicity tests, Methods for estimating LC_{50} or $LD_{50,}$ Bioassay and its applications in toxicology

REFERENCES:

Recommended readings for 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 NewYork.
7. Cells into organs. 2nd Edition.The forces that shape the Embryo.John Philip Trinkaused. 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 HillPublishing 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.

Recommended readings for Parasitology:

1. Chakraborty, P. (2004), T.B.Medical parasitology, New Central Book Agency, Publishers, New Delhi.
2. Ananthanarayanan, R and Jayaram Panicker, C.K. (2006). Textbook of Microbiology, OrientLongMan Publishers, New Delhi.
3. Markell, E.K., M.Voge, M and John,D. T (2002), Medical Parasitology. W.B. Saunders Publishers, Philadelphia.USA.
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7. Soulsby, E.J.L. (2004), Helminths, Arthropods and Protozoa of Domesticated Animals, Bailliere Tindall and Cassell Pvt. Ltd., Publishers, London.
8. Roberts, L.S., J.Janovy, S.Nadler, (2013), Foundations of Parasitology, McGraw-Hill Publishers, New York.

Recommended readings for 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.

M. Sc. Semester-IV Zoology
Course category: DSE
Course code: M-ZO243T
Paper–Elective1: Animal Physiology-IV (Physiology of Respiration and Reproduction)

Total Credits: 4 Hours: 60

Course objectives:

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

Course outcomes:

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 and female reproductive systems, menstrual cycle, andropause and menopause.
4. Pregnancy-fertilization, hormonal regulation of pregnancy, physiology of lactation.
5. Ovarian and testicular steroid hormones and the physiological role**.**
6. 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.

1.4 Lung volumes and capacities, partial pressure of gases.

Unit-II

2.1 Oxygen dissociation curve, Carbon -dioxide dissociation curve.

2.2 Carbonic anhydrate, chloride shift.

2.3 Neural and chemical regulation of respiration

2.4 Hypoxia, Cyanosis.

Unit-III

3.1 Endocrine control of spermatogenesis and oogenesis

3.2 Leydig cells, sertoli cells and their hormones

3.3 Follicular cells and luteal cells and their hormones

3.4 Corpus luteum- formation, structure, hormones and functions

Unit-IV

4.1 Placenta - structure, hormones and functions

4.2 Physiology of lactation

4.3 Role of hormones and pheromones in reproduction

4.4 Causes of infertility in male and female; Invitro fertilization (IVF) and Test Tube baby

M. Sc. Semester-IV Zoology

Course category: DSE

DSE LAB Elective1:

Animal Physiology-IV (Physiology of Respiration and Reproduction)

Total Credits: 4 Hours: 30

Practicals:

I. Physiology Experiments

1. Body size and oxygen consumption in aquatic animals.
2. Effect of pH, temperature on oxygen and carbon dioxide concentration in pond water.
3. Biochemical estimation of tissue cholesterol (Source of tissue**:** Local recognized fish markets/ slaughter houses/ poultry farms etc.)
4. Estimation of SGOT/SGPT from blood sample (Source of blood**:** Local recognized pathology laboratory)

II. Quantitative Analysis

1. Determination of fructose in seminal vesicle/ semen (Source of semen: Government artificial insemination centre)
2. Determination of semen constituents (Source of semen: Government artificial insemination centre)
3. Estimation of percentage quantity of lactose in milk in vertebrates.

IV. Qualitative Analysis

1. Histochemical localization of Glycogen (Source of tissue: Local recognized fish markets/slaughter houses/ poultry farms etc.)
2. Histochemical localization of lipid (Source of tissue: Local recognized fish markets/slaughter houses/ poultry farms etc.)
3. Histochemical localization of protein (Source of tissue: Local recognized fish

markets/slaughter houses/ poultry farms etc.)

V. Histological Study of - Testis, Ovary, Thyroid, Adrenal, Corpus luteum in ovary, Leydig cells in testis, Lung with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

REFERENCES:

1. A. G. Giese: "Cell Physiology" (3rd Ed) Saunders, Toppan
2. Gerald Karp: "Cell Biology" McGraw Hill Kogakusha Ltd.
3. Darnell, Loddish, Baktimore: "Molecular Cell Biology" Scientific American Books.
4. C. A. Keil, E. Neil & E.N. Joeb (1982): "Samson Wright, Applied Physiology" Oxford Univ. Press.
5. R. Eckert & D. Randall (1982): "Animal Physiology: 2nd Ed." W. H. Freeman & Co.
6. W. A. Hoar (1982): "General & Comparative Animal Physiology 3rd Ed." Prentice Hall Inc.
7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
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M. Sc. Semester-IV Zoology
Course category: DSE
Course code: M-ZO244T
Paper–Elective2: Fish and Fisheries-IV (Fishery technology and Fish pathology)

Total Credits: 4 Hours: 60

Course objectives:

To comprehend the key concepts of fishery technology and fish pathology.

Course outcomes:

After completion of this course, students will learn about:

1. Construction and maintenance of fish farm, gears and crafts in inland water, Indian fishery legislation, effects of water pollution on fisheries.
2. Plankton study, manufacture and maintenance of aquarium, hybridization technique.
3. Sex determination, sex reversal and chromosome manipulation in fishes.
4. Spoilage and methods of preservation of fish, fish products and by-products.
5. 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 legislations 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, Moina)
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 chromosomal manipulation in fish
3.4 Fish conservation: In-situ and Ex-situ, cryopreservation technique and its applications

Unit-IV

4.1 Spoilage and methods of curing and 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) Fish protein (fish floor) vi) Fish glue vii) Fish manure
4.3 Fish pathology: i) Signs of sickness and effects on fish ii) Pathological procedures for diagnosis of fish diseases
4.4 Fish diseases and its control: a) Viral diseases b) Bacterial diseases c) Fungal diseases d) Protozoan diseases

M. Sc. Semester-IV Zoology
Course category: DSE
DSE LAB Elective2:
Fish and Fisheries-IV (Fishery technology and Fish pathology)

Total Credits: 4 Hours: 30

Practicals:

1. Study of WBC count in fish blood (Source of fish blood**:** Local recognized fish markets).
2. Determination of peroxide value (PV) in fish oil
3. Quantitative estimation of zooplankton by Sedgwick Rafter cell method.
4. Study of Weberian ossicles in *Labeo rohita, Tor tor & Wallago attu* withthe help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
5. Study of accessory respiratory organs in *Channa, Anabas, Heteropneustes* and *Clarias* with the help of already preserved material/ ICT tools/ charts/ models/ photographs etc.
6. Assessment of maturity of gonads using already available preserved specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.

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M. Sc. Semester-IV Zoology
Course category: DSE
Course code: M-ZO245T
Paper–Elective 3:
Mammalian Reproductive Physiology-IV
(Reproductive toxicology, Embryology and Fertility)

Total Credits: 4 Hours: 60

Course objectives:

To understand the key elements of reproductive toxicology, embryology and fertility.

Course outcomes:

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–allantoic placenta, foetal membranes.
3. Intrauterine and intracervical devices (IUDS and IUCDS), medicated and nonmedicated IUD's, pregnancy vaccine, recent advances in female contraception.
4. Vasectomy and reversible vasocclusion, antagonist, anti-androgen and anti- spermiogenic compounds.

Unit-I

1.1 Chemical toxicants and Testicular toxicity.
1.2 Environmental factors and reproductive health.
1.3 Induction of gonadal toxicity in females.
1.4 Interruption of pregnancy by pesticides.

Unit-II

2.1 Implantation of mammalian blastocyst.
2.2 Development of chorio–allantoic placenta.
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.

M. Sc. Semester-IV Zoology
Course category: DSE
DSE LAB Elective 3:
Mammalian Reproductive Physiology-IV
(Reproductive toxicology, Embryology and Fertility)

Total Credits: 4 Hours: 30

Practicals:

1. Study of histochemical localization of lipids in rat / mouse ovary by Sudan Black–B method (Propylene glycol method) with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
2. Experimental (histological slides for identification) study of the following with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
   i) Effects of ovariectomy and oestrogen replacement on pituitary, uterus and vagina.
   ii) Effects of some female antifertility drugs on ovary and adrenal gland
3. Histology: (Identification of slides) Histological changes in female reproductive organs during different phases of oestrous cycle in continuous and seasonal breeder with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
4. Embryology: Study of various stages of development of mammalian egg, development of foetal membranes, different types of placenta, progestational changes in uterus with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
5. Field work: Visit to laboratory for embryo transfer and family planning clinics.

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M. Sc. Semester-IV Zoology
Course category: DSC/DSE
Course code: M-ZO246P
LAB: (Based on Paper-I + II+ Elective)

Total Credits: 4 Hours: 30

Practicals:

Section A: Developmental Biology

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).

Section A: Parasitology and Toxicology

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. 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.
5. Study of life cycles of various parasites with the help of already available specimens, permanent slides/ ICT tools/ models/ charts/ photographs etc.
6. Gram staining of bacteria.
7. Micrometry- Calibration of microscope and measurement of microorganisms.
8. Determination of LC_{50} value of a toxicant (heavy metal/pesticide) for fish/snail under laboratory conditions. Apply Chi-square test.
9. Study of behavioural response of a fish/snail under different doses of toxicant stress in laboratory conditions.
10. Determination of oxygen consumption of fish/snail exposed to toxicant.

Scheme of Marking for Practical Examination:

Distribution of Marks:	**Max. Marks: 120**
1. Whole mount of chick embryo / sperm count	15
2. Preparation of developmental stages of live eggs of *Lymnea*	10
3. Gram staining of bacteria / measurement of microorganism.	10
4. Determination of LC_{50} value of a toxicant for fish/oxygen consumption of fish.	10
5. Identification and comment on spots (1 to 10)	30
6. Experiment from elective paper	10
7. Experiment from elective paper	10
8. Submission of certified Practical record	20
9. Viva voce	05