

INDIRA GANDHI UNIVERSITY, MEERPUR, REWARI



**Examination Scheme
&
Syllabi
For
M.Sc. Zoology
(SEMESTER- I to IV)
(2019-2021)**

INDIRA GANDHI UNIVERSITY, MEERPUR, REWARI

Scheme of Examination for M.Sc. Zoology

Semester-I

Credits = 32

Marks = 650

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credits			Examination Scheme			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessment	Practical	
ZOO101	Diversity of Invertebrates	CC	04	--	04	04	--	04	80	20		100
ZOO102	Cell Biology	CC	04	--	04	04	--	04	80	20		100
ZOO103	Biostatistics	CC	04	--	04	04	--	04	80	20		100
Discipline Centric Elective Course (Any Two)												
ZOO104	Cytogenetics	DCEC	04	--	04	04	--	04	80	20		100
ZOO105	Biomolecules and Metabolism	DCEC	04	--	04	04	--	04	80	20		100
ZOO106	Tools & Techniques	DCEC	04	--	04	04	--	04	80	20		100
ZOO107	Lab Course-I (Based on ZOO 101-103)	CC	--	04×03	12	--	02×03	06	-		50	50
ZOO108	Lab Course-II (Based on ZOO 104-106)	CC	--	04×02	08	--	02×02	04	-		50	50
ZOO109	Seminar/Journal club	CC	--	--	--	-	-	01	-		-	25
ZOO110	Self Study Paper	CC	--	--	--	-	-	01	-		-	25
Total			20	20	40	20	10	32	400	100	100	650

CC = Core Course

DCEC = Discipline Centric Elective Course

Scheme of Examination for M.Sc. Zoology

Semester-II

Credits = 34

Marks = 700

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credits			Examination Scheme			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessment	Practical	
ZOO201	Developmental Biology	CC	04	--	04	04	--	04	80	20		100
ZOO202	Animal Physiology	CC	04	--	04	04	--	04	80	20		100
ZOO203	Molecular Biology	CC	04	--	04	04	--	04	80	20		100
ZOO204	Diversity of Vertebrates	CC	04	--	04	04	--	04	80	20		100
Discipline Centric Elective Course(Any One)												
ZOO205	Bioinformatics	DCEC	04	--	04	04	--	04	80	20		100
ZOO206	Chronobiology	DCEC	04	--	04	04	--	04	80	20		100
Foundation Elective Course												
ZOO207	Communication Skills and Personality Development	FEC	02	--	02	02	--	02	40	10		50
ZOO208	Lab Course-I Based on ZOO 201-203	CC	-	04×03	12	--	02×03	06	-		50	50
ZOO209	Lab Course-II Based on ZOO 204-206	CC	-	04×02	08	--	02×02	04	-		50	50
ZOO210	Seminar/Journal club	CC	-	-	-	-	-	01	-		-	25
ZOO211	Self Study Paper	CC	-	-	-	-	-	01	-		-	25
Total			22	20	42	22	10	34	440	110	100	700

CC = Core Course

DCEC = Discipline Centric Elective Course

FC = Foundation Elective Course

Scheme of Examination for M.Sc. Zoology

Semester-III

Credits = 35

Marks = 750

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credits			Examination Scheme			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessment	Practical	
ZOO301	Molecular Endocrinology and Neural Physiology	CC	04		04	04		04	80	20		100
ZOO302	Immunology	CC	04		04	04		04	80	20		100
ZOO303	Genetic Engineering	CC	04		04	04		04	80	20		100
ZOO304	Population Genetics	CC	04		04	04		04	80	20		100
Discipline Centric Elective Course (Any One)												
ZOO305	Environmental Biology and Toxicology	DCEC	04		04	04		04	80	20		100
ZOO306	Aquaculture	DCEC	04		04	04		04	80	20		100
Open Elective Course/ MOOCs Courses(SWAYAM)												
ZOO307	Environmental Pollution	OEC	03		03			03				100
Lab Courses												
ZOO308	Lab Course-I Based on ZOO 301-303	CC	-	04×03	12	--	02×03	06	-		50	50
ZOO309	Lab Course-II Based on ZOO 304-306	CC	-	04×02	08	--	02×02	04	-		50	50
ZOO310	Seminar/Journal club	CC	--	--		-	-	01	-		-	25
ZOO311	Self Study Paper	CC	--	--		-	-	01	-		-	25
Total			20	20	40	20	10	35	400	100	100	750

CC = Core Course

DCEC = Discipline Centric Elective Course

OEC = Open Elective Course

Scheme of Examination for M.Sc. Zoology

Semester-IV

Credits = 32

Marks = 650

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credits			Examination Scheme			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessment	Practical	
ZOO401	Animal Behaviour and Wild Life Conservation	CC	04		04	04		04	80	20		100
ZOO402	Proteomics and Genomics	CC	04		04	04		04	80	20		100
ZOO403	Insect Morphology and Physiology	CC	04		04	04		04	80	20		100
ZOO404	Bio-Systematics and Evolution	CC	04		04	04		04	80	20		100
Discipline Centric Elective Course(any one)												
ZOO405	Parasitology	DCEC	04		04	04		04	80	20		100
ZOO406	Fish and Fisheries	DCEC	04		04	04		04	80	20		100
ZOO407	Lab Course-I Based on ZOO 401 - 403	CC	-	04×03	12	--	02×03	06	-		50	50
ZOO408	Lab Course-I Based on ZOO 404-406	CC	-	04×02	08	--	02×02	04	-		50	50
ZOO409	Seminar/Journal club	CC	-	-		-	-	01	-		-	25
ZOO410	Self Study Paper	CC	-	-	-	-	-	01	-		-	25
Total			20	20	40	20	10	32	400	100	100	650

CC = Core Course

DCEC= Discipline Centric Elective Course

Duration: 02 Years
Total Credits = 133
Total Marks = 2750

General Guidelines**1. Seminar**

In each semester, there will be a paper on seminar presentation of 25 marks with 01 credit. In this paper, the student will be required to present a seminar of about 15-20 minutes on the theme/ topic such as review of research papers/ articles published in National/ International Journals in his/her area of interest. The topic will be selected by the student in consultation with the teacher allotted to him/her by the department..

An Internal committee of two teachers constituted the Chairperson of the department for each student will evaluate the seminar presentation. The evaluation (Internal evaluation only) will be based on the presentation of student, depths of subject matter and answer to questions. There will be a Coordinator to be nominated by the Chairperson of the Department among the teachers of the department.

For seminar, the topics should be chosen in the following manner:

Semester	any topic (not related to the syllabi)
Semester	any Basic Research Paper/Article
Semester	any National Level Research paper/Article
Semester and onwards	any Foreign Research paper/Article

2. Self Study Paper

In each semester, there will be a self study paper of 25 marks with 01 credit. The objective of this paper is to create habits of reading books and to develop writing skills in a manner of creativity and originality. The students will select a topic of their own interest in the given area in consultation with their teachers/Incharge/mentors. After selecting a suitable title for the paper, the students will be required to prepare a hand written in his/her own handwriting report about 6-10 pages. The students will be required to submit the report after getting it checked by the concerned teacher and will be asked to re-submit the report after making the required corrections (if any) before the commencement of the examinations of that semester. The structure of the paper will include the following:

- Introduction
- Main Body
- Conclusion

The thoughts presented in the paper must be original work of the students.

The paper will be evaluated by the panel (one external and one internal examiner) to be appointed by the Chairperson of Department from the prescribed panel of the University.

The evaluation of Self Study paper will be done as given below:

- Evaluation of the paper 15 Marks
- Viva-voce on the paper 10 Marks
- Total 25 Marks

3. Current Affairs

In each semester, there will be a paper on current affairs of the concerned subject covering its latest developments. It

will consist of 100 marks (80 marks-Theory+20 marks-Internal Assessment) with 04 credits.
Further, the concerned departments will design and approve the syllabi of this course/paper by respective PGBOS&R as per requirement of the subject. However, the Departments should suggest the relevant readings such as newspapers and magazines etc.

**M.Sc. Zoology
Semester-I**

**ZOO- 101
Diversity of Invertebrates**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Introduction to invertebrates with their general characters and classification up to class Level Minor Phyle, Concept and significance, Organization and general characters of Acoelomate, Pseudocoelomates and Coelomates minor phyla (with special emphasis on Ctenophora, Rotifera, Endoprocta, Ectoprocta, Phoronida, Sipunculida and Echiuroidea).

Organization of coelom, Concept and structure of Acoelomate, Pseudocoelomates and Coelomates, Protostomia and Deuterostomia, Metamerism in Annelida, Pseudometamerism.

Unit-II

Locomotion, Flagella and ciliary movement in Protozoa, Hydrostatic movement in Coelenterata, Annelida and Echinodermata, Nutrition and Digestion, Patterns of feeding and digestion in lower metazoan, Filter-feeding in Polychaeta, Mollusca and Echinodermata, Respiration, Organs of respiration : Gills, lungs and trachea, Respiratory pigments, Mechanism of respiration

Unit-III

Excretion: Organs of excretion: Coelom, coelomoducts, Nephridia and Malpighian tubules. Mechanism of excretion and osmoregulation, Nervous system, Primitive nervous system: Coelenterata and Echinodermata, Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda), Trends in neural evolution. Mode of reproduction

Unit-IV

Invertebrate larvae, Larval forms of free living invertebrates, Strategies and Evolutionary, significance of larval forms, Conservation of invertebrates, Introduction to insects, Mouthparts of Insects, How are insects able to fly? Mechanism of insect flight Metamorphosis in insects Hormonal control of moulting. Social life in insects, Integrated pest management

Practicals:

1. Live demonstration of Amoeboidal movements conjugation in paramecium and flagellar moments in euglena.
2. Slides and Museum specimens:
 - (a) PROTOZOA: *Gregarina*, *Monocystis*, *Ceratium*, *Euplotes*, *Didinium*, *Noctiluca*, *Radiolaria*, *Stentor*, *Opalina*.
 - (b) PORIFERA: Sectional view of *Sycon* (T.S., L.S.), *Grantia* (T.S.)
 - (c) CNIDARIA: *Obelia* polyp and Medusa, *Pennaria*, *Aurelia*-Tentaculocysts, *Virgularia*, *Spongodes*, *Zoanthus*, *Favia*.
 - (d) ANNELIDA: *Ozobranchus*, *Glossiphonia*, *Eunice*, *Chloea Flava*, *Polynoe*, *Terebella*, *Eurythoe*.
 - (e) ARTHROPODA: *Cyclops*, *Daphnia*, *Chelifer*, section of *Peripatus*, *Balanus*, *Lepas*, *Palinurus*, *Uca*, *Pyna*, *Hippa*, *Gongylus*, *Bellostoma*, *Limulus*, *Squilla*, *Eupagurus*.
 - (f) MOLLUSCA: Museum specimens of *Dolabella*, *Pteria*, *Nertie*, *Sanguinolaria*, *Chicoreus*, *Ficus*, *Lambis*, *Tridacna*, *Onchidium*, *Olcia*, *Murex*, *Turritella*, *Bulla*, *Cardium*, *Area*.
 - (f) ECHINODERMATA: Museum specimen of *Linckia*, *Echinodiscus*, *Holothuria*, *Antedon*.
 - (h) Study of Slides of *Bugula*, *Plumatella*, *Cristatella*, *Pectinatella*
3. Study of mouth parts of different insects.
4. Mounting: Trachea, Crustacean Larva, *Cyclops*, *Nauplius*, *Daphnia*, *Zoea*, *Mysis*, *Cercaria*.
5. Dissection of *Loligo*/*Sepia*, grass-hopper, Prawn, Cockroach, Earthworm to expose various systems.

Suggested Reading:

1. Hyman, L.H. The invertebrates, Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltr J. London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The Invertebrates. Vol.2. McGraw Hill Co., New York.
5. Hyman, L.H. The Invertebrates. Vol.8. McGraw Hill. Co., New York.
6. Barnes, R.D. Invertebrate Zoology, IIIrd edition. W.B. Saunders Co., Philadelphia.
7. Russel-Hunter, W.D. A Biology of higher invertebrates, the Macmillin Co. Ltd. London.
8. Hyman, L.H. the Invertebrates smaller coelomate groups, Vol. V. McGraw Hill Co., New York
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, A.A. Student text book of Zoology. Vol. I, II and III Central Book Depot, Allahabad
11. Parker, T.J., Haswell, W.A. Text book of Zoology, McMillan Co., London.

**M.Sc. Zoology
Semester-I**

**ZOO-102
Cell Biology**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Biomembranes: Molecular composition and arrangement, functional consequences, membrane transportation; diffusion, active transport and pumps, uniports, symports and antiports, Donnan equilibrium; ion movements and cell function:, Maintenance of cellular pH; Receptor mediated endocytosis,

The Extra Cellular Matrix Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata Ca^{++} dependent and Ca^{++} independent Homophilic cell-cell adhesion

Unit-II

Cytoskeleton and cell movement: Structure and organization of actin filaments, Actin, myosin and cellular movements, Structure and dynamic organizations of microtubules, Intermediate filaments, Cilia and flagella, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Protein sorting and transport, Protein uptake into the ER, Membrane proteins and Golgi sorting, Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway

Unit-III

Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, The events of M phase, Meiosis and fertilization, Genome organization, Chromosomal organization of genes and noncoding DNA, Mobile DNA, Pathways of intracellular signal transduction, Signaling networks

Unit-IV

Cell death and cell renewal: Apoptosis, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, Oncogenes, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing

Practicals:

1. Preparation of mitotic and meiotic chromosomes.
2. Calculation of morphometric data and preparations of idiogram.
3. Determination of chiasma frequency and terminalization coefficient.
4. Preparation of polytene chromosomes and mapping.
5. Study of permanent slides of different types of cancer and their stages

Suggested Readings:

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.

**M.Sc. Zoology
Semester-I**

**ZOO- 103
Biostatistics**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Permutations and combinations, Functions, Limits and Continuity, Exponential and Logarithmic functions, Differential Calculus : Rules of differentiation, Higher derivatives, Maxima and minima, Integration, Integration by parts, Definite integrals, Properties of definite integrals, Elementary ideas of differential Equations.

Unit-II

Types of data, Collection and Graphical representation of data, Measures of central tendency: Mean, Median, Mode, Quartile, Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression.

Unit-III

Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.

Testing of hypothesis: Parameter and Statistic, Sampling distribution and Standard error, Null and Alternative hypotheses, Simple and composite hypotheses, Two types of errors, Level of significance and Power of the test, One tailed and two tailed tests.

Unit-IV

Tests of significance: t and Z tests for mean and proportion for one and two samples, Chi square test of goodness of fit and independence. F test, Analysis of variance for one way and two way classification, Elementary ideas of Designs of Experiments.

Practicals

Descriptive statistics: Systemic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion (using calculators).

Correlations (Product Moment and Spearman's Rank Correlation) and Linear Regression

Tests of significance (Mean, Standard Deviation, proportion, Correlation Coefficient)

Chi Square Test of Goodness of fit, test of independence of attributes, Analysis of Variance (One way and Two way).

Books recommended:

1. Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10th Edition, Wiley Series.
2. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2nd Edition, CRC Press
3. Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd.
4. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House
5. B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers, JPB

**M.S c. Zoology
Semester-I**

**ZOO- 104
Cytogenetics**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Biology of Chromosomes: Molecular anatomy of eukaryotic chromosomes; Metaphase chromosomes: Centromere, Kinetochore, Nucleolus organizers and rRNA genes, Telomere: structure and Functions, Heterochromatin and euchromatin, Giant Chromosomes: Polytene Chromosomes, Lampbrush Chromosomes

Unit-II

Sex Chromosomes: Sex determination and the Y Chromosome, Dosage compensation in *C. elegans*, *Drosophila* and Humans, Nature and mechanism of genomic imprinting, X- inactivation and imprinting, Sex specific imprinting

Unit-III

Genes in Pedigrees: Mendelian pedigree pattern, Inheritance of mitochondrial diseases, Complications to the basic pedigree patterns, Non-Mendelian traits. Somatic Cell Genetics: Cell fusion and somatic cell hybrids – agents and mechanism of fusion, Heterokaryon – Cell lines and selection systems and chromosome segregation,

Unit-IV

Gene Mutations : Spontaneous mutations – Base pair substitution and frame shift mutations
Induced mutations – Radiation, chemical and environmental, In –vitro site specific mutagenesis.
Detection of mutagens – The Ames test and sister chromatid exchanges, Genetics of Cell Cycle:
Genetic regulation of cell division in yeast and eukaryotes, Molecular basis of cellular check points.

Practical:

1. Making karyological preparations from testicular material of suitable insects by squash and air drying techniques to study the structure and behaviour of chromosomes during mitosis and meiosis.
2. Study of chiasma frequency and terminalisation co-efficient.
3. Study of mitosis from hepatic caecae of suitable insects and preparation of karyotype and idiogram.
4. Demonstration of banding techniques (C, G and T).
5. Study of NORs in insect chromosomes.
6. Making preparations from salivary glands of *Chironomus* larvae / *Drosophila* larvae to study polytene chromosomes.
7. Effect of temperature on polytene chromosomes.
8. Preparation of human buccal smear to study sex chromatin.
9. Nuclear sexing from polymorphonuclear leucocytes.
10. Identification of meiotic and mitotic stages from permanent slides.
11. Gel electrophoresis : Practical demonstration.
12. Isolation of genomic DNA.
13. PCR : Introduction and practical demonstration.

Suggested Readings:

1. Atherly, A.C., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Genetics : Analysis and Principles. Benjamin/Cummings, Longman Inc.
3. Fairbanks, D.J. and W.R. Anderson. Genetics – The Continuity of Life. Brook/Cole Publishing Company ITP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons. Inc., NY.
5. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An Introduction to Genetic Analysis. W.H. Freeman and company, NY.
6. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo.
7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons. Inc., NY.
8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo.
9. Tom Strachan & Read, A.P. Human Molecular Genetics 3rd edition, Garland Publishing 2004, London.

**M.Sc. Zoology
Semester-I**

**ZOO-105
Biomolecules and Metabolism**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Chemical foundations of Biology –pH, pK, acids, bases, buffers, weak bonds, covalent bonds, Principles of thermodynamics. Classes of organic compounds and functional groups atomic and molecular dimensions, space filling and ball and stick models. Macro molecular and supra molecular assemblies. Water and its properties.

Unit-II

Amino acids and peptides-classification, chemical reactions and physical, properties, Sugars - classification and reactions, metabolism of carbohydrate, Heterocyclic compounds-and secondary metabolites in living systems -nucleotides, pigments, isoprenoids, Separation techniques for different biomolecules.

Bio-energetics and oxidative phosphorylation. Blood clotting – biochemistry, body fluids –pH and acid base balance and their importance in clinical biochemistry, muscle contraction.

Techniques in the study of proteins, carbohydrates and lipids.

Unit-III

Physical techniques in proteins, nucleic acids and polysaccharides structure analysis (UV, IR, MMR, LASER, MASS, Fluorescence spectroscopy, Differential calorimetry, X-ray Crystallography, Ultra Centrifugation, Electron cryomicrography, Scanning Tunneling microscopy.

Unit-IV

Lipids- classification, structure and functions Proteins-protein and protein legand interactions, end group analysis, hierarchy in structure, Ramachandran map.

Conformational properties of polynucleotides, Polysaccharides - types, secondary and tertiary structural features, analysis- theoretical and experimental; Protein folding – biophysical and cellular aspects, enzymes coenzymes, in born errors of metabolism.

Practicals:

1. Titration of amino acids
2. Colorimetric determination of pK
3. Model building using space filling/ball and stick models
4. Reactions of amino acids, sugars and lipids
5. Isolation of DNA and protein
6. Quantitation of Proteins and Sugars
7. Analysis of oils-iodine number, saponification value, acid number
8. UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
9. Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis
10. Mitosis & Meiosis study

**M.Sc. Zoology
Semester-I**

**ZOO-106
Tools & Techniques**

Maximum marks: 100
Theory examination: 80
Internal assessment: 20
Time: 3hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-I

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes.

Centrifuge technique: Principle, types of centrifuge, density gradient centrifuge in isolation of cell, cell organelles and biomolecules.

UNIT-II

Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC) and FPLC. Application of chromatographic technique in biology.

Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).

UNIT-III

Spectroscopy: Fluorescence, UV, visible, Infrared, Atomic absorption spectroscopy, NMR and ESR spectroscopy; Mass spectrometry (LC-MS, GC-MS), X-ray diffraction. Tracer Biology: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography. Application of different spectroscopic technique in biology.

UNIT-IV

Nature and types of radiation, preparation of labelling biological sample, detection and measurement of radiation, GM counter, Scintillation counter. Flow cytometry. Safety measurement in handling radioisotopes, ELISA, RIA and non-radiolabelling.

Suggested Laboratory Exercises

1. Demonstration of working of different types of microscopes.
2. Demonstration of Chromatography i.e. TLC, HPLC, GC.
3. To demonstrate the separation of proteins with the help of electrophoresis.
4. To study various molecular biology techniques i.e. PCR.
5. To demonstrate the use of spectrophotometer.
6. Purification of protein by column chromatography.
7. Visit of various laboratories in the university, preparation and submission of report.

Suggested reading:

1. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.
2. Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
3. Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, New York.
4. Hames, B.D.(Ed.).1998. Gel Electrophoresis of Proteins: A Practical Approach, 8th edition. PAS, Oxford University Press, Oxford, UK.
5. Scott, R.P.W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., New York.
6. Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition. Cambridge University Press, Cambridge, UK.

**M.Sc. Zoology
Semester-II**

**ZOO- 201
Developmental Biology**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Structure, chemistry, dynamics and regulation of sperm activity, capacitation and egg-surface targeting. Molecular biology, cytology and biochemistry of oogenesis: Synthesis and storage of maternal transcripts, proteins and cell organelles. rDNA amplification in amphibia; transcription on lampbrush chromosomes, ovulation and its hormonal control in mammals.

Unit -II

Molecular and cellular biology of fertilization: acrosome reaction and signal transduction, monospermy and species-specificity. Egg activation, early cleavages and blastocyst formation in mammals and biochemical and cellular changes during the passage down the oviduct to the uterus.

Unit -III

Implantation and formation of the placenta in mammals. Gastrulation in mammals-formation of primitive streak, morphogenetic movements and neural induction. Organogenesis and foetal development. Pattern forming genes and expression in Drosophila and mammalian embryos. Growth Factors and Signal Cascades BMP, Nodal, Wnt, Notch and Retenoid signaling during gastrulation.

Unit -IV

Introduction to stem cells: Molecular basis of embryonic and adult stem cells, Pluripotency and its application. Cell cycles regulators in stem cells. Epigenetic mechanism of cellular memory, Germ line stem cells and its cloning. Programmed morphogenetic histogenetic cell death (apoptosis). Erythropoiesis, myelopoiesis. Ageing.

Practicals :

1. To study the different stages of development in frog and chick through permanent slides.
2. To study the spermatogenesis of rat and grasshopper through slides.
3. To prepare the permanent stained slides of developing stages from fertilized egg of hen.
4. To study different larvae in invertebrates from permanent slides.
5. To study the larvae of invertebrates (Redia, Cercaria, Arthropod larvae, Glochidium larva) through permanent slides.
6. Study of salivary gland chromosomes of larvae of chironomus/Drosophila from permanent slides.
7. Study of metaphase karyotypes from photographs/permanent slides of Drosophila, grasshopper and man/rat.
8. Study of sex-chromatin Bars body from human buccal mucosa.
9. Demonstration of monohybrid and dihybrid cross, Co-dominance, Incomplete dominance and Epistasis with the help of beads and photographs.

Suggested Readings:

1. Developmental Biology (2003) - Gilbert S. F, SinauerAsso.
2. Principles of Development (2002) - Wolpert L et al., Oxford University Press
3. The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
4. Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
5. Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge University Press.
6. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, TwoVolume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2012, Academic Press.
7. R. Lanza, J. Gearhart et al (Ed), Essential of Stem Cell Biology, Elsevier Academic press.

**M.Sc. Zoology
Semester-II**

**ZOO- 202
Animal Physiology**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Nutrition: Introduction, chemistry, metabolic role and sources of vitamins & deficiency diseases due to them. Biological significance and regulation of minerals and deficiency diseases due to them. Physiology of digestion & absorption. Malnutrition & under nutrition.

Circulation: Chemistry and composition of blood and their functional significance; biochemistry of haemoglobin and myoglobin; Mechanism of blood coagulation and homeostasis. Cardiac cycle and its regulatory mechanisms. Cardiac output and micro circulation, blood pressure and its regulation.

Unit -II

Respiration: Types of respiration, mechanism of breathing; biochemistry of respiratory gaseous exchange; Transport of respiratory gases; Regulatory mechanisms (humoral and neural) of respiration. Respiratory acidosis, alkalosis and regulation of pH.

Unit -III

Excretion: Types of excretion and nitrogenous wastes; functional anatomy of renal unit; biophysical and chemical mechanisms of ultrafiltration, reabsorption and secretion, transport mechanisms, urine formation & regulatory control of sugar, urea, Na^+ K^+ , and H^+ ; Role of kidneys in regulation of acid-base balance and osmoregulation, counter current mechanism. Homeostasis.

Unit -IV

Physiology of Muscles: Types of muscles and their components; Molecular organization & interaction of myosin & actin. ATPase activity of myosin, power-stroke, ATP binding and hydrolysis; Role of troponin and tropomyosin and Ca^{++} in regulation of muscle contraction. Contraction of smooth & cardiac muscles, role of phosphorylation, Ca^{++} and kinases.

Stress Physiology:- Physiological adaptations acclimatization & acclimation in response to high, low ambient temperature, physiological adaptation at high altitude and in deep sea environment.

Practicals:

1. To demonstrate that the optimum activity of salivary amylase is pH dependent.
2. Estimation of Haemoglobin.
3. Determination of TLC, DLC & RBC.
4. Determination of bleeding and clotting time.
5. Determination of blood groups.
6. Measurement of blood pressure.
7. Estimation of ESR.
8. To study the effect of exercise on cardiovascular and respiratory systems.
9. To estimate the glucose level in blood of mammal, Prothrombin test, Haematocrit.
10. To study the effect of insulin on blood glucose level of mammal.

Suggested Readings:

1. Guyton, A.X., Text Book of Medical Physiology, 7th edition, Saunders Company (1986).
2. Best, J.P., Best and Taylor's Physiological basis of medical practice, 11th ed. William and Wilkins (1985).
3. Hoar, W.S., General and Comparative Physiology, Adaptation and Environment, 3rd ed. Cambridge University, Press (1985).
4. Vander, A.J., Sherman, J.H. and Luciano, D.S., Human Physiology, McGraw Hill Publ. Co. (1990).
5. Gillian Pocock and Christopher D. Richards. Human Physiology. The Basis of Medicine Oxford University Press (2001).

**M.Sc. Zoology
Semester-II**

ZOO- 203
Molecular Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

DNA Replication: Mechanism of DNA replication in Prokaryotic and eukaryotic cells. Enzymes and accessory proteins involved in DNA replication and DNA repair. Transcription: Prokaryotic & Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5'- Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA & its stability.

Unit -II

Translation: Prokaryotic and eukaryotic translation, Regulation of translation, co- and post translational modifications of proteins. Protein Localization: Synthesis of secretory and membrane protein & their import into nucleus, mitochondria, and peroxisomes, Receptor mediated endocytosis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins

Unit -III

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head & their designing strategies, hairpin and other ribozymes. Applications of Antisense and ribozyme technologies. Homologous Recombination: Holliday junction, gene targeting, gene disruption, and Cre/Lox recombination, RecA and other recombinases Molecular Mapping of Genome: Genetic and physical maps & their applications.

Unit -IV

Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers & their applications viz., forensic, disease prognosis, genetic counseling, Pedigree, animal trafficking and poaching; Germplasm maintenance, taxonomy and bio-diversity Genome Sequencing: Genome sizes, organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of Sequencing, sequence information for identification of defective genes

Practicals:

1. Isolation of Genomic DNA.
2. Isolation of RNA.
3. Quantitative analysis of DNA.
4. Restriction digestion of DNA.
5. Ligation of DNA fragments.
6. Molecular weight analysis using agarose gel electrophoresis.
7. Isolation of plasmid DNA.
8. Western blotting.
9. Southern blotting.
10. Preparation of competent cell.

Suggested Readings:

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA.
3. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
3. Gene VI, Benjamin Lewin, Oxford University Press, U.K.
4. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.), VCH Publishers, Inc., New York.
5. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
6. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
8. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford

**M.Sc. Zoology
Semester-II**

ZOO- 204

Diversity of Vertebrates

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Origin of Chordates, Protochordata, hemichordate & urochordata
Classification of Vertebrates upto orders, Vertebrate integument and its derivatives:
Development, general structure and functions of skin and its derivatives, Glands, scales, horns, claws, nails, hoofs, feathers and hairs
Skeletal system: Types, function, body size and skeletal elements of the body, Comparative account of jaw suspensorium, Vertebral column, Limbs and girdles

Unit -II

Digestive system: Comparative account of Dentition, Stomach, Digestive organs & Glands
Respiratory system: Characteristics of respiratory tissue, Internal and External Respiration,
Comparative account of respiratory organs

Unit –III

General plan & types of circulation in various groups, Blood, Evolution of heart, Evolution of aortic arches, and Portal systems , Evolution of Urinogenital system in vertebrate series

Unit –IV

Nervous system, Comparative anatomy of nervous system in relation to its functions, Comparative anatomy of brain & spinal cord, Nerves-Cranial, Peripheral and Autonomous nervous systems, Sense organs, Simple receptors, Organs of Olfaction and taste, Lateral line system, Electroreception

Practicals

1. Museum specimens and slides :
Chondrichthyes: Zygaena, Pristis, Narcine, Trygon, Rhinobatus, Chimaera.
Actinopterygii: Polypterus, Acipenser, Lepidosteus, Muraena, Mystus, Catla.
Hippocampus, Syngnathus, Exocoetus, Anabas, Diodon, Tetradon, Echeneis and Solea.
Dipneusti (Dipnoi) : Protopterus (Lung fish)
Amphibia: Uraeotyphlus, Necturus, Amphiuma, Ambystoma and its Axolotl larva. Triton, Salamandra, Hyla, Rhacophorus.
Reptilia : Hemidactylus, Calotes, Draco, Varanus, Phrynosoma, Chamaeleon. Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Vipera, Crocodilus, Gavialis, Chelone and Testudo.
Aves: Casuarius, Ardea, Anas, Milvus, Pavo, Eudynamis, Tyto and Alcedo.
Mammalia : Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaca, Manis, Hystrix, Funambulus, Panthera, Canis, Herpestes, Capra, Pteropus.
2. Demonstration of dissection of Labeo through video clipping/models/charts:
Digestive and Reproductive systems
Circulatory system: heart, afferent and efferent branchial arteries.
Nervous system: cranial nerves and internal ear.
3. Study of the skeleton of Labeo, Rana, Varanus, Gallus & Oryctolagus.
4. Demonstration of dissection of chick and white rat through video clipping/models/charts.
Chick : Digestive, arterial, venous and urinogenital systems.
White rat : Digestive, arterial, venous and urinogenital systems.
5. Study of the histology of different organs of frog and rat/rabbit through permanent stained slides.
6. Study of poison apparatus in snakes through charts.

Suggested Readings:

1. Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh.
2. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
3. Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick and Jackson, London.
4. Kingsley, J.S. Outlines of Comparative Anatomy of Vertebrates. Central Book Depot, Allahabad.
5. Kent, C.G. Comparative anatomy of vertebrates.
6. Milton Hilderbrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
7. Sedgwick, A. A Students Text Book of Zoology, Vol. II.
8. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York and London.
9. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
10. Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw Hall Book Co., New York.
11. Messers, H.M. An introduction of vertebrates anatomy.
12. Montagna, W. Comparative anatomy. John Wiley and Sons Inc.
13. Andrews, S.M. Problems in vertebrate evolution. Academic Press, New York.

**M.Sc. Zoology
Semester-II**

**ZOO-205
Bioinformatics**

Maximum marks: 100
Theory examination: 80
Internal assessment: 20
Time: 3hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Computers: An overview of computers, microcomputers, VDUs and printer; What is programming? Algorithms; Languages and packages: Introduction to MS Office, MS Access, introduction to SQL (structured query language) Handling arrays, procedures. Colour, sound and graphics; Use of standard packages.

Unit-II

Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Pattern modifiers.
Applications of PERL in Bioinformatics: Storing DNA sequence, DNA to RNA transcription, Finding motifs, Counting nucleotides, Generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA

Unit-III

Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Preliminary ideas of query and analysis of sequence information.

Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, NeedlemanWusch&SmithWaterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison.

Unit-IV

Database Search Algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results. Pattern Recognition Methods in Sequence Analysis: Concept of a sequence pattern, regular expression based patterns. The use of pattern databases like PROSITE and PRINTS. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAs. Markov chains and Markov models and their use in gene finding. Concept of HMMS, the Forward backward and the Viterbi algorithm. The Baum Welch algorithm for training a HMM. Use of profile HMM for protein family classification.

Practicals:

1. Retrieve Nucleotide sequences from NCBI serve.
2. Retrieve Protein sequences from PDB.
3. Analysis of sequences Similarity using BLAST/pBLAST/nrBLAST
4. To predict protein secondary structures by using iPred.
5. Perform phylogenetic analysis using PHYLIP.
6. Perform multiple sequence alignment by using ClustalW.
7. Primer design
8. Computational modeling of genomic, transcriptomic and proteomic

Suggested Readings:

1. Jin Xiong (2006) Essential Bioinformatics. Cambridge publisher
2. ZhumurGhosh and BibekanandMallick (2008) Bioinformatics: Principles and Applications. Oxford University Press publisher
3. OrpitaBosu and SimminderKaurThukral(2007).Bioinformatics. Oxford University Press publisher
4. M.Lesk (2002) Introduction to Bioinformatics. Oxford University Press publisher
5. Fundamental Concepts of Bioinformatics, Dan E. Krane, Michael L. Raymer, Michael L. Raymer, Elaine NicponMarieb, 2002, Benjamin/Cummings
6. P. Rastogi and N. Mendiritta (2013) Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt.Ltd; 4th Revised edition
7. Mount and David W (2004) Bioinformatics: sequence and genome analysis. Cshl Press, 2nd edition
8. Harisha S (2007) Fundamentals of Bioinformatics. I K International Publishing House Pvt. Ltd
9. Dan E. Krane (2003) Fundamentals concepts of bioinformatics. Dorling Kindersley (RS); First edition
10. David Edwards and Jason Stajich (2009) Bioinformatics: Tools and Applications. Published by Springer

M.Sc. Zoology
Semester-II

ZOO-206
Chronobiology

Maximum marks: 100
Theory examination: 80
Internal assessment: 20
Time: 3hrs

Unit-I

Theory Milestones in clock research; Chronobiology in 21st century; Evolution of biological timing system; Clocks, genes and evolution; Adaptive functional significance of biological clocks. Studying biological clocks; Biological Rhythms - Ultradian, Tidal/ Lunar, Circadian and Circannual rhythms; Temperature effects and compensation; Perception of natural zeitgeber signals;

Unit-II

Geophysical environment - Seasons; proximate and ultimate factors. Entrainment, masking and zeitgeber cycles; parametric and non-parametric entrainment; Entrainment models; Phase shift, Phase response curves (PRC) and phase transition curves (PTC); Organization of circadian system in multicellular animals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to *Drosophila*; Circadian pacemaker system in vertebrates with particular reference to rodents; Suprachiasmatic nucleus (SCN) as the main vertebrate clock; concept of core and shell.

Unit-III

Diversity and complexity of the clock system; Melatonin: Input or output signal of the clock system; Molecular Biology of the circadian pacemaker system: Experiments in the generation of models for the feedback loop comprising the clock, Pre-molecular genetics era, Generic core circadian feedback loop; Molecular clockworks in Cyanobacteria, Neurospora, *Drosophila* and mammals; Cellular and molecular bases of Entrainment.

Unit-IV

Photoreception and photo-transduction; The physiological clock and measurement of day length; Role of photic and non-photic cues in seasonality; Reversal of roles of principal and supplementary cues; Evolution of photoperiodism: comparative studies; Circannual rhythms and seasonality; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases - Chronopharmacology, chronomedicine, chronotherapy.

Suggested Literature:

1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
2. Insect Clocks D.S. Saunders, C.G.H. Steel, X., afopoulou (ed.)R.D. Lewis. (3rd Ed) 2002 Barenz and Noble Inc. New York, USA
3. Biological Rhythms: Vinod Kumar (ed 2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Practicals

1. Assay of circadian rhythms using animal model systems.
2. Assay of circadian activity rhythms in human.
3. Ambulatory blood pressure monitoring and circadian analysis.
4. Quantifying oscillations: phase, period and amplitude.
5. Dry lab exercises on the previously recorded data.
6. Recording of body temperature (T_b) of human.
7. Experiments demonstrating the photoperiodic clock.

M.Sc. Zoology
Semester-II

ZOO- 207

Communication Skills and Personality Development

Maximum Marks: 50
Theory Examination: 40
Internal Assessment: 10

1

Time: 3 hrs

Note: The examiner shall set nine questions in all covering the whole syllabus. Question No.1 will be compulsory and consist of 04 small questions of two marks each, covering the whole syllabus. The remaining 8 questions will be set from the syllabus on two questions from each unit basis; out of which the students will attempt four questions selecting one from each unit. All questions carry 08 marks each.

Unit I

Writing Skills

Letter Writing, Resume Writing, CV Writing, Difference between bio-data, Resume and CV, cover letter, Preparation of Report, Paragraph writing

Unit II

Interview Skills

Job Interview: Importance and Factors Involving Job Interview; Characteristics of Job Interview; Job Interview Process; Job Interview Techniques- Manners and etiquettes to be maintained during an interview; Sample Questions Commonly asked During Interview, Dress Code, Mock-Interview, How to be Successful in an Interview.

Unit III

Oral Presentation

Delivering a Presentation, Tools that enhance the effect of the presentation, conducting presentations in a smooth and self-assured manner. Group presentation, Group discussions, Group projects. Group Discussion, Differences between group discussion and debate, Narrating a story/an incident.

Unit IV

Technology-based Communication

Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.

Suggested readings

1. Sethi, J & et al. A Practice Course in English Pronunciation, Prentice Hall of India, New Delhi.
2. Sen, Leena. Communication Skills, Prentice Hall of India, New Delhi.
3. Prasad, P. Communication Skills, S.K. Kataria & Sons.
4. Bansal, R.K. and J.B. Harrison. Spoken English, Orient Language.
5. Roach Peter. English Phonetics and Phonology.
6. A.S. Hornby's. Oxford Advanced Learners Dictionary of Current English, 7th Edition.
7. T. Balasubramaniam: Phonetics & Spoken English.

**M.Sc. Zoology
Semester-III**

ZOO- 301

Molecular Endocrinology and Neural Physiology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT- I

Overview: Glands, cellular secretions (autocrine, exocrine, endocrine), Secretory mechanism, ways of secretion (Autocrine, merocrine, holocrine) and regulation of glandular secretion.

Hormones: Types, nature, synthesis, release and action action. Receptor, molecular mechanism and signal transduction.

UNIT-II

Role of hypothalamus in hormonal control. Anterior pituitary hormones, posterior pituitary hormones; thyroid gland and thyroid hormones, pancreas (insulin and glucagon). Endocrine control of food and fluid intake/obesity calcium regulation, adrenal gland.

Reproductive organs and their hormonal control in male and females; estrogen and androgen; Reproductive cycle, parturition and pathologies.

UNIT-III

Introduction to evolution and development of Nervous system. Structural and functional aspects of nervous system (CNS,PNS&ANS). Anatomy of brain and its cellular composition (types of neurons, glia and their functions). Neuroglia interaction.

UNIT-IV

Structure of neuron, membrane proteins, channels (voltage gated and ligated), Na⁺, K⁺ pump, Na⁺, K⁺ ATPase. Bioelectricity, membrane excitability, nerve conduction. Neurohormones and neurotransmitters. Neuroendocrine regulations of physiological functions. Structure of synapse and synaptic transmission. Senses (vision,olfaction and touch).

Practicals :

1. To identify the stage of oestrous cycle.
2. To show the endocrine glands in rat through charts/models/video clipping.
3. To study the histology of endocrine glands through permanent stained slides.
4. To study the corrective measures for myopia, hypermetropia, astigmatism, cataract.
5. To study the structure of eye, ear and different types of neurons through charts/models.

BOOKS RECOMMENDED

1. *General Endocrinology* by **Turner, C.D. and Bagnars, W.B.** Saunders Company; 1976.
2. *Comparative Endocrinology of Invertebrates* by **Highnam, K.C.** and Hill, L. Enwaral Arnold Ltd., London; 1981.
3. *Endocrinology* by **Golds -Worthy, G.J. Robinson, J. and Mordue, W.** John Wiley and Sons, New York; 1981.
4. *An Introduction to Invertebrates Endocrinology* by **Tombes, A.S.** Academic Press, New York; 1970.
5. *Comparative Vertebrate Endocrinology* by **Bentley, P.J.** Cambridge Univ. Press; 1998.
6. *Endocrinology* (4th ed) by **Hadley, M. E.** Prentice Hall; 1996.

**M.Sc. Zoology
Semester-III**

**ZOO- 302
Immunology**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Introduction; Phylogeny of Immune System- Innate and acquired immunity; Clonal nature of immune response; Organization and structure of lymphoid organs; Nature and Biology of antigens and antibody.

Unit -II

Major histocompatibility complex, BCR (B cell receptor) & TCR (T cell receptor), generation of diversity; Complement system; Cells of the Immune system: Hematopoiesis and differentiation; Lymphocyte trafficking, B-Lymphocytes, T-Lymphocytes, Macrophages, Dendritic cells; Natural killer and Lymphokine - activated killer cells, Eosinophils, Neutrophils and Mast Cells.

Unit -III

Cytokines and their role in immune regulation: T-cell regulation, MHC restriction; Immunological tolerance; Cell - mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; Hypersensitivity.

Unit -IV

Autoimmunity; Transplantation; Immunity to infectious agents (intercellular parasites, helminths & viruses); Tumor Immunology; AIDS and other Immunodeficiency; Hybridoma Technology and Monoclonal antibodies.

Practicals :

1. Blood film preparation and identification of cells
2. To identify blood group antigens
3. Lymphoid organs and their microscopic organization
4. Immunization, Collection of Serum
5. Double diffusion and Immuno-electrophoresis
6. (2015-16)
7. Transfection of Hela Cells
8. Radial Immuno diffusion
9. Purification of IgG from serum
10. Separation of mononuclear cells by Ficol1-Hypaque
11. Con-A induced proliferation of thymocytes (by MTT method)
12. ELISA
13. Hapten Conjugation and quantitation
14. Immunodiagnosics (demonstration using commercial kits)

Suggested Readings:

1. Benjamin E. (1996), Immunology – A short course 3rd Edition, John Wiley, New York.
2. Kuby J. (1997), Immunology, 3rd Edition, W.H. Freeman & Co., New York.
3. Roitt, I.M. (1997), Essential Immunology, 9th Edition, Oxford Black Well Science, London.
4. Tizard I.R. (1995), Immunology – An introduction, 4th Edition, Philadelphia Saunders College press.
5. Gupta P.K. (2003), Biotechnology and Genomics, Rastogi Publications, Meerut.
6. Anant Narayan, Text Book of Immunology.
7. Pommerville et al (2004), Alcamo's Fundamentals of Microbiology, Jones and Bartlett Publishers.
8. Richard Coico (2009) Immunology - A short course, Geoffrey Sunshine (Wiley Blackwell).
9. William Paul (1999) Fundamentals of immunology , (Lippincott Williams & Wilkins).
10. Peter John Wood, Dorling KInderseley (2007), Understanding immunology, (Pearson Education, India).

**M.Sc. Zoology
Semester-III**

**ZOO- 303
Genetic Engineering**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Scope in Genetic Engineering. Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation cloning, gene expression. Cloning and patenting of life forms. Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers.

Unit -II

Nucleic Acid Purification, Yield Analysis, Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and cloning. Alternative Strategies of Gene Cloning. Transgenic and gene knockout technologies. Targeted gene replacement, chromosome engineering

. Unit -III

Microarray, Site-directed Mutagenesis and Protein Engineering. DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays

Expression strategies for heterologous genes, Vector engineering and codon optimization, host engineering, in vitro transcription and translation, expression in bacteria expression in bacteria, yeast, insect cells, mammalian cells and in plants.

. Unit -IV

Recombinant proteins: Purification and folding, characterization and stabilization. Phage Display, T-DNA and Transposon Tagging. Gene tagging and its role. Gene therapy: Vector engineering strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Practicals:

1. Bacterial culture and antibiotic selection medias. Prepration of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of lambda phage DNA.
4. Quantitation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA
6. Construction of restriction map of plasmid DNA.
7. Cloning plasmid/phagemid vectors.
8. Preparation of helper phage and its titration
9. Preparation of single stranded DNA template
10. DNA sequencing
11. Gene expression in E. coli and analysis of gene product
12. PCR and Reporter Gene assay (Gus/CAT/b-GAL)
13. Western Blotting

Suggested Readings

3. Gene cloning and DNA analysis – An Introduction (2006) 5th edition, T.A Brown, Blackwell publisher.
4. Essential genes (2006), Benzamin Lewin, Pearson education international.
5. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.
6. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.
7. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur.
8. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.
9. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science.
10. Molecular Biology of Gene (2008) 6th edition, Watson, Baker,Bell. Gann,Levine and Losick, Pearson education Inc.
11. Biotechnology-Appling the genetic Revolution (2009), Clark and Pazdernik, Academic Press
12. Molecular Cloning : A Laboratory Manual (2000), J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York
13. DNA Cloning : A Practical Approach (1995) , D.M. Glover and B.D. Hames, IRL Press, Oxford,
14. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998), S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.

M.Sc. Zoology
Semester-III

ZOO – 304**Population Genetics**

Maximum Marks : 100

Theory Examination : 80

Internal Assessment : 20

Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit I

Concept of evolution: Darwinism and Neo-Darwinism, Hardy-Weinberg law of genetic equilibrium.

A detailed account of destabilizing forces: (i) Natural selection, (ii) Mutation, (iii) Genetic drift, (iv) Migration (v) Meiotic drive. Patterns and mechanism of reproductive isolation, modes of speciation

Unit II

Quantifying genetic variability: Genetic structure of natural populations, phenotypic variations, Models explaining changes in genetic structure of populations. Factors affecting human disease frequency Mendelian basis of transmission of disease

Unit III

Molecular population genetics: Patterns of change in nucleotide and amino acid sequences Ecological significance of molecular variations Emergence of Non-Darwinism-Neutral Hypothesis

Unit IV

Genetics of quantitative traits in populations: Analysis of quantitative traits Quantitative traits and natural estimation of heritability Genotype-environment interactions Inbreeding depression and heterosis Molecular analysis of quantitative traits, phenotypic plasticity

Practicals:

1. Study of salivary gland chromosomes of larvae of chironomus/Drosophila from permanent slides.
2. Study of metaphase karyotypes from photographs/permanent slides of Drosophila, grasshopper and man/rat.
3. Study the normal human karyotype
4. Study of sex-chromatin Bars body from human buccal mucosa, drum stic in human blood.
5. Demonstration of monohybrid and dihybrid cross, Co-dominance, Incomplete dominance and Epistasis with the help of beads and photographs.
6. Study of genetic disorders with the help of photographs.
7. Study of structural and numerical alteration of chromosomes: deletion,

Suggested Reading Material

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

M.Sc. Zoology
Semester-III

ZOO – 305

Environmental Biology and Toxicology

Maximum Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-1

Environmental policies at global and national level. Remote sensing and geographic information system: Basic concepts, procedure and Applications. Concept of sustainable development: utility and significance

UNIT-II

Environment impact assessment: environmental monitoring different phases and significance. Solid waste management: Primary waste products-Solid waste, toxic biological and hospital landfills, incineration, source reduction and recycling.

UNIT -III

Environmental Toxicology: Food additives, air, water and soil pollutants; noise and plastic pollution. Effect of pollutant on ecosystem with case study of important Organo-phosphorous and Organo-chlorine pesticides, Nitrates, Polychlorinated biphenyls, Clenbutarol. Biodeterioration.

UNIT-IV

Bioremediation, its role and significance. Toxicological risk assessment and management. Principles and significance of systematic toxicology. Genotoxicology. Applications of toxicology anthropogenic activities and environment. Human toxicology and medicinal ethics.

Practicals:

1. Bioassay to demonstrate toxicological effect.
2. Study of various components of pond ecosystem.
3. Determination of Water quality characteristics viz: Dissolved oxygen, pH, free carbon dioxide, Salinity, transparency, alkalinity and hardness.
4. Determination of phosphate, ammonia and nitrate in water.
5. Determination of sediment chemistry: Moisture, Carbonate, Nitrate, pH, Phosphate, Texture and Organic Carbon

Suggested Reading Material:

26. Concepts of Ecology by Edward J. Kormondy; Prentice Hall of India (Pvt.) Ltd.
27. Fundamentals of Ecology by W.B. Odum, E.P. Saunders, Toppan Co. Ltd., Tokyo, Japan.
28. Ecology by Paul Colin Vacx: John Wiley & Sons, Inc.
29. Environmental Pollution by H.M Dix., John Wiley Publications, New York.
30. Handbook of Solid Waste Management by Wilson, Van Nostrand, Reinhold.
31. Environmental Studies by D.B. Botkin, & E.A. Keller, Martill Publising Co., Columbs, Toronto, London.
32. Ecology of Natural Resources, Francoid remade, John Wiley & Sons, New York, Singapore.
33. Ecology by Paul Colinvaux; John Wiley & Sons, New York, Chichester, Brisbane, Toronto, Singapore.
34. Applied Ecology and Environmental Management by Edward I. Newman.
35. Principle of Environmental Science by W.P. Cunningham & M.A. Cunningham.
36. Environmental Impact Assessment Methodologies by Y. Anjaneyulu.
37. Bioremediation Technology by Fulekar, M.H.
38. Biotranformation: Bioremediation Technology for Health & Environmental Protection by R. D. Stapleton Jr. and V.P. Singh (Ed), Elsevier.
39. Casarett & Doull's Toxicology: The Basic Science of Poisons by Curtis Klaassen

M.Sc. Zoology
Semester-III

ZOO – 306
Aquaculture

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Unit-I

Theory Culture technology– freshwater (carps, catfishes, murels, prawns), brackish water (asian sea-bass, milk fish, mullets, crabs, shrimps), mariculture (mussels, oysters, sea weeds), fish food organisms (algae; Artemia; zooplankton). Water Quality Requirements for Aquaculture- Role of temperature, pH, salinity, dissolved oxygen, ammonia, nitrite, nitrate, phosphate, Biological oxygen demand, Chemical oxygen demand.

Unit-II

Integrated farming - fish-cum-live stock farming, paddy-cum-fish farming, aquaculture engineering aquahouse, hatchery, ponds, race ways, recirculating system, cage, pen. Fish seed technology - natural collection, bundh breeding, induced breeding, cryopreservation of gametes. Transport of finfish and shellfish- transport of eggs, fry, fingerlings and adults.

Unit-III

Nutrition of aquatic animals - nutritional requirements of commercially important finfish and shellfish, dietary requirements of larvae and brooders, feed types, manufacture and ingredients, anti-nutritional factors in fish feed ingredients and their treatments, use of attractants and growth stimulants in fish feeds, alternative protein sources in aquaculture diets, feeding techniques, role of probiotics in nutrition. Setting up of display aquarium- freshwater and marine aquaria, selection of compatible species, breeding of aquarium fishes.

Unit-IV

Role of genetics in aquaculture– gynogenesis, androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, production of transgenic fish, impact of GMOs on aquatic biodiversity. Fish health- infection and diseases in fish, common fish pathogens, routes of pathogen entry in fish, methods of colonization and spread of pathogens, immune - evasion mechanisms of fish pathogens. Environmental impact of aquaculture- aquacultural wastes and future developments in waste minimization, environmental consequences of hypernutrification. Fish vaccines strategy and use in aquaculture.

Suggested Literature:

1. Fishponds in Farming Systems, Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Beveridge, M. C. M., Wageningen Academic Publishers, Netherlands
2. Aquaculture Principles and Practices, Pillay, T. V. R., Blackwell Publishing, USA
3. Aquaculture and Fisheries Biotechnology Genetic Approaches, Dunham, R. A., CABI Publishing, USA

Practicals

1. Estimation of hydrobiological parameters- temperature, pH, conductivity, salinity, dissolved oxygen, primary productivity, ammonia, nitrite, nitrate, phosphate, biological oxygen demand, chemical oxygen demand of nursery, rearing, stocking and breeding ponds.
2. Estimation of ovarian egg counts.
3. Culture of live food organisms and assay of nutritional quality of live food; estimation of population density of live food organisms.
4. Decapsulation and hatching of Artemia cysts for use in hatcheries.
5. Demonstration of breeding pools and hatcheries.
6. Induced breeding of Indian major carps and catfishes.
7. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.
8. Collection and identification of aquatic weeds and aquatic insects.
9. Study of feeding habits of fishes by gut content analysis.
10. Isolation and estimation of fish immunoglobulins; Molecular techniques in fish health management.
11. Aquarium design and maintenance.
12. Formulation and preparation of artificial fish food for Indian major carps and Prawns.
13. Analysis of proximate composition of fish and processed products.
14. Visit to freshwater/ marine fish farm.

**M.Sc. Zoology
Semester-IV**

ZOO- 401

Animal Behaviour and Wild Life Conservation

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Concept of Animal behaviour and its scope. Stereotyped and acquired behaviour patterns: Tropisms, Taxes, Reflexes, Instincts, learning & reasoning; Change in major modes of adaptive behaviour in phylogeny. Aggregation and society: its types and advantages. Types of social organisation in animals

Unit-II

Biological rhythms and concept of biological clock. Various means of communication in animals: chemical, visual, auditory and touch. Concept of learning: law of learning, types of learning – Habituation, trial & error. Pheromones and animal behaviour: types of pheromones, its role in animal behaviour. Learning, latent learning, Insight, Imprinting, Classical conditioning & Instrumental learning.

Unit-III

Wildlife: Definition, significance and wildlife zones of the world and India. PAS Protected Area Systems: Concept and management. Wild life census: its planning, understanding of sample counts, block counts, road side counts, dung counts, pugmark census, water-hole census.

Unit-IV

Wild life damage: its nature and definition, various methods to control wild life damage. Wildlife and illegal trade & control. Wildlife conservation techniques, role of WWF, IUCN, UNEP, Red Data Book; Categories of Endangered Wildlife Species. National projects: Project tiger, Project elephant, Project rhinoceros, Project crocodile

Practicals:

1. Field study of nesting behaviour of common available avian fauna of the region.
2. To prepare charts of wildlife zones of India and the world
3. To study mobbing response of birds in field.
4. Demonstration of food preferences in *Tribolium/ Rhizopertha/ Callosbruchus*.
5. To study the effect of temperature on gill movement in fishes.
6. Preparation of field diary on the basis of observations regarding habitat, habits of
7. common available avian fauna of the region.
8. Study of morphological changes in common avian species during breeding season.
9. Demonstration of different stages of reproductive cycle in rat/mouse.
10. Field visit to a zoo or wildlife part/sanctuary and preparation of field report.
11. Preparation of charts of endangered amphibians, reptiles and mammals with ecological remarks.
12. Animal behaviour patterns using Photostat sheets.
13. Analysis of standard pug marks of large sized wild mammals

Suggested Reading Materials:

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOLWattenslip, Pratunam Bangkok, 10400, Thailand
3. Ali, S. Ripley S.D. Handbook of Birds of India, Pakistan 10-Vols. Oxford University Press, Bombay.
4. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
5. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun.
6. E.P. Gee, The Wildlife of India.

**M.Sc. Zoology
Semester-IV**

**ZOO- 402
Proteomics and Genomics**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT-I

Genomics: Genome sequencing strategies and programs, new technologies for high throughput sequencing, methods for sequence alignment and gene annotation; Approaches to analyze differential expression of genes - ESTs, SAGE, microarrays and their applications; gene tagging; gene and promoter trapping; knockout and knock-down mutants; dynamic modulation of protein structure and function

UNIT-II

Comparative genomics of model plants and related crop species; Recombination-based cloning techniques; RNAi and gene silencing, genome imprinting, small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing, genomic tools to study methylome and histone modifications.

UNIT -III

Analysis of proteins by different biochemical and biophysical procedures like CD (Circular Dichroism), NMR, UV/Visible and fluorescent spectroscopy, protein identification and analysis on ExPASy server, other protein related databases, 1-D and 2-D gel electrophoresis for proteome analysis, Sample preparation, gel resolution and staining; Mass spectrometry based method for protein identification like PMF (protein mass fingerprinting) and LCMS.

UNIT-IV

Image analysis of 2D gels: Data acquisition, spot detection & quantitation, gel matching, data analysis, presentation, databases, conclusions; DIGE (Differential In Gel Electrophoresis), alternatives to 2-DE for protein expression analysis; Analysis of post-translational modifications and protein-protein interactions; protein chips and arrays, future directions in proteomics, scope of functional proteomics.

SUGGESTED READINGS:

1. Buchanan B, Gruissem G, and Jones R (2000) *Biochemistry and Molecular Biology of Plants*, American Society of Plant Physiologists, USA.
2. Hammes GD (2005) *Spectroscopy for the Biological Sciences*; Wiley Interscience, USA.
3. Harlow and Lane D (Eds.) (1988) *Antibodies – A Laboratory Manual*; Cold Spring Harbor Laboratory, USA.
4. Lieber DC (2006) *Introduction to Proteomics: Tools for New Biology*; Humana Press, NJ.
5. Pennington SR, Dunn MJ (Eds.) (2002) *Proteomics: From Protein Sequence to Function*, BIOS Scientific Publishers, United Kingdom.
6. Sambrook J and Russell DW (2001). *Molecular Cloning – A Laboratory Manual*, Vols I – III, Cold Spring Harbor Laboratory, USA.
7. Singer M and Berg P (1991). *Genes and Genomes: A Changing Perspective*; University Science Books, CA, USA.

**M.Sc. Zoology
Semester-IV**

ZOO- 403

Insect Morphology and Physiology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT -I

Classification and diagnostic features of insects: Distinctive characters and interrelationship of various insect orders. Classification of Orthoptera, Hemiptera, Depidoptera, Diptera and Coleoptera up to families (important ones only). Evolution of wings its variation.

UNIT II

Pollination and Myrmacochory. Insect societies: Subsociality in insect; Eusociality in insect (Colony and Castes in Hymenoptera and Isoptera). Insec growtht metamorphosis, moulting and diapause. Insect Predation and parasitism

UNIT-III.

Structure and function of following systems in insects: digestive system, respiratory system, circulatory system, immune system and excretory system.

UNIT-IV

Anatomy and physiology of following systems in insects: Reproductive system, Nervous system.Receptors, sound reception and sound production and insect vision. Semio-chemicals (Pheromones, Kairomones and allomones).

Practical:

1. Study of insect biodiversity in natural environment and preparation of project based on the observation.
2. Identification marks and taxonomic status of insect pests of crops vegetables, fruits and stored products mentioned in theory syllabus.
3. Demonstration of dissection of insects for the study of following systems through charts/models/video clippings. :
 - a. Digestive System
 - b. Nervous System
 - c. Reproductive System.
4. Systematic position upto family and ecology of the following medical and veterinary pests :
 - a. *Anopheles* b. *Culex* c. *Aedes* d. Blowfly e. Botfly f. Horsefly
 - g. Fleshfly
5. Systematic position upto family and ecology of the following medical and agricultural pests : a. *Helicoverpa*, b. *Spodoptera*, c. *Plutella*, d. Pinkboll worm, e. *Dysdercus* f. *Phenacoccus* g. Blister beetle
6. Introduction to apiculture practices and handling of Beehives.
7. Study of male and female external genitalia of insects through permanent slides.
8. Study of different types of larvae and pupae with the help of charts/ photographs/ diagrams.

Suggested reading material

1. The Insect-Structure and Function. - by R.F. Chapman.
2. Imm's General Text Book of Entomology –by O.W. Richards and R.G. Davies.
3. The Insect an outline of Entomology- by P.G. Gullan and P.S. Cranston.

M.Sc. Zoology

Semester-IV

ZOO- 404

Biosystematics and Evolution

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-I

Definitions and perspectives of systematics, classification and taxonomy, goals and importance of taxonomy. Procedures of taxonomy -identification, classification, nomenclature, phena, taxa, category. Taxonomic Key and its significance. Qualitative and quantitative methods of analysis of variations.

UNIT-II

History and theories of classification. International code of Zoological nomenclature-principles, objectives and rules for nomenclature, type system and priority for different taxa. Polytypic species, race, variety, cline, subspecies. Species concepts - Typological species concept, nominalistic species concept, biological species concept, evolutionary species concept. Difficulties in applying biological species concept.

UNIT- III

Evolutionary time scale: eras, periods and epoch. Major events in evolutionary time scale: origins of unicellular and multicellular organisms. Molecular evolution: molecular divergence and molecular clock.

UNIT IV

Concept of Speciation and its methods. Interrelationship among different phyla of Invertebrates and their evolutionary significance. Origin of Vertebrates: Pisces, Amphibia, Reptilia, Aves and Mammalia. Stages of primate evolution.

Practicals based on theory paper:

1. Use of key to identify the fishes of the region, representing different families.
2. Methods of describing common insects representing different orders, with particular reference to the recording of taxonomic characters.
3. Study of ancestry of man, horse, camel and elephant through charts/models.
4. Visit to a Fossil park/Geology and Anthropology museums.
5. Study of origin of invertebrate and vertebrate groups through charts.

BOOKS RECOMMENDED

1. *Genetics and the origin of species* by **T. Dobzhansky**, Columbia University Press; 1951.
2. *Principles of Systematic Zoology* by **E. Mayr**, Tata McGraw Hill Publishing Co. Ltd., New Delhi; 1976.
3. *Taxonomy* by **R.E. Blackwelder**, John Wiley & Sons, New York; 1967.
4. *Organic Evolution* by **Lull**, MacMillan Co., New York; 1947.
5. *Time, life and Man* by **R.A. Stirton**, John Wiley and Sons, New York; 1959.
6. *Evolution of the Vertebrates* by **E.H. Colbert**, Willy Eastern Ltd., New Delhi; 1969.

M.Sc. Zoology
Semester-IV

ZOO- 405
Parasitology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT-I

Introduction to Parasitology, different types of animal associations: definitions; Parasitism, Mutualism, Hyperparasitism. Hosts: host types, regular hosts, irregular hosts, intermediate hosts. Parasite Host Specificity: Kinds of parasite host specificity, specificity factors related to infection and growth. Host-parasite interaction.

UNIT-II

Parasitic (Morphological and physiological) adaptations: Protozoa, Helminths, Nematodes and Arthropods. Immunity to Parasites: Brief account of immunity to malaria, leishmaniasis, trypanosomiasis, schistosomiasis and ascariasis.

UNIT-III

Vectors - Brief account of various insect vectors of human parasitic infections. Parasite Transmission: Introduction, mechanism, circadian rhythm. Zoonosis: viral; rabies, japs encephalitis. Prarastic: Hydatid disease

UNIT-IV

Ecology of parasites : Ecological niche, host size, and parasite numbus, biological control, evolution of parasitism: Fahrenholz Rule: Szidat Rule, Eichler Rule.origin of parasitism: progressive and retrogressive evolution.

Practicals :

1. To study the protozoans and helminth parasites infecting frog, toad and common household insects through slides/charts.
2. To study the helminth parasites infecting gut of the sheep and goat obtained from slaughter house.
3. To study the parasites from stained blood smears - *Leishmania*, *Plasmodium* and *Trypanosoma*.
4. To study the vectors of different parasitic infections (Mosquito, ticks, sandfly etc.).

BOOKS RECOMMENDED

1. *Parasitology : The Biology of Animal Parasites*, 5th edition by **Noble, E.R. and Noble, G.A.**, Lea & Febiger, Philadelphia; 1982.
2. *Physiology of Parasites* by **Chapell, L.H.**, Blackie, Glosgow, London; 1979.
3. *Immunology of Infection* by **Kaufmann, S.**, Academic Press; 1999.
4. *An Introduction to Animal Parasitology* by **Smyth, J.D.**, Hodder & Stoughton, London; 1976.

**M.Sc. Zoology
Semester-IV**

**ZOO- 406
Fish and Fisheries**

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT-I

Aquaculture: scope and its types: traditional, extensive, intensive, semi-intensive, flow through and re-circulatory. Principle of composite fish culture, Composite fish culture of endemic and exotic fishes in India. Ecology of fish pond ecosystem: Physico-chemical conditions of ponds water and soil; Biological conditions of waters; Classification of water bodies on the basis of productivity

UNIT-II

Induced breeding: Definition, different kinds of hatcheries and advantages of induced breeding in fishes. Use of synthetic chemicals for induced breeding. Estuarine and brackish water fishes in India: characteristics species and their exploitation.

UNIT-III

Fish pathology and ageing: Fish diseases: Fungal, bacterial, protozoan, worm and crustacean diseases of fishes. Major and minor constituents of fish including minerals and trace elements in fish. Post mortem changes in fish- rigor mortis, autolysis, auto-oxidation, biochemical and microbial spoilage of fish. Age and growth determination in fishes using hard parts such as scales, opercular bones etc.

UNIT-IV

Fish processing and preservation: (drying, salting and smoking), Chilling and freezing of fish, canning of fish and fish products. Fish transportation and marketing. Concept of Transgenic organisms, GMO's and bio-safety regulations.

Practicals :

1. To estimate the dissolved oxygen in water.
2. To estimate the pH of water.
3. To estimate the phosphate of water.
4. To determine the BOD of water.
5. To study the benthic organisms.
6. To study the different types of fishing gears.
7. To study the Indian culturable fishes.
8. To study the Exotic culturable fishes.

BOOKS RECOMMENDED

1. *Fish and Fisheries of India* by **Jhingran, V.G.**, Hindustan Publishing Corporation, New Delhi; 1991.
2. *Aquaculture Production FAO Fisheries Circular No. 815* by Rev.FAO Rome;1991.
3. *Aquaculture in Asia* by **Joseph, M.M.**, Asian Fisheries Society, Mangalore; 1990.
4. *Inland Fisheries of India, Vol.I & II* by **Talwar P.K. and Jhingran A.G.**, Oxford & IBH, New Delhi; 1991.
5. *Freshwater Fishery Biology* by **Lagler, K.F.**, Wm. C. Brown Company Dubuque, Iowa; 1969.
6. *Methods for Assessment of Fish Production in Freshwaters* by **Bagenal, T.B.**, IBP Handbook No.3, Blackwell Scientific Publications Ltd., Oxford; 1970.
7. *Fundamentals of Ecology* by **Odum, E.P.**, W.B. Saunders Co. Philadelphia; 1971.
8. *Limnology* by **Welch, P.S.**, McGraw Hill Book Co., New York; 1952.
9. *Limnology* by **Watzel, R.G.**, W.B. Saunders Co. Philadelphia; 1983.
10. *The Biology of Polluted Waters* by **Hynes, H.B.N.**, Liverpool University Press, Liverpool; 1978.
11. *Fundamentals of Limnology* by **Ruttner, F.**, University Press Toronto, 1975.
12. *Fishes: An Introduction to Ichthyology* by **Moyle, P.B. and Cedh, J.C.**, Prentice Hall Inc. Jersey USA; 1986.
13. *Fishery Development* by **Agarwal, S.C. and Johal, M.S.**, Narendra Publishing House, Delhi; 2004.
14. *History of Fishes* by **Norman, J.**, Ernst Brown, London; 1999.
15. *Biology of fishes* by **Kyle H.M.**, Biotech. Books, New Delhi; 2007.
16. *Freshwater Ecology : Concepts and environmental applications* by Dodds, Walter K. Academic Press. USA; 2002.
17. *The Biology of fishes: New Introduction* by **Dr. Vijay Dev Singh** by M. Hary. Kyle. Biotech. Books, New Delhi; 2007.
18. *Fish Management and Aquatic Environment* by **Kumar, A. and Dubey, P.**, Daya Publishing House, New Delhi; 2006.