Master of Science in Zoology

(M.Sc. Zoology)

(Choice Based Credit System)

Program Structure & Syllabus for M.Sc. Zoology

Revised syllabus

With effect from 2021-‘22 Admitted batch

Department of Zoology

College of Science and Technology

Andhra University

Visakhapatnam

A N D H R A U N I V E R S I T Y

M.Sc. DEGREE EXAMINATION IN ZOOLOGY - SYLLABUS
(Effective from 2021- '22 academic year)

The Department of Zoology, College of Science and Technology, Andhra University has been offering M.Sc. Programs in Zoology since 1946.Over a period of time, the scope for subjects like Zoology has been widened due to over whelming knowledge and diversification of core subjects into many specialized areas. Thus, keeping in view the present need of the students, and to keep thrust on the emerging trends at national and international level, the present task of syllabus revision has been taken up. Besides, the syllabus also modified to promote students' performance at national level competitive examinations like UGC – CSIR NET, SLET, other tests offered by many state and centraluniversities to gain entry into M. Phil /Ph. D programs and also for entry level tests concerned with many job opportunities.

1. AFFILIATION

The proposed programme shall be governed by the Department of Zoology, Andhra University, Visakhapatnam – 530 003.

2. ELIGIBILITY

To have passed the qualifying examination of this University as detailed in AUCET (Andhra University Common Entrance Test) regulations or an examination of any other University recognized by the Academic Council as equivalent there to.

3. PROGRAMME STRUCTURE

The M.Sc. Zoology Programme in this University is a two year course, each academic year consisting of two semesters ordinarily consecutive, as given below:

First Year - Semester – 1 & Semester – 2
Second Year - Semester – 3 & Semester – 4

A. Each semester would consist of four papers. Semesters I and II (1st Year), Semesters III and IV (2nd Year). It is mandatory for each student to complete a project, assigned at the end of 3rd Semester and goes on until 4th semester, to be submitted before the fourth semester examinations. The project work will be assigned by the concerned teacher.

B. The syllabus for M. Sc Zoology (2 year program) is formulated on par with other Universities in the country and to be implemented from academic year 2021 –'22.

C. The syllabus for practical course of the above programme was formulated based on the syllabus given for theory.

D. In all the four semesters of M. Sc Zoology, four papers/courses in each semester are provided.

E. Marks and credits are allotted to theory & practical papers in each semester. There willbe 100 marks for each theory and 200 marks for 4 practical's each 50 marks.

F. F. Seminars will be conducted for students at the end of I & III semestersfor 50 marks.

A comprehensive viva-voce will be conducted for students at the end of II & IV semesters for 50 marks. Thus, the total marks for each semester 650 x 4 semester 2600 marks.

G. Examination pattern will be as follows:
Each theory paper will be evaluated for 100 marks out of which 80% of marks will be for Semester End Examination (SEE) while the remaining 20% marks will be for Mid Semester Examination. There will be two such internal Mid Semester Examinations and the average of the two will be considered. The candidate should at least attend one Mid Semester Examination.

Similarly, each practical will be evaluated for a total of 50 marks, out of which 80% of marks for Semester End Examination (40 Marks) and 20% (10 Marks) for Continuous Internal Assessment.

H. The Semester End Examination question paper comprises of five units. Each unit consists of two questions from each unit of syllabus with sub questions of a & b.

I. An external paper setter shall set the question paper. There shall be either single or double valuation as per the University guidelines.

J. Similarly, there shall be semester-end examination of 2 - 3 hours duration for each practical course. Paper-setting and evaluation shall be done jointly by two examiners, one internal and one external.

K. Performance Evaluation of the candidates with respect to each paper shall be carried out only at the semester – end examination.

L. A candidate appearing for the whole examination shall be declared to have passed the examination if he/she obtains not less than 50% of the total marks in all papers including practical's and records put together. And, also not less than 40% in each paper/practical at the semester - end (40% marks for a maximum of 100 marks for each paper). All other candidates shall be deemed to have failed in the examination.

M. Candidates who have completed the first semester course and have earned the necessary attendance and progress certificate shall be permitted to continue the second semester course irrespective of whether they have appeared or not at all the first semester examination papers. Such candidates may be permitted to appear for the examination of the earlier semester along with the examination of the later semester simultaneously.

N. Candidates shall put in an attendance at the college for not less than 75% of the total number of working days. Condonation for shortage of attendance (only up to 66%) may be granted on the recommendation of the Principal of the College concerned, as per the University examination guidelines.

O. No condonation shall be recommended in the case of candidates who have not put in the required attendance at the college as per the University examination guidelines (less than 55%).

P. If a candidate represents the University officially at games, sports or other extra-curricular activities organized officially, it will be deemed that he/she has attended the college on the days he/she is absent for the said purpose.

Q. The names of successful candidates at the examination shall be arranged in order in which they were registered for the examination (as per the list), based on the total grades obtained by each candidate in I to IV Semester end examinations, put together.

R. Only that candidate who appears and passes examination in all papers of all four semesters at first appearance is eligible to be placed in the first class with distinction. Candidate who has not passed all papers relating to any semester at the first appearance shall not be eligible for any medals, or prizes by the University or to receive certificates of rank.

VI. EXAMINATION SCHEDULE FOR EACH SEMESTER

Semester Duration: 4 months (Excluding holidays and time for Semester-end examination).
Theory: Number of periods per theory paper: 4 to 5 hours per week. Each period of 50 minutes duration.
Practical: Students will be distributed into 2 to 3 batches with 20 students in each batch per practical. Each practical class shall be of 3 periods (3 x 50 minutes duration/batch).

M.Sc. Zoology Colleges

1. **TSR & TBK P.G. and Degree College, Gajuwaka, Visakhapatnam**
2. **Chitanya Womens P.G and Degree College, Gajuwaka, Visakhapatnam.**

HOW IS M.Sc. ZOOLOGY COURSE BENEFICIAL?

- Candidates after completing the course can enter any field of biological and biomedical research.
- They can become researchers, teachers and can be trained in any fields of biology within a short duration. If their past learning outcome in excellent they are fit for doing any job in biomedical field.
- They have also job scopes in the environmental and ecosystem management sector.
- They have also scopes of career in environmental consulting firms in private sector.

EXAMS ONE CAN ATTEMPT AFTER COMPLETING M.SC ZOOLOGYCOURSE

- Indian Council of Agricultural Research (ICAR) - ARS- NET Exam
- CSIR/UGC – NET JRF exam in Life Sciences
- Indian Council of Medical Research (ICMR)
- GATE Life Sciences
- Entrance exams conducted by TIFR, NII, NIN, IISC. Etc.
- Indian Forest Service (IFS)
- Union public service commission and State public service commission

M.Sc. ZOOLOGY EMPLOYMENT AREAS

- Colleges & Universities
- Zoos & National Parks
- Veterinary Sector
- Biotechnology Companies
- Clinical pathology labs
- National scientific institutions like ZSI, FSI etc

JOB TYPES

- Zookeeper
- Wildlife Rehabilitator
- Zoology Teacher in colleges and Universities
- Wildlife Educator
- Biological Laboratory Technician
- Research Associate
- Research Scientist
- Wild life researcher

AFTER COMPLETING M.SC ZOOLOGY YOU CAN BECOME

- Zoology Faculty Member
- Zookeeper
- Animal rehabilitator
- Animal Caretakers
- Online tutor
- Zoo Curator
- Wildlife Biologists
- Research Associate
- Animal breeders
- Fishery consultant
- Aquaculture entrepreneur

ADVANCED DEGREES - RESEARCH

Ph.D.

DEPARTMENT OF ZOOLOGY, ANDHRA UNIVERSITY
COURSE STRUCTURE WITH EFFECT FROM THE ACADEMIC YEAR 2021-'22

MSc Zoology - I Semester							
S. No	**Paper Title**	**Maximum Marks**			**Credits**		
		Theory Semester end exam + Mid)	**Practical Semester end**	**Total marks**	**Theory**	**Practical/ Viva Voce**	**Total**
Z / 101	Biosystematics, Biodiversity and Taxonomy	80 + 20	50	150	4	2	6
Z / 102	Biostatistics and Bioinformatic	80 + 20	50	150	4	2	6
Z / 103	Tools &Techniques for Biology	80 + 20	50	150	4	2	6
Z / 104	Molecular Cell Biology	80 + 20	50	150	4	2	6
Z / S	Seminars		50			2	2
	Total Marks& Credits	**400**	**250**	**650**	**16**	**10**	**26**
MSc Zoology –II Semester							
S. No	**Paper title**	**Maximum Marks**			**Credits**		
		Theory Semester end exam + Mid)	**Practical Semester end**	**Total marks**	**Theory**	**Practical/ Viva-Voce**	**Total**
Z / 105	Immunology	80 + 20	50	150	4	2	6
Z / 106	General and Comparative Physiology	80 + 20	50	150	4	2	6
Z / 107	Molecular Biology	80 + 20	50	150	4	2	6
Z / 108	Biomolecules	80 + 20	50	150	4	2	6
Z / V	Viva – Voce		50			2	2
	Total Marks	**400**	**250**	**650**	**16**	**10**	**26**
MSc Zoology –III Semester							
S. No	**Paper Title**	**Maximum Marks**			**Credits**		
		Theory (Semester end exam + Mid)	**Practical Semester end**	**Total marks**	**Theory**	**Practical/ Viva Voce**	**Total**
Z/109	Population Genetics &Evolution	80 + 20	50	150	4	2	6
Z/110	Developmental Biology	80 + 20	50	150	4	2	6
Z/111	Aquaculture	80 + 20	50	150	4	2	6
Z /112	Principles of Ecology & Conservation	80 + 20	50	150	4	2	6
	Online Course through Moocs /SWAYAM				4		4
	Value added Course - IPR				2		2
Z / S	Seminars		50			2	2
	Total Marks	**400**	**250**	**650**	**16**	**10**	**32**
MSc Zoology –IV Semester							
S. No	**Paper Title**	**Maximum Marks**			**Credits**		
		Theory Semester end exam + Mid)	**Practical semester end**	**Total marks**	**Theory**	**Practical/ Viva Voce**	**Total**
Z /113	Endocrinology and Animal Behaviour	80 + 20	50	150	4	2	6
Z /114	Parasitology	80 + 20	50	150	4	2	6
Z /115	Genetics and Molecular Cytogenetics	80 + 20	50	150	4	2	6
Z / 116	Biotechnology and Applied Biology	80 + 20		100	4	-	6
	Online Course through Moocs /SWAYAM				4		4
	Value added Course- Research methodology				2		2
Z/ P	**Project work**	-	50	50	-	2	2
Z/V	**Viva voce**		50			2	2
	Total Marks	**400**	**250**	**650**	**16**	**10**	**32**

Total number of Credits=116

M.Sc. ZOOLOGY
SEMESTER - END EXAMINATION
Theory Model Question Paper

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five units. Each unit consists of two questions from each unit of syllabus with sub- questions of a & b. All units to be covered equally. Each question carries 16 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions, selecting one from each unit.

Course title _____ Code _____

Answer one question from each Unit

All questions carry equal marks

Time: 3 Hours Max. Marks. 80 (16 x 5 =80)

	Unit – I
1.	a.
	b.
	(or)
2.	a.
	b.
	Unit – II
3.	a.
	b.
	(or)
4.	a.
	b.
	Unit – III
5.	a.
	b.
	(or)
6.	a.
	b.
	Unit – IV
7.	a.
	b.
	(or)
8.	a.
	b.
	Unit – V
9.	a.
	b.
	(or)
10.	a.
	b.

Course Structure and Scheme of Examination

- The program shall be called M.Sc. ZOOLOGY
- The program shall be based on semester system. The recommended duration is 4 Semesters
- A student shall have to take the suggested courses for the four semesters. Each course/ paper shall carryfour hours of contact period and taught per every week for 12 weeks. This amounts to 48 lectures duration of 50 minutes each.
- Admission shall be based on entrance examination
- Laboratory courses/practicals will be conducted as per the suggested syllabus for first year and 2nd year of the course.
- Practical examinations shall be conducted at the end of each semester.
- In the present curriculum, it is resolved to award marks while evaluating the student. Each course (theory) shall be evaluated for 100 marks. Practical examination for 50 marks and seminars/Viva-voce/Project work for 50 marks.
- Total marks for evaluation in all (I, II, III, & IV) semesters are 2600 (i.e., 650 marks for each semester). The candidate should obtain a minimum of 50% to qualify for the degree.
  - ✓ Paper-setting shall be by external examiner
  - ✓ Evaluation of theory and practical's are as per the University regulation i.e. by external and internal examiners or external/internal.
  - ✓ Seminar evaluation is done by a committee or internal examiner
- On the basis of total marks obtained by each candidate in all four semesters put together, they will be awarded grades as per the percentage of marks obtained

'O' grade	:	75% and above in individual subject.
'A' grade	:	65 - 74% in individual subject.
'B' grade	:	60 - 64 % in individual subject
'C' grade	:	55 - 59% in individual subject.
'D' grade	:	50 - 54 % in individual subject.
'E' grade	:	40 - 49% in individual subject.
'F' grade(fail)	:	less than 40%.

M.Sc. ZOOLOGY
PAPER CODE & PAPER TITLE

SEMESTER - I

Paper Code	Title of the Paper
Z/ 101	Biosystematics, Biodiversity and Taxonomy
Z/ 102	Biostatistics and Bioinformatics
Z/ 103	Tools and Techniques for Biology
Z/ 104	Molecular Cell Biology
Z/ 101 - 104	Practicals for all theory papers

SEMESTER - II

Paper Code	Title of the Paper
Z/ 105	Immunology
Z/ 106	General and Comparative Physiology
Z/ 107	Molecular Biology
Z/ 108	Biomolecules
Z/ 105 – 108	Practical's for all theory papers

SEMESTER - III

Paper Code	Title of the Paper
Z/ 109	Population Genetics and Evolution
Z/ 110	Developmental Biology
Z/ 111	Aquaculture
Z/ 112	Principles of Ecology and Conservation
Z/ 109 – 112	Practicals for all theory papers

SEMESTER - IV

Paper Code	Title of the Paper
Z/ 113	Endocrinology and Animal Behaviour
Z/ 114	Parasitology
Z/ 115	Genetics and Molecular Cytogenetics
Z/ 116	Biotechnology and Applied Biology
Z/ 113 – 116	Practicals for 113,114,115 theory papers and Project work in the place of 116 theory paper

Syllabus 2021-'22
M.Sc. Zoology Programme - I Semester
Theory Syllabus - Paper Code Z / 101
BIOSYSTEMATICS, BIODIVERSITY AND TAXONOMY
(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**
Credits: 4 **Internals: 20Marks**

Course Objectives:
CO 1. To obtain knowledge on basic concepts of biosystematics & taxonomy
CO 2. To learn about trends in biosystematics
CO 3. To know about species Concept
CO 4. To have knowledge on conservation of biodiversity
CO 5. To learn about taxonomic procedures, keys & ICZN

	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	√	√	√	√	√
PO 2					
PO 3				√	
PO 4					
PO 5					
PO 6				√	
PO 7				√	
PO 8					
PO 9					

UNIT – I

1.1 Definition & basic concepts of biosystematics & taxonomy.

1.2 History, Problems, aims and tasks in taxonomy.

1.3 Importance and applications of biosystematics in biology

1.4 Material basis of biosystematics – Taxonomic attributes.

UNIT – II

2.1 Theories of biological classification (Essentialism, Nominalism, Empirism, Cladism)

2.2 Evolutionary classification.

2.3Trends in biosystematics- Concepts of different conventional and newer aspects.

2.4 Chemotaxonomy; Cytotaxonomy; Molecular taxonomy; Eco - taxonomy and Behavioral taxonomy

UNIT – III

3.1 Species Concept - Different species concepts - Typological, Nominalistic, Biological& evolutionary species concept.

3.2 Sub-species and other infra specific categories, Polytypic species.

3.3 Dimensions of speciation- types of lineage changes, production of additional lineage

3.4 Speciation – Allopatric, Sympatric & Parapatric speciation, and factors affecting speciation.

UNIT – IV

4.1 Sustainable utilization of Biodiversity - Origin of biodiversity, Types of biodiversity & ecosystem, Threats of biodiversity.

4.2 Equitable sharing & conservation of Biodiversity (in-situ & ex-situ & gene banks).

4.3 Genetic Variations & Non genetic Variations - Molecular perspectives on conservation of Biodiversity,

Hierarchy of categories.

4.4 Origin of reproductive Isolation (Prezygotic & Post zygotic mechanisms).

UNIT – V

5.1 Taxonomic procedures – taxonomic collections, preservation, curetting of animals and Process of identification. Preservation of specimens.

5.2 Taxonomic Keys - Procedure keys in taxonomy, Types, merits & demerits.

5.3 Systematic publications – different kinds of publications, Process of typication and different Zoological types.

5.4 International code of Zoological Nomenclature (ICZN) - Operative principles, Interpretation and application of important rules, Zoological nomenclature, formation of scientific names of various taxa. Interpretation of rules of nomenclature.

Suggested Readings

1. M. Kato. The Biology of Biodiversity, Springer.
2. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
3. G.G. Simpson, Principle of Animal taxonomy, Oxford IBM Publishing Company.
4. E.O. Wilson. The diversity of Life (The College Edition), W.W. Northern & Co.
5. B.K. Tikkadhar, Threatened Animals of India, ZSI Publication Calcutta.
6. Mayr, E. 1969. Principles of Systematic Zoology. McGraw-Hill, N.Y.
7. Mayr, E. 1970. Populations, species and evolution, Cambridge Mass, Harvard Univ. Press.
8. Ferguson, A., 1976. Biochemical systematics and evolution, john biley and Sons, N.Y., Toronlo.
9. Gote, H.E. 1982. Animal Taxonomy.
10. Mayr, E. & E. Aschhok. 1991. Principles of systematic, McGraw Hill Book Co. London.
11. Minell, A. 1983. Priological systematics, The state of Art champan of Hill, London.
12. Quicke, D.L.J. 1996. Principles and Techniques of contemporary Taxonomy.Blacky Academic and Professional, London, New York.
13. Sebuh, R.T. 2000. Biological systematics: Principles & Application, Cornell University Press.

Learning Outcomes: After completion of this course, students are able to

LO1. Classify animals on the basis of their relation to other animals by body structure, external characters, development and DNA

LO2. Apply the International rules of nomenclature to give a scientific name to animals which are found during research.

LO3. Understand the gradual development and evolutionary history of different kinds of living organisms from earlier forms over several generations

LO4. Understand and demonstrate various animals, biodiversity and related indices

Syllabus 2021 – 2022

M.Sc. Zoology Programme - I Semester

Theory Syllabus - Paper Code Z / 102

BIOSTATISTICS AND BIOINFORMATICS

(Effective from admitted Batch 2021 – 2022)

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: No. of Credits: 4 **Internals: 20Marks**

Preamble: Biostatistics is basic application of statistics to biological observations to validate the laid hypothesis and orient towards the right pathway to achieve the goal in biological experiments. This course provides the methodology, basis of choosing correct methodology for biological observations. Bioinformatics is an interdisciplinary field mainly involving molecular biology and genetics, computer science, mathematics, and statistics. The most common problems are modeling biological processes at the molecular level and making inferences from collected data.

Course Objectives:

CO 1: This course is meant to impart knowledge to students on the most import skill which is required in this era for any scientific worker on statistical analysis.

CO 2: The course is designed in such a way that the students get the confidence to use statistics for the daily design of experiments, data collection, and analysis of results.

CO 3: To understand explosion, nature and types of biological data and its role in biological research to solve biological problems.

CO 4. To learn basic concepts of representing biological data and analyzing the data using central tendency and deviation methods.

CO 5: To understand the methodology for laying hypothesis and proving or disproving the hypothesis using different significance tests.

CO 6: To understand the concept of Correlation and Regression and to apply for data analysis.

CO 7: To understand the concept and applications of bioinformatics for resolving biological problems.

CO 8: To understand the concept and types of literature databases, nucleic acid databases, metabolic, protein and interaction databases; and their uses to understand various biological concepts.

CO 9: The mandatory hand on practical exercises in the available computer lab in the Department will benefit students to learn all that they require to use their bioinformatics knowledge for the study of science.

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9
PO 1	√	√	√	√	√	√	√	√	√
PO 2		√							
PO 3			√	√					
PO 4			√						
PO 5				√					
PO 6			√				√		
PO 7									
PO 8								√	
PO 9									√

Course Content:

UNIT – I

1.1 **Introduction to Biostatistics** – Importance of Statistics in biology, Application and Role of biostatistics in modern research. Samples and populations, variables in biology, Accuracy and Precision. Sampling – Characteristics, advantages and methods of sampling and sampling errors.

1.2 **Data Collection and Presentation**: Types of biological data. **Presentation of the data** - Frequency distribution tables Preparation of ordered, discrete, continuous and Cumulative frequency distribution tables.

1.3 **Diagrammatic and Graphical Presentation of data** - Data presentation by diagrams, graphs and curves, Skewness and Kurtosis.

UNIT – II:

2.1 Measures of central tendency - Mean, Median and Mode

2.2 **Measures of dispersion**: Standard deviation, variance and coefficient of variance.

2.3 **Probability and distributions** - Elements of Probability, definition, terminology and laws, independent events. Addition and multiplication rules, conditional probability, example –Bernoulli.

2.4 **Probability distributions**: Binomial and Poisson distribution Normal Distribution: frequency distributions of continuous variables, properties of normal distribution, applications of normal distribution.

UNIT – III

3.1 **Proportion data**- Examples of Proportion data- MPM- sterility testing of medicines- animal toxicity- infection and immunization studies e.g., LD50, ED50, PD50 statistical treatment to proportion data- Chi-square test- goodness of fit to normal distribution.

3.**2** **Count data**- Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.). Statistical treatment to count data- poission distribution- standard error- confidence limits of counts.

3.3 **Tests of Significance** - Concepts of Null hypothesis and alternative hypothesis, degrees of freedom Level of significance, errors of inference. Students t-test, Chi-square test.

UNIT – IV:

4.1 **Analysis of Variance –** One Way and Two-Way ANOVA - Applications in biology

4.2. **Correlation** - Concepts and applications of correlation and regression, Bivariate data, Scatter plot, correlation coefficient (r), properties, interpretation of r.

4.3. **Linear regression** - Fitting of lines of regression, regression coefficient, coefficient of Determination standard curves and interpolations of unknown y-values thereon.

UNIT – V: Bioinformatics

5.1. **Introduction to Bioinformatics**; Types of Biological data and its applications using computational tools; Omics studies; Major resources of Bioinformatics: Nucleic acid sequence databases NCBI, Genbank, EMBL, EMBL – EBI, Protein sequence databases: Swiss- prot, PDB, BLAST, PSI- BLAST (Steps involved in use and interpretation of results). Literature databases: PubMed, PubMed Central and Public Library of Sciences. File formats- FASTA, GCG and Clustal W.

5.2. **Databank search**- Data mining, data management and interpretation. Multiple sequence alignment of genes and primer designing. Phylogenetic analysis with the program PHYLIP, DISTANCES, and GROWTREE. Basics of designing a microarray, image analysis and normalization, annotations.

5.3 **Genomics & Proteomics:** Proteins, secondary structure and folding, RNA secondary structures, protein prediction tools- protein secondary structure, molecular modelling, identification and characterization of protein mass fingerprint, world- wide biological databases. Protein modelling, protein structure analysis, docking,

Course Learning outcomes:

LO 1: Recognize importance and value of logical and statistical thinking, training, and approach to problem solving, in the discipline of biological sciences.

LO 2: Can condense the given raw data and present diagrammatically & graphically. Calculate the central tendency value of mean, median, mode for the given data. Estimate the deviation among the raw data from the central tendency value.

LO 3: Identify and choose correct statistical method to analyze the data

LO 4: Lay down the hypothesis and subject it to validation using significance tests.

LO 5: Correlate the two variables and able to make regression lines for prediction of correct observation in the data.

LO 6: Understand the concept of bioinformatics to solve biological problems. Describe the principles behind retrieving and analyzing biological data to understand to complex biological networks.

LO 7: Understand the concept and types of literature databases and their role biological research. Understand the concept and types of nucleic acid and protein databases.

LO 8: This course will make them suitably knowledgeable to undertake biostatistical and bioinformatics-based jobs in the Scientific institutes, in addition to the teaching institutions.

Suggested Readings

1. Statistics - Gupta and Kumar
2. Biostatistics – A foundation for analysis in the Health Sciences: W.W. Daniel
3. Biostatistics - J. Zar
4. Biometry - Sokal, R.R. & F.J. Rohlf , Freeman, San Francisco.
5. Statistical methods for environmental biologists - Snedecor, G.W. and W.G. Cochran, John Wiley & sons. New York.
6. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA.
7. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA.

Syllabus 2021-'22
M.Sc. Zoology Programme - I Semester
Theory Syllabus - Paper Code Z / 103
TOOLS AND TECHNIQUES FOR BIOLOGY
(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**
Credits: 4 **Internals: 20Marks**

Course Objectives:

CO 1. To obtain knowledge on chemical and biological assays

CO 2. To learn about microscopy

CO 3. To know about microtomy & cryotechniques

CO 4. To have knowledge on microbiological and cell culture techniques

CO 5. To learn about radiation techniques and electrophysiological methods

	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	√	√	√	√	√
PO 2					
PO 3					
PO 4	√	√	√	√	√
PO 5	√	√	√	√	√
PO 6	√	√	√	√	√
PO 7				√	
PO 8					
PO 9					

UNIT – I

1.1. Assays- Chemical and Biological assay, Centrifugation, Working Principle and applications of Centrifugation; differential and density gradient centrifugation, Ultrafiltration.

1.2. Electrophoresis – Electrophoresis, Agarose Gel electrophoresis, 2- D Electrophoresis workingPrinciple, structural components and applications of electrophoresis. Analysis of RNA, DNAand proteins by one and two-dimensional gel electrophoresis, Isoelectric focusing gels.

1.3. Chromatography-Working Principle and applications of chromatography, Chromatography Planar chromatography (paper & TLC), Gas Chromatography (GC-MS), High Performance Liquid Chromatography (HPLC), and LC-MS

1.4. Spectrophotometer - UV-visible, fluorescence, circular dichroism, absorption spectrophotometry principles and applications, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction and NMR. Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

UNIT – II

2.1. Microscopy - Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells.

2.2. Principle and applications of different types of microscopes - Light, Phase Contrast, Fluorescence microscopy.

2.3. Electron microscopy: SEM, TEM and Atomic force microscopy (AFM).

2.4. Image processing methods in microscopy: Image acquisition- 2D image techniques- 3D image techniques- Analysis.

UNIT – III

3.1. Microtomy- Working principle and different types of Microtomes. Knives and Blades.

3.2. Tissue embedding (paraffin wax), Section cutting, Floatation (water bath), slide mounting, drying (oven or hot plate) and section adhesives.

3.3. Applications of microtomy in biological studies: Traditional Histology Technique-Frozen section procedure- Electron Microscopy Technique-Spectroscopy Technique.

3.4. Cryotechniques- History and applications of Cryotechniques for light and electron microscopy. Different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM.

UNIT – IV

4.1. Media preparation & Sterilization, Inoculation and growth monitoring.

4.2. Biochemical Mutants and their use, Microbial assays.

4.3. Cell Culture System - History and scope of animal cell and tissue culture, Advantages and disadvantages of tissue culture, Substrates and Culture media, Treatment of substrate surfaces, Feeder layers, gas phase for tissue culture, Culture media for cells and tissues, Culture procedures.

4.4. Cell culture techniques - Primary culture and large scale cell cultures, Tissue and Organ Culture: Primary explanation techniques, Tissue culture (slide, flask and test tube cultures), Organ culture, whole embryo culture, and tissue engineering (artificial skin and artificial cartilage).

UNIT-V:

5.1. Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

5.2. GM (Geiger-Muller) Counter, Scintillation Counter – Principle, Types, Description and Applications.

5.3. Autoradiography – Principle and applications.

5.4. Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

Suggested Readings

1. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K and Walker J.M. Cambridge University Press
2. Biophysical& Biochemical Techniques, Wilson K and Walker J.M.,
3. Laboratory Exercises and techniques in Cellular Biology, Anthony Contan to Wiley Publ.2012
4. Histological & Histochemical methods: Theory and Practice, Kiernan J.A. Scion Publ.
5. Histochemistry: Pearse A.G.E, Garfield.
6. Animal cell culture - A practical approach, Ed. John R.W. Masters, IRI Press.
7. Introduction to Instrumental Analysis. Robert Braun. McGraw Hill International Edition.
8. A Biologist Guide to Principles and Techniques of Practical Biochemistry. KWilson & K.H. Goulding, ELBS Edition.

Student Learning Outcomes: LO1. Student will learn about the basics of most often used tools, techniques, methodologies and methods of analysis used in biological research.

LO2. Student will become comfortable and proficient, working in the lab and in the field.

Syllabus 2021 – 2022

M.Sc. Zoology Programme - I Semester

Theory Syllabus - Paper Code Z / 104

MOLECULAR CELL BIOLOGY

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Preamble: Our life and health depend upon the intricate relationship between the cellular and nuclear components. This course discusses about the organization of various cellular components, cytoskeletal structure and the amazing physiology of cellular interactions and communication both with the matrix and the genetic components. The course provides insights of various signaling cascades and their regulation. Completion of this course improves the understanding of the genetic basis for life and opens up new approaches for the investigation, diagnosis and treatment of disease.

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

CO 1: Acquire the knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of cellular processes that exist in all cell types.

CO 2: Design and develop models and Sketch for various types of cells and cell organelles.

CO 3: Explain and illustrate the ultrastructure and functions of various cell organelles.

CO 4: Illustrate the chemistry and organization of cytoskeleton.

CO 5: Explain the concepts of cell signaling

CO 6: Illustrate the types, development and causes of Cancer

CO 7: Diagrammatically represent the cell cycle phases and its regulation. Can make models.

CO 8: Understand the organization of Chromosomes and Genes.

CO 9: Understand the fact that as we go down the scale of magnitude from cells to . organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9
PO 1	√	√	√	√	√	√	√	√	√
PO 2			√	√	√	√	√	√	
PO 3		√							
PO 4									
PO 5									
PO 6									√
PO 7			√						
PO 8									
PO 9									√

Course Content

UNIT – I

1.1 **Cytoskeleton in eukaryotic cell architecture and function** - Recapitulation of the structure of the eukaryotic cell with emphasis on how it functions as a unit of life.

1.2 **Structure and dynamics of microfilaments**; Cytoskeletal elements in cell shape and motility; their structure and dynamics (Microtubules, Cilia and Flagella). Cell movements – intracellular transport, role of kinesin and dynein.

1.3 **Microtubules:** structure, organization and dynamics; Role of microtubules in cell shape and mitosis; Structure and function of intermediate filaments.

UNIT - II

2.1 **Membrane structure and function -** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels.

2.2 **Transport across cell membranes -** Active transport with suitable examples, membrane pumps, mechanism of sorting and regulation of intracellular transport. Cotransport by symporters and antiporters, Membrane potential.

2.3 **Acidification of cell organelles and stomach**; transepithelial transport; Maintenance of cellular pH; Cell excitation; Bulk transport: Receptor mediated endocytosis. Intracellular trafficking.

UNIT – III

3.1 Protein sorting and targeting to organelles; Targeting of proteins to lysosomes for degradation; Molecular mechanism of the secretory pathway; Secretion of neurotransmitters.

3.2 **Cell signaling –** Types and stages of cell signaling. Cell-Cell interactions: Cellular gap junctions and adhesions; structure and functional significance of plasmodesmata; Mechanisms of cellular recognition and communication.

3.3 C**ellular communication:** Extracellular matrix, Signal transduction, Intracellular receptor and cell surface receptors; Signaling via G-protein linked receptors (PKA, PKC, CaM kinase); Overview of various cellular signaling cascades with examples such as Egfr, Notch, Wingless, JAKSTAT etc.; Enzyme linked receptor signaling pathways; Network and cross- talk between different signal mechanisms; regulation of signaling pathways, Programmed cell death.

UNIT – IV

4.1 **Cell division and Cell Cycle -** Overview of mitosis and meiosis; chromosome labeling and cell cycle analysis; cell cycle and control mechanisms; types and regulation of cyclins, sister chromatid cohesion remodeling; differential regulation of cohesion complex during mitosis and meiosis; mitotic spindle and arrangement of chromosomes on equator; regulation of exit from metaphase, chromosome movement at anaphase.

4.2 Genetic control of meiosis with examples from yeast.

4.3 **Steps in cell cycle** - Role of Cyclins' and Cyclin Dependent Kinases (CDKs) in the regulation and control of cell cycle.

4.4 **Cell cycle checkpoints –** Different types of check points, Checkpoint genes and significance of checkpoints in cell cycle.

UNIT – V

5.1 **Organization of Genes and Chromosomes -** Hierarchy in organization

5.2 Chromosomal organization of genes and non-coding DNA, Mobile DNA, unique and repetitive DNA, interrupted genes, gene families.

5.3 Morphological and functional elements of eukaryotic chromosomes, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.

5.4 **Cancer -** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

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.
3. Cell Physiology Source Book: A Molecular approach, Sperelakis, (2001), Academic Press, New York, USA.
4. Cell and Molecular Biology: Gerald Karp. (1996), John Wiley and Sons. Inc.
5. Molecular Biology: W.H Freeman G: Lodish,H., Ber, A., Zipuoskry, L.S., Matsudaira, P., Bahimore, D and Damell J. (2001).
6. Cell Biology: Pollard J.P. and W.C. Earnshaw. (2002).

Course Learning outcomes:

By the end of the units from I - V, the student will be able to:

Lo1: Understand how the cell functions as a unit of life and its organelles.

Lo2: Gain knowledge about the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes.

Lo3: Be able to draw parallels between the physiological processes at the cellular and organismic levels.

Lo4: Appreciate the importance of cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.

Lo5: Acquire knowledge on cell cycle and cell signaling.

Lo6: Understand the mechanism of Cell Communication.

Lo7: Know about the complex organization of Chromosomes and Genes.

Lo8: Gets in depth knowledge on Cancer and its causes and genetics.

SEMESTER - I
Paper Code Z / FS 101

BIOSYSTEMATICS, BIODIVERSITY AND TAXONOMY

LIST OF EXERCISES FOR LABORATORY COURSE

1. A practical approach towards Biosystematics and taxonomy - Examples representing different taxa in the order of evolution.
2. Techniques of collection and preservation with respect to insects and fishes
3. To prepare identification keys of various animal groups
4. To study external morphological features of various animal groups (Eg. beaks & claws of birds, scales of fishes, wing venation and external genitalia of insects).
5. Methods of collection, preservation and identification of fauna – zooplankton, insects, fishes, birds etc.
6. Representative forms of terrestrial and aquatic fauna.

SEMESTER - I
Paper Code Z / FS 102

BIOSTATISTICS AND BIOINFORMATICS

LIST OF EXERCISES FOR LABORATORY COURSE

1. Sampling – Lottery method and Random digits
2. Preparation of frequency distribution tables using biological data.
3. Graphical presentation of the data.
4. Measures of Central Tendency – Mean, median and mode
5. Measures of Dispersion – Standard deviation and Coefficient of variation
6. Probability – Tossing the coin
7. Chi – Square analysis – Testing significance
8. Coefficient of Correlation
9. Nucleic acid and protein databases.
10. Retrieval and analysis of DNA or protein sequence from NCBI.

SEMESTER - I
Paper code Z/FS 103

TOOLS AND TECHNIQUES FOR BIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Separation of call organelles by Differential centrifugation.
2. Separation of protein by electrophoresis (Native & SDS page).
3. Separation of amino acids by paper and Thin Layer Chromatography - Demonstration of column Chromatography.
4. Validation of Beer-lamberts law of a colored compound (CuSO4).
5. Spectrophotometer – Estimation of Biomolecules
6. pH meter - Preparation of buffer.
7. Light microscopy - Observation of unstained and stained cells.
8. Demonstration of - Fixation, Dehydration, Sectioning and staining of animal tissue.
9. Preparation of chick fibroblast and viability testing.

I SEMESTER
Paper Code Z/ FS 104
MOLECULAR CELL BIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Sub-cellular fractionation – separation of macromolecules
2. Isolation of mitochondria from mouse liver by differential centrifugation.
3. Stages of Mitosis and Meiosis
4. Squash preparation – Acetoorcein staining
5. Preparation of Meiotic chromosomes using Haemotoxylin / Feulgen stain - *Poecilocera picta*
6. Isolation of Nuclei and determination of its purity
7. Isolation of mitochondria and plastids and Examination under microscope
8. Isolation of mitochondria and chloroplast DNA – Qualitative analysis of DNA

Syllabus 2021 – 2022

M.Sc. Zoology Programme - II Semester

Theory Syllabus - Paper Code Z / 105

IMMUNOLOGY

Hours per week: 4 **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Preamble: This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. A description of cells involved in the immune response either innate or acquired. How the immune system recognizes self from non-self. B and T cell maturation and specific responses. Other topics covered will include Ag. – Ab. Reactions, Tumor immunology and Transplantation Immunology.

The primary objective of this course is

Course Objectives: Upon successful completion students will be able to

CO1. Develop skills necessary for critical analysis of contemporary literature on topics related tohealth and disease and role of immune system.

CO2 Understand what are the molecular and cellular components and pathways that protect an organism from infectious agents?

CO3 Provide students with knowledge on how the immune system works and be able to compare and contrast the innate versus adaptive immune systems.

CO4 Acquire knowledge to compare and contrast humoral versus cell-mediated immune responses; distinguish and characterize CD4+ T helper cell lineages Th1, Th2, Th17, and regulatory T cell (Treg) and CD8+ cells.

CO5 Understand and characterize antibody isotypes, development, and functions; provide an overview of the Ag. – Ab. Interactions and diagnostic methods for disease diagnosis.

CO6 Understand the role of cytokines in immunity and immune cell activation; and be able to identify and characterize cytokines of particular immune importance;

CO7 Understand the significance of Major Histocompatibility Complex in terms of immune response and Transplantation.

CO8 The course also emphasizes the research and development opportunities for therapeutic intervention arising from recent advances in immunology.

CO9 Upon completion of the course students have a sound understanding of the essential elements of the immune system, preparing them to engage further in this rapidly evolving field.

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9
PO 1	√	√	√	√	√	√	√	√	√
PO 2		√	√						
PO 3								√	
PO 4				√				√	
PO 5								√	
PO 6									√
PO 7									
PO 8									√
PO 9									√

Course Content

UNIT – I

1.1 **Overview of the Immune system -** A Historical Perspective of Immunology, Important Concepts for understanding the Mammalian Immune Response, the Good, Bad, and Ugly of the Immune System. Clonal Selection Theory.

1.2 **Cells, Organs, and Microenvironments of the Immune System –** Haematopoiesis, Cells of the Immune System, Lymphoid Organs – their structure and Function.

1.3 **Antigens -** Immunogenecity, Antigenecity and factors effecting immunogenicity, Epitopes and Haptens. Superantigens and their properties and immune response.

UNIT – II

2.1 **Antibodies –** Gross and molecular structure of Immunoglobulin molecule, Antibody Classes and their effector functions. Polyclonal & Monoclonal antibodies and their application.

2.2 Ag. - Ab. Interactions and Diagnostic techniques – Diagnostic techniques: Immunoprecipitation based techniques, Agglutination reactions, Ab assays based on Ag binding to solid phase supports (RIA, ELISA, ELISPOT, Western Blotting), Immunofluorescence based imaging techniques. Vaccines

2.3 The Major Histocompatibility Complex and Antigen Presentation - Structure and function of MHC Molecules, General Organization and Inheritance of the MHC, Role of MHC and expression patterns.

2.4 **Antigen Presentation**: Endogenous and exogenous pathway of antigen processing and presentation, Cross presentation of exogenous antigens, Presentation of nonpeptide antigens.

UNIT - III

3.1 Innate Immunity – External defences (Anatomical, chemical, biological barriers), Internal defences – Cellular (Neutrophils, macrophages, NK cells & TKRs), Extra cellular (Cytokines, Complement Proteins, Coagulation proteins).

3.2 Inflammatory Responses. Molecular recognition and regulation and Evasion of Innate and Inflammatory Responses, Interactions between the innate and adaptive immune systems, Ubiquity of Innate Immunity. Adaptive immunity

3.3 Receptors and Signalling – B and T cell Receptors; Structure and their role in signal

Transduction, Properties of Cytokines, Cytokines and associated Receptor Molecules.

3.4 The Complement System – Components and functions of Complement, complement activation, biological consequences of complement activation, Complement deficiencies.

UNIT – IV

4.1 T -Cell Development - Early thymocyte development, Positive and Negative Selection, Maturation, self-tolerance, Apoptosis. T-Cell Activation, Differentiation, Memory - T-Cell Activation and the Two-Signal Hypothesis. T-Cell Differentiation and T-Cell Memory.

4.2 B-Cell Development - B - Cell development, Development of B-1 and marginal - zone B cells, Comparison of B- and T-Cell development. B-Cell Activation, Differentiation and memory generation. T-dependent and T-Independent B-Cell responses, Negative regulation of B Cells.

4.3 Effector Responses- Cell Mediated Immunity, Humoral Immunity, Immune response kinetics, Antibody mediated effector functions, Cell mediated effector responses.

UNIT V

5.1 **Allergy,** Hypersensitivities, and Chronic Inflammation Type I- Hypersensitivity reaction, Antibody mediated (Type II) Hypersensitivity reactions, Immune Complex-Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity (DTH), Chronic Inflammation.

5.2 **Autoimmunity & Immunodeficiency Disorders:** Establishment and maintenance of tolerance, Autoimmunity. Immunodeficiency Disorders - Primary and Secondary Immunodeficiency diseases.

5.3. Transplantation Immunology – Transplantation antigens, Transplantation immunology, Graft Versus Host Disease.

5.4 **Cancer and the Immune System–** Terminology, Malignant transformation of cells, Tumour antigens, Immune response to cancer, Cancer Immunotherapy.

Suggested Reading:

1. KUBY Immunology by Judith A. Owen, Jenni Punt, Sharon A. with contributions by Patricia P. Jones. Seventh Edition, W. H. Freeman and Company, New York.
2. Janeway's Immunobiology, 9th Edition, by Kenneth M. Murphy & Casey Weaver
3. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Saunders, 2015.
4. Basic Immunology: Functions and Disorders of the Immune System, Elsevier Saunders, 2006.
5. Roitt's Essential Immunology by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt.
6. Text book of Immunology by Unani and Benacerraf.

Course Learning Outcomes:

1. Utilize the knowledge in educating the society in understanding the immune capacity of one's own health system and how to keep healthy by maintaining immunological balance.
2. Impart knowledge to stake holders on various aspects of immune system and defense mechanism like the structure, properties and functions of antibodies, importance of innate body defense, role of different types of T cells, B cells and APCs etc.
3. Understand the importance of vaccines, vaccination programme and its propagation. Application of various diagnostic techniques and their applicability.
4. Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.
5. Learn to review the literature to determine the strengths and weaknesses of the data published in immunology and its novelty.
6. To get employability in diagnostic laboratories and research laboratories where he can upgrade his knowledge to design new methods for various immunotherapeutic strategies

(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**
Credits: 4 **Internals: 20Marks**

Course Objectives:
CO 1. To obtain knowledge on physiology & anatomy of digestive & respiratory systems
CO 2. To learn about physiology & anatomy of circulatory system
CO 3. To know about physiology & anatomy of excretory system
CO 4. To have knowledge on physiology & anatomy of nervous system & muscles
CO 5. To gain knowledge on physiology of homeostasis & stress

	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	√	√	√	√	√
PO 2	√	√	√	√	√
PO 3	√	√	√	√	√
PO 4					
PO 5					
PO 6	√	√	√	√	√
PO 7					
PO 8					
PO 9					

Unit – I

1.1. Functional anatomy of digestive system.

1.2. Digestion and absorption. Neuroendocrine regulation of gastro – intestinal movements and secretions. Energy balance, BMR

1.3 Respiratory system - Comparison of respiration in different species, anatomical considerations. Breathing movements, transport and exchange of gases, waste elimination. Respiratory quotient. Respiratory Pigments.

1.4 Neural and hormonal control of breathing. Respiratory acidosis and alkalosis and regulation of blood PH.

Unit –II

2.1. Blood & Circulation - Blood corpuscles, hemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, hemostasis.

2.2. Cascade of biochemical reactions (factors) involving in blood coagulation.

2.3. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue.

2.4. ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation.

Unit –III

3.1.Excretory system - Comparative physiology of excretion, kidney and its renal units.

3.2. Physiology of urine formation. The significance of Henley's loop.Role of hormones in renal physiology.

3.3. Waste elimination- Formation of nitrogenous excretory products NH3, Urea & Uric acid.

3.4. Micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Unit – IV

4.1 Nervous system - Structure of neuron, Fundamentals of nerve impulse- resting potential, Action potential, role of ion channels.

4.2 Types of synapses- electrical and chemical, gap junctions, ligand gated channels and the Mechanism of synaptic transmission, cholinergic and adrenergic, Neuromuscular junction.

4.3 Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural

control of muscle tone and posture.
4.4 Types of muscles: Striated, non-striated and cardiac muscles. Ultra-structure of striated muscle. Muscle contraction – Muscle proteins, sliding filament theory.

Unit – V
5.1 Homeostatic mechanisms of the body - Concepts of Homeostasis.
5.2 Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.
5.3 Stress Physiology - Basic concept of environmental stress and strain, concepts of elastic and plastic strain, stress resistance, stress avoidance and stress tolerance. Responses to biotic and abiotic factors.
5.4 Sense organs - Vision, hearing and tactile response.

Suggested Readings

1. Eckert, R: Animal Physiology: Mechanisms and adaptation, W.H. Freeman and Company, New York
2. Hochackka, P. W. and Somero, G.N: Biochemical adaptation, Princeton, N.J.
3. Hoar,W.S: General and Comparative Animal Physiology, Prentice Hall of India.
4. SchimdtNeisen: Animal physiology, Adaptation and Environment, Cambridge.
5. Stamd,F.L: Physiology: A regulatory systems approach, Macmillan publishing Co.New York.
6. Punmer, L.: Practical Biochemistry, Tata McGraw-Hill.
7. Prosser,C.L. and Brown: Comparative Animal Physiology.
8. Wilson,K and Walker,J: Practical Biochemistry.
9. Willmer, PIG Sone and Johnson, Environmental Physiology. Black Well Science, Oxford, U.K.944p
10. Newell, R.C: Adaptation to environment, Essays on the physiology of marine animals. Butterworths, London, UK 539pp.
11. Townsend, C.R and P. Callow: Physiological Ecology - An evolutionary approach resource use, Blackwell Sci. Publication, Oxford, UK

Student Learning Outcomes:

LO 1: Student will have an enhanced knowledge and appreciation of animal physiology

LO 2: Understand the functions of important physiological systems

LO 3: Understand how these separate systems interact to yield integrated physiological responses to different challenges

LO 4: Will be able to perform, analyse and report on experiments and observations in physiology

Syllabus 2021 – 2022
M.Sc. Zoology Programme - II Semester
Theory Syllabus - Paper Code Z / 107
MOLECULAR BIOLOGY

Hours per week: 4 **Semester End Examination: 80Marks,**
Credits: 4 **Internals: 20Marks**

Preamble: The paper Molecular Biology encompasses the basic study and understanding the central dogma.

Course Objectives: By the end of the Course student should be able to

CO1 Understanding the basic organization of the genome of prokaryotes and eukaryotes.

CO2 Understand prokaryotic and eukaryotic replication, transcription, translation processes and regulation.

CO3. To understand the difference between prokaryotic and eukaryotic genetic material, types of genes and other organelle genomes (mitochondrial & plastid).

CO4 To explain the concept of DNA replication and study the enzymes involved at both prokaryotic and eukaryotic levels.

CO5 To learn about eukaryotic and prokaryotic promoters, RNA polymerase, mechanism and inhibition of transcription.

CO6 To outline the concept of translation, genetic code, mechanism of protein synthesis, post translation modifications in eukaryotes, protein processing and targeting.

CO7 To study prokaryotic and eukaryotic gene regulation, sporulation in Bacillus subtilis, DNA methylation and epigenetic gene regulation.

CO8 This knowledge can be employed in determining the function of various genes and proteins for better understanding of cellular life processes.

	CO 1	**CO 2**	**CO 3**	**CO 4**	**CO 5**	**CO 6**	**CO 7**	**CO 8**	**CO 9**
PO 1	√	√	√	√	√	√	√	√	√
PO 2		√	√	√	√	√			
PO 3								√	
PO 4									
PO 5								√	
PO 6									
PO 7									
PO 8									
PO 9								√	

Course Content

UNIT – I

1.1 **Chemical composition of DNA -** Discovery of DNA, Evidence for DNA as the genetic material. Chemical structure of DNA and Base composition, biologically important nucleotides, Watson-Crick model, Supercoiled DNA, Structure of different types of nucleic acids, hydrolysis of nucleic acids. Conformation of nucleic acids: A-, B-, Z-, DNA, t-RNA, micro-RNA. Stability of nucleic acid structure.

1.2 **DNA content and C - value paradox-** Genome size and content over members of different orders and of the same family (Genomes of bacteria, viruses, plasmids, mitochondria and chloroplast). Methods to measure DNA content variation - Various types of DNA sequences

(simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites)

1.3 DNA Resolving the paradox by DNA-DNA and DNA-RNA hybridization kinetics, Kinetics of DNA-DNA hybridization, DNA-RNA hybridization, Cot curves, Rot curves.

UNIT - II

2.1 **DNA damage -** DNA damaging agents, Physical, chemical and biological mutagens; types of damage caused by endogenous and exogenous agents, Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shift, mis-sense and non-sense mutations

2.2 **DNA repair mechanisms**: Direct reversal, photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, double strand break repair, SOS repair; Recombination: Homologous, non-homologous and site-specific recombination.

2.3 **Enzymes involved**; Types of topoisomerases and their function in adding or removing super helical structures.

UNIT III - DNA replication

3.1 **Prokaryotic DNA replication -** Replication origin and site. Enzymes and accessory proteins and their mechanisms - DNA polymerases, composition and features, replication factors and mechanism of replication, leading strand and lagging strand synthesis, processivity and fidelity and regulation of replication. Extrachromosomal replicons, Replication of single stranded DNA, M13 viral DNA. Link with cell cycle.

3.2 **Eukaryotic replication -** Replication origin, replication fork, replication initiation complexes and their assembly, licensing factors, DNA polymerases and their composition telomerase and mode of action, replication factors, disassembly of chromatin components and reassembly during replication.

3.3 Prokaryotic gene regulation: Lac and Trp operons. Lytic and lysogenic phases of Bacteriophage λ life cycle. Sporulation in Bacillus subtilis. Eukaryotic gene regulation: Role of chromatin in eukaryotic gene regulation. Cis-trans elements, DNA methylation, chromatin remodeling. Environmental gene regulation. RNAi in gene regulation. Epigenetic gene regulation

UNIT IV RNA Transcription

4.1. Types of RNA, secondary and tertiary structure and function.

4.2. Prokaryotic and Eukaryotic transcription; Transcription factors and machinery, formation of initiation complex, transcription activator and repressor.

4.3. RNA polymerases, capping, elongation, and termination. RNA processing, RNA editing, splicing, and polyadenylation. Nuclear Export of m-RNA.

4.4. **Post transcriptional modifications -** RNA splicing and processing (5' capping, Poly A adenylation), mRNA editing, inhibitors of transcription, reverse transcription.

UNIT V - Protein Translation

5.1 Ribosome structure, Genetic code (codon anticodon recognition, wobble hypothesis, mutations).

5.2 **Prokaryotic and eukaryotic translation –** Polypeptide synthesis (initiation, elongation, termination), control of eukaryotic translation, Effect of antibiotics on protein synthesis

5.3 **post-translational modification** of proteins, protein folding, protein sorting; Mitochondrial translation, proteomics and proteomic analysis.

Suggested Readings

1. Alberts, B., Bray, D. and Hopkin, K. (2004). Essential Cell Biology. 3rd edition. Garlan Science, U.S.A.
2. Dale,W.J. and Schontz, V.M.(2007). From Genes to Genomes. John Wiley & sons ltd. England.
3. Flint. S.J, L.W. Enquist, R.M. Krug, V.R. Racaniello and A.M. Skalka, (2000) Principles of Virology, ASM Press, Washington D.C.

4. Gerald Karp (1996). Cell and Molecular Biology – Concepts and Experiments. John Wiley and Sons, Inc., New York.
5. Griffiths AJF, H.J. Muller., D.T. Suzuki, R.C. Lewontin and W.M. Gelbart (2000). An introduction to genetic analysis. W.H. Freeman, New York.
6. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky and James Darnell. (2003). Molecular Cell Biology, W.H Freeman and Company, New York.
7. Miglani G.S. (2002). Advanced Genetics, Narosa Publishing House, New Delhi.
8. Watson, J.D. T.A. Baker, S.P. Bell, A. Lann. M. Levine and R. Losick. (2004). Molecular Biology of genes, V Edition, Pearson Education RH Ltd., India.

Student Learning outcomes:

LO 1: Utilize the knowledge for undertaking either research positions, or employability positions in scientific laboratories or academic institutions.

LO 2: Imbibes deep understanding of molecular biology, and can explore different enzymes involved in DNA replication, the mechanism of DNA replication in prokaryotes and eukaryotes, the basic concept of DNA damage and repair.

LO3: Imparts knowledge to other stake holders and can bring social awareness on some misconceptions regarding molecular data and genetic code

LO 4: To highlight the mechanism of prokaryotic and eukaryotic protein synthesis.

LO 5: Details of eukaryotic post translational modifications. • To study the inhibitors of protein synthesis. • Explore the concepts of protein processing and targeting.

LO 6: Highlight prokaryotic gene regulation through sporulation in Bacillus subtilis. • Illustrate the role of chromatin and chromatin remodeling in eukaryotic gene regulation.

LO 7: Learn about DNA methylation and Cis-trans elements. Describe the concept of environmental gene regulation, epigenetic gene regulation and RNAi mediated gene regulation.

Syllabus 2021-'22
M.Sc. Zoology Programme - II Semester
Theory Syllabus - Paper Code Z / 108
BIOMOLECULES
(With effect from 2021- '22 admitted batch)

Hours per week: 4 **Semester End Examination: 80Marks**
Credits:4 **Internals: 20Marks**

Course Objectives:
CO 1. To impart knowledge on various biomolecules
CO 2. To learn about chemistry and bioenergetics of carbohydrates
CO 3. To have knowledge on biological importance of proteins
CO 4. To know about the role of lipids in biological functions
CO 5. To gain knowledge on Nucleic acids & Enzymes

	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	√	√	√	√	√
PO 2	√	√	√	√	√
PO 3					
PO 4					
PO 5					
PO 6	√	√	√	√	√
PO 7					
PO 8					
PO 9	√	√	√	√	√

UNIT- I

1.1 Biomolecules- chemical composition and bonding , chemical reactivity , ionization of water.

1.2 Weak acids and weak bases (pH) , buffers: buffering in biological systems, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

1.3 Principles of bioenergetics – Principles and Laws of thermodynamics, reaction kinetics, colligative properties and their applications in biological system : entropy and enthalpy.

1.4 Standard free energy changes standard reduction potentials, reaction.

UNIT- II

2.1 Carbohydrates- Definition and classification of carbohydrates, nomenclature.

2.2 Reaction of Mono-saccharides- Acid derivatives of Mono-saccharides, amino-sugars, Oligo - saccharides, structure and properties.

2.3 homo and hetero - polysaccharides, peptidoglycan, glycosaminoglycans, glycoproteins and other glycoconjugates.Biosynthesis and degradationof glucose and glycogen.

2.4 Bioenergetics - Glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

UNIT- III

3.1 Amino acids – classification, Peptide bond,

3.2 Proteins – classification, structural organization of proteins, primary structure, secondary structure, tertiary structure, quaternary structure.

3.3 Conformation of proteins (Ramachandran plot) domains, motifs and folds. Denaturation &renaturation of proteins.Biosynthesis of urea.

3.4 Tissue proteinin health and diseases, collagen-structure and synthesis, abnormal collagens, elastin, keratins,muscle proteins, lens proteins and cataract.

UNIT- IV

4.1 Biological importance of lipids. Fatty acids: classification, nomenclature.

4.2 Simple fats:Triacylglycerol (Triglycerides) – Physical properties. Reactions – Hydrolysis, Saponification,Rancidity. Acid number, Saponification number, Iodine number oxidation, Ketosis, Reichert-Meissl-Wollnyvalue.

4.3 Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins,plasmologens,Glycolipids, Sphingolipids Steroids: Biologically important steroids- cholesterol,Vitamin D, Bile acids, Ergosterol, Terpenes. 4.4 Prostaglandins- Structure, types, synthesis andfunctions. Lipoproteins.

UNIT- V

5.1 Structural organization of DNA (Watson-Crick model)-Characteristic features of A,B,C and Z DNA. Structural organization of tRNA and micro RNA- stability of proteins and nucleic acids.

5.2 Protein-nucleic acid interactions- Electrostatic interaction,hydrogen bonding stacking interactions. DNA binding proteins-DNA regulatory proteins, foldingmotifs, finger motifs, Zipper motifs, conformation flexibilities- Biological roles of nucleotides andnucleic acids.

5.3 Enzymes: Classification- (I.U.B.system) co-enzymes, iso-enzymes, ribozyme. Enzyme specificity.Mechanismof action of enzymes.Formation of enzyme substrate complex.Various theories.
5.4 Enzyme kinetics:Michaelis-Menten equation. Km value and its significance.Enzyme velocity and factors influencingenzyme velocity.Enzyme inhibition- suicide inhibition and feedback inhibition. Enzyme regulation:Types of regulation, Allosteric regulations-Key enzymes, Covalent modification.

Suggested Readings

1. Nelson.D.L, Cox. M. M. Lehninger's Principle of Biochemistry. 4th ed. Freeman, 2004
2. Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper's Biochemistry.27th ed. McGraw Hill, 2006.
3. Dixon & Webb. Enzymes.3rd ed. Longmans, 1979.
4. Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry. 6th ed. Freeman, 2006.
5. Adams. R. L, Knowler.J.Leader. D.P. Biochemistry of Nucleic Acids.Cambridge Univ 1998.
6. Donald Voet: Fundamentals of Biochemistry.
7. West, E.S. Todd, Mason &Vanbruggen: Textbook of Biochemistry, Macmillan & Co.
8. Nigam. 2007. Lab Manual of Biochemistry. Tata McGraw-Hill Education, USA

Student Learning Outcomes:

LO 1: Understand the organic chemical principles in life processes.
LO 2: Understand the structure & function of important biological molecules such as DNA, RNA & enzymes
LO 3: Understand biological processes such as protein biosynthesis, DNA replication & RNA biosynthesis

II - SEMESTER
PAPER CODE - Z/FS 105

IMMUNOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Lymphoid organs in Rat, Chick and Fish – Dissection & display.
2. Lymphoid organs – Histology slides
3. Cells of the Immune system - Staining with Giemsa.

   To determine Total Leukocytes Count (TLC) of the given sample.

   To determine Differential Leukocytes Count (DLC) of the given sample.
4. Isolation of lymphocytes from peripheral blood by ficoll method.
5. Viability of lymphocytes by Trypan blue staining.
6. Lysis of red blood cells (hypotonic lysis with H2O and ammonium chloride).
7. Antigen – Antibody reactions – Kits
   a) Hemagglutination assay for ABO blood group typing and determination of Rh factor.
   b) Agglutination test which detects the presence of serum agglutinins (H and O) - Diagnostic test for typhoid
8. To perform Radial Immunodiffusion (RID) by Mancini's technique.
9. To perform Double Immunodiffusion (DID) by using Ouchterlony method.
10. To perform the Quantitative precipitation assay-test.
11. To learn the technique of rocket Immuno-electrophoresis.
12. To perform Erythrocyte Rosette-forming Cell Test - ERFC.

II SEMESTER
PAPER CODE - Z/FS 106

GENERAL AND COMPARATIVE PHYSIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Action of pepsin in digestion of proteins.
2. Estimation of salivary amylase activity.
3. Estimation of lipase activity.
4. Oxygen consumption and estimation in an aquatic or terrestrial animal.
5. Determination of cell fragility by osmotic hemolysis experiment.
6. Water and ionic regulation of freshwater animal in different osmotic media.
7. Observation of an earthworm's responses in the cases of repeated stimulation and dual stimulation.
8. Observation of the response of invertebrates to different lighting conditions.
9. Estimation of Urea, Ammonia.

II SEMESTER
PAPER CODE - Z/FS 107

MOLECULAR BIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Isolation of genomic DNA from animals and microorganisms.
2. Estimation of DNA (diphenyl method)
3. Estimation of RNA (Orcinol method)
4. UV absorption spectra of native and denatured DNA
5. Isolation of plasmid and determination of purity.
6. Determination of molecular weight and quantification of DNA.

II SEMESTER
PAPER CODE - Z/FS 108

BIOMOLECULES

LIST OF EXERCISES FOR LABORATORY COURSE

1. Estimation of glycine by formal titration
2. Estimation of proteins by Lowry and Biuret methods
3. Analysis and identification of monosaccharides
4. Estimation of maltose by DNS method
5. Determination of Iodine value of oils
6. Estimation of Cholesterol
7. Extraction of biochemical constituents from various tissues.
8. Estimation of Enzyme activity (e.g.Urease)
9. Effect of pH and temperature on enzyme activity- Amylase.
10. Purification & Estimation of Casein in milk.

Syllabus 2021 – 2022

M.Sc. Zoology Programme - III Semester

Theory Syllabus - Paper Code Z / 109

POPULATION GENETICS AND EVOLUTION

Hours per week: 4 **Semester End Examination: 80Marks,**

Credits: 4 **Internals: 20Marks**

Preamble: The course is designed with an objective to make student understand the intricate relationship of evolution and the various phenotypic and genotypic factors which influence genetic make of populations at large. It also enables students how the knowledge of population genetics help the students to employ and exploit the knowledge for the benefit of people.

Course Objectives: At the successful completion of the Course, the student gets

CO 1: In-depth knowledge into the area of Population genetics.

CO 2: It also involves passing across to the students how the principles of Mendelian genetics play a role in Population genetics.

CO 3: introduce the principles underlying the genetics of populations

CO 4: let the students have an understanding of the implications and conditions under which gene and genotype frequencies change and/or remain the same

CO 5: help the students realize the principles underlying the Hardy-Weinberg law and its application

CO 6: understand the actual forces that drive evolution, sources of variation and the principle of natural selection.

CO 7: through understanding of Quantitative genetics and its applications

CO 8: the idea of construction of Phylogenetic trees using molecular data.

CO 9: the scope and areas of application of Population genetics.

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9
PO 1	√	√	√	√	√	√	√	√	√
PO 2		√	√						
PO 3		√	√	√					
PO 4					√				
PO 5								√	√
PO 6							√		√
PO 7									
PO 8									√
PO 9								√	√

Course Content

UNIT – I

1.1 **Theories of organic evolution-** Lamarckism, Neo Lamarckism, Darwinism, Neo Darwinism. Concepts of Variation - Genetic drift, Migration, Selection, Adaptation, Struggle, Fitness and Mutations.

1.2 Natural Selection, the Modern Synthesis, Evolution of populations.

1.3 Origin of unicellular and multicellular organisms, plants and animal - Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane; Experiment of Miller (1953).

1.4 **The first cell -** Evolution of Prokaryotes; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT – II

2.1 **Gene Frequency and Genetic Equilibrium –** Gene pool, gene frequencies and genotype frequencies, Hardy Weinberg Law, conservation of gene frequency. Assumptions and Testing Hardy-Weinberg principle with population models.

2.2 **Gene evolution -** Multigene families, gene duplication and Divergence, Molecular drive.

2.3 **Speciation and Evolution –** Race formation, the species, modes of speciation (allopatric, parapatric, sympatric). Evolutionary processes causing speciation - natural selection, sexual selection, random genetic drift, Muller incompatibility.

2.4 **Evolutionary genetics of speciation -** Evolution of Proteins and nucleotide sequences. Mechanism of reproductive isolation.

UNIT III

3.1 **Genetic structure of populations -** Optimum phenotypes and Selection pressure, kinds of selection, Fisher's theorem, genetic variability, Canalization, Genetic homeostasis, genetic load, genetic death. Mutational and Segregational load.

3.2 Phenotypic Variation

3.3 Models explaining the genetic structure of populations

3.4 Factors effecting Human disease frequency

UNIT IV: Genetics of quantitative traits in populations

4.1 Analysis of quantitative traits, Quantitative traits and natural selection,

4.2 Heritability or Estimation of – Broad sense and narrow sense heritability,

4.3 Genotype: Environment interactions

4.4 Inbreeding and Heterosis.

UNIT V: **Molecular Population Genetics**

5.1 **Molecular phylogeny-** Immunological techniques, amino acid sequences, DNA – DNA hybridizations nucleic acid phylogeny.

5.2 **Patterns and modes of substitution -** Nucleotide substitutions, Evolutionary rate, Molecular clock.

5.3 Phylogenetic trees, construction method, phylogenetic gradualism, punctuated equilibrium, phylogenetic classification, phenetics, cladistics.

5.4 **Induced Changes in genetic material -** Ionizing and UV radiation, Chemical mutagens, Oxygen and environmental effects, DNA repair, induced mutations in humans.

Suggested Readings

1. Dobzhansky, Th. Genetics and origin of Species. Colombia University Press
2. Dobzhansky, Th., F.J. Ayala. G.L. Stebbens and J.M. Valentine. Evolution, Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutionary Biology. Suinuaer Associates, INS Publishers, Dunderland
4. Hartl, D.L. A Primer of population genetics. Sinauer Associates, INC, Massachusetts
5. Jha, A.P. Genes and Evolution, John Publication, New Delhi
6. King, M. Species Evolution – the role of chromosomal change. The Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and genetics. Oxford University Press, New York
8. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston, London.

Student Learning outcomes:

LO 1: know how knowledge on Population genetics will help in understanding the disease frequency in the populations.

LO 2: Develop an idea on application of knowledge of population genetics to the society.

LO 3: analyze as well as assesses the implications of changes in gene and genotype frequencies.

LO 4: Understand the genetic structure of Populations and the influencing factors.

LO 6: Know the significance of Quantitative traits, their quantification, and importance in applied aspects.

LO 7: Utilize the acquired knowledge for research and employability in academic institutions.

Syllabus 2021-‘22
M.Sc. Zoology Programme - III Semester
Theory Syllabus - Paper Code Z / 110
DEVELOPMENTAL BIOLOGY
(With effect from 2021- ’22 admitted batch)

Hours per week: 4 Semester End Examination: 80Marks
Credits: 4 Internals: 20Marks

Course Objectives:
CO 1. To impart knowledge on basic concepts of development
CO 2. To learn about gametogenesis, fertilization & early development
CO 3. To have knowledge on morphogenesis and organogenesis
CO 4. To know about the advanced technologies
CO 5. To gain knowledge on assisted reproduction technologies & contraceptive measures

	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	√	√	√	√	√
PO 2	√	√	√	√	√
PO 3					
PO 4					
PO 5					
PO 6	√	√	√	√	√
PO 7	√	√	√	√	√
PO 8					
PO 9					

UNIT – I

1.1 Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

1.2 Heterogamy in eukaryotes.

1.3 Comparative account of differentiation of gonads in a mammal and an invertebrate (Snail).

UNIT - II

2.1 Production of gametes – Spermatogenesis, Spermiogenesis (Sperm structure, Semen composition and formation; assessment of sperm functions), Oogenesis and Vitellogenesis (Ovarian follicular growth and differentiation) cell surface molecules in sperm - egg recognition in mammals (Rodents), Acrosomal reaction, zygote formation.

2.2 Fertilization - Pre-fertilization, Biochemistry of fertilization, Post-fertilization

2.3 Cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, embryogenesis.

UNIT – III

3.1 Cell aggregation and differentiation in Dictyostelium, Axes and pattern formation in Drosophila, amphibia and chick.

3.2 Organogenesis – vulva formation in Caenorhabditiselegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons,

3.3 Post embryonic development - larval formation, metamorphosis; environmental regulation

of normal development; sex determination.

UNIT – IV

4.1 Collection and cryopreservation of gametes and embryos.

4.2Multiple ovulation and embryotransfer technology (MOETT) (Superovulation,In vitro oocyte maturation, In vitrofertilization, embryo transfer).

4.3 Transgenic animals and knockouts: Production & Applications.

4.4 Embryonic stem cells.

UNIT – V

5.1 Assisted reproduction technologies –Ovulation induction- In vitro fertilization- Pre-implantation genetic diagnosis- Mitochondrial replacement therapy- gamete intrafallopian transfer- Reproductive surgery, treating- cryopreservation.

5.2 Embryo sexing and cloning, Screening for geneticdisorders, ICSI, Cloning of animals by nuclear transfer

5.3 Teratological effects of Xenobiotics.

5.4 contraception: Barrier methods- hormonal birth control- intrauterine devices (IUDs) - Surgical sterilization - behavioral methods - Immunocontraception.

Suggested Readings

1. Gilbert, S.F. Developmental Biology. 10th Edition, Sinauer Associated Inc., Massachusetts
2. Balinsky, B.I. Introduction to Embryology. Saunders, Philadelphia
3. Berril, N.J. and Karp, G.Development Biology. McGraw Hill, New York
4. Hamburger V & Hamilton HL. Handbook of chick developmental stages.Saunders Publications.1965.
5. Berril, N.J. and Karp, G.Development Biology. McGraw Hill, New York
6. Stanley Shostak, Embryology - An Introduction to Developmental Biology
7. Muthukaruppan and Pitchappan. Animal development – A laboratory guide.Co-SIP – ULP Publicatiions, India.First Edition, 1979.
8. Austen, C.R. and Short, R.V. Reproduction in animals
9. Schatten and Schatten. Molecular biology of fertilization
10. F.T. Longo. Fertilization, Chapman & Hall
11. R.G. Edwards. Human Reproduction

Student Learning Outcomes:

LO 1: Will master the foundational knowledge that defines the field of developmental biology

LO 2: Will gain the knowledge of main anatomical changes that occur during development

LO3: Will acquire knowledge on advanced technologies in reproductive biology

Syllabus 2021-‘22
M.Sc. Zoology Programme - III Semester
Theory Syllabus - Paper Code Z / 111
AQUACULTURE
(With effect from 2021- ’22 admitted batch)

Hours per week: 4 Semester End Examination: 80Marks
Credits: 4 Internals: 20Marks

Course Objectives:

CO 1. To impart knowledge on basis of aquaculture

CO 2. To learn about construction & management of aquaculture ponds

CO 3. To have knowledge on aquaculture of different shell fish & fin fish

CO 4. To know about the water quality & feed management

CO 5. To gain knowledge on post harvest technology

	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	√	√	√	√	√
PO 2	√	√	√	√	√
PO 3					
PO 4	√	√			
PO 5					
PO 6	√	√	√	√	√
PO 7	√	√	√	√	√
PO 8	√	√	√	√	√
PO 9	√	√	√		√

UNIT – I

1.1 Basis of Aquaculture - General Principles, Scope, Definition, Cultural and Socio-economic basis, Biological and Technological basis. National resources and Aquaculture development.History and Present status of Aquaculture.

1.2 Types of culture systems - Traditional, extensive, semi-intensive and intensive culture, monoculture, polyculture/ composite culture, monosexculture; cage culture, `pen culture, raft culture,race way culture, culture in recirculatory systems, warm water and cold-water aquaculture, sewage fed fish culture.

1.3 Biological characteristics of aquaculture species - Fish seed resources and transportation. Fish seed technology - Natural collection, bundh breeding, induced breeding. Transport of finfish and shellfish- transport of eggs, fry, fingerlings and adults.Fish hatchery.Design and construction of Shellfish hatcheries and management.

1.4 Reproduction and Genetic selection - Reproductive cycles, control of reproduction, preservation of gametes (cryopreservation), use of sex steroids for sex reversal. Genetic selection and Hybridization.

UNIT - II

2.1 Selection of site for aquaculture– Survey and location of suitable site (topography; soil characteristics; acid sulphate soils. Land based and Open water farms. Construction of fresh water & brackish water fish farms.

2.2 Pond preparation and Management - Design and construction of pond layout, construction, water intake system, drainage system. Aeration and aerators, recent advances in aquaculture

engineering, tips for better aquaculture practices.

2.3 Pre stocking Management- Sun drying, ploughing, tilling, desilting, liming, fertilization and eradication of weed fishes, Stocking, Acclimatization of seed and release, species combinations, stocking density and ratio, Maturation section, larval and post larval sections.

2.4 Post Stocking Management- Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms, Specific food consumption, food conversion ratio (FCR), protein efficiency ratio, true net protein utilization, apparent net protein utilization, biological value of protein.

UNIT – III

3.1 Freshwater culture – Indian Major Carps, Catfishes, Murrels and Prawn culture

3.2 Brackish water culture – Grey mullets and milk fish, Sea bass and sea breams, Crabs and Crayfish culture.

3.3 Mariculture - Molluscan culture; Lobster culture, Mussel culture, Pearl oyster culture, Edible oyster culture and Seaweed culture. Ornamental fish culture

3.4 Integrated farming - Paddy cum fish culture and Fish cum Livestock culture.

UNIT - IV

4.1 Hydrology of Ponds- Types of ponds; sources of water: precipitation, direct run off, stream inflow, ground water inflow, regulated inflow. Losses of water: evaporation, seepage, outflow, consumptive use, water budgets of embankment ponds, water budget of an excavated pond, water exchange.

4.2 Water quality management: Physico-chemical factors- Light - Temperature - Turbidity – dissolved oxygen –COD-BOD- pH-alkalinity-salinity- ammonia- hardness- turbidity.

4.3 Feed management: Principles of fish nutrition - Nutritional requirements of commercially important finfish and shellfish. Feed types, feeding techniques and schedules, protein requirements at different ages of finfish and shellfish, wet and dry feeds, Role of probiotics in nutrition.

4.4 Feed formulation and processing-Pulverizer,grinder, mixer, pelletizer, crumbler, drier, extruder/expander, vacuum coater and fat sprayer-Feed storage methods- feeding schedules and ration size- FCR.

UNIT - V

5.1 Post harvest technology: Handling- Storage- curing- battered and breaded products.

5.2 Methods to suppress bacterial growth: Salting- drying- smoking- fermentation- canning-cooling & freezing

5.3 Economics of different kinds of aquaculture and productivity of culture ponds.

5.4 Environmental impact of aquaculture - Aquaculture wastes and future development in waste minimization, environmental consequences of hyper-nutrification, Use of Antibiotics in aquaculture: beneficial and harmful effects.

Suggested Readings

1. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well
2. Scientific Publications.
3. Jhingran, V.G. 1993. Fish and fisheries of India. Hindustan Publishing Corporation, New Delhi.
4. RavishankarPiska, 1999. Fisheries and Aquaculture.Lahari Publications, Hyderabad.

5. Santanam, R., Ramanathan, N. and Jegatheesan, G. 1990. Coastal Aquaculture in India.
6. CBS Publishers & Distributors, Delhi.
7. Bardach, J.E., Ryther, J.H. and McLarney, W.O. 1972. Aquaculture. John Wiley & Sons
8. Inc., USA.
9. Ghosh, S.., Palanisamy, K. and Pathak, S.C. 1994. Shrimp and Freshwater Hatchery Public
10. Relations Division, National Bank for Agriculture and Rural Development, Bombay.
11. Dunham, R. A. Aquaculture and Fisheries Biotechnology Genetic Approaches, CABI
12. Publishing, USA.
13. Mathew Landau. 1995. Introduction to Aquaculture. Daya Publishing House, New Delhi.
14. Chakrabarti, N. M. 1998. Biology, Culture and Production of Indian Major Carps.Narendra
15. Publishing House, New Delhi.
16. Coche, A. G. and J. F. Muir. 1996. Pond Construction and Fresh Water Fish Culture, Pond Farm
17. Structures and Layouts, Simple Methods for Aquaculture. FAO.Daya Publishing House, New Delhi.
18. Wheaton, F. W. 1985. Aquaculture Engineering. MPEDA, Cochin.
19. Upadhyay, A. S. 1995. A Handbook on Design, Construction and Equipment's in Coastal
20. Aquaculture (Shrimp Farming). Daya Publishing House, New Delhi.
21. MPEDA 1990. Aquaculture Engineering and Water Quality Management. Cochin, India.
22. MPEDA, 1991. Handbook on Shrimp Farming, Kochi, India.
23. Aquaculture Practices

Student Learning Outcomes:

LO1: Will be familiar with the methods of planning for aquaculture development

LO 2: Will have knowledge of **construction & management of aquaculture ponds**

LO 3: Will learn about a**quaculture** of different shell fish & fin fish of freshwater and brackish water

LO 4: Will get an understanding of **water quality & feed management**

LO 5: Will be familiar with **post harvest technology**

Syllabus 2021 – 2022

M.Sc. Zoology Programme - III Semester

Theory Syllabus - Paper Code Z / 112

PRINCIPLES OF ECOLOGY & CONSERVATION

Hours per week: 4 **Semester End Examination: 80Marks,**

Credits: 4 **Internals: 20Marks**

Preamble: The course will enable the student the understand the various aspects of ecosystem and its biology. It also helps the student the importance of ecological and biological conservation. It improves students understanding of his immediate environment and his responsibility towards it.

Course Objectives: The successful completion of the Course,

CO 1: Provide students with the scope to develop knowledge base covering all attributes of the environment.

CO 2: Help students to understand the structure and function of an ecosystem, habitat ecology and Ecological niche.

CO 3: Enable them to understand population growth attributes.

CO 4: Develop awareness among the young students about the surrounding environment, the impact of climate change and its mitigation, and biodiversity.

CO 5: Enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with due diligence.

CO 6: Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental concerns of varied dimensions of present times.

CO 7: Provide with a direction and technical capability to carry on lifelong learning and show teamwork and collaborative endeavor, and decision making.

CO 8: Improve the employability including the enhancement of self-employment potential and entrepreneurial aptitude, and fill the technical resource gap especially in the Indian context. CO 9: Help graduates appreciate requirement of framing environmental policy guidelines.

Matrix showing Pos vs COs

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9
PO 1	√	√	√	√	√	√	√	√	√
PO 2		√	√						
PO 3					√				
PO 4					√				
PO 5									
PO 6				√					
PO 7				√					
PO 8				√					√
PO 9									√

Course Content

UNIT – I:

1.1 **Ecology:** Basic concepts, scope, multidisciplinary nature and relevance; Ecosystem concept, organization and significance; Biosphere concept, organization and significance; Cybernetic nature of ecosystems. Ecosystem structure; ecosystem function.

1.2 **Factors affecting ecosystem**: Major environmental factors (biotic and abiotic) influencing organisms in various ecosystems; Concept of limiting factors; Liebig's law of the minimum; Shelford law of tolerance.

1.3 **Habitat and Ecological Niche** – Concept of habitat and niche; niche width and overlap niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

UNIT – II

2.1 **Ecosystem -** Nature of ecosystem, bio- geochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes.

2.2 **Productivity**: Primary productivity; concept, methods of estimation, world patterns of primary productivity and Man's exploitation of primary productivity; Secondary productivity; concept, methods of estimation, world patterns of secondary productivity, and man's exploitation of secondary productivity.

2.3 **Energy flow and trophic dynamics**: Energy flow in ecosystems; Concept of trophic dynamics and trophic cascade; Food chains, food webs and trophic levels; Ecological pyramids; Energy transfer; Ecological efficiencies; Biogeochemical cycles (water, oxygen, carbon, nitrogen, phosphorus and Sulphur) and man's impact.

2.4 **Climate change** - Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations.

UNIT – III:

3.1 **Attributes of population**: Population growth, density; Density dependent and density independent factors; Natality, mortality, biotic potential, carrying capacity; Survivorship and age structure; Seasonal population fluctuation.

3.2 **Population energetics and interactions**: Population energetics; Patterns of population distribution, aggregation and Allee's principle; Isolation; Population interactions: competition (allelopathy), parasitism, predation, herbivory, protocooperation, commensalisms, mutualism.

3.3 **Population growth –** Growth of organisms with non-overlapping generations, exponential growth, Verhulst – Pearl logistic growth model, Stochastic and time lag models of population growth, stable age distribution, population growth projection using Leslie Matrix. Lotka- Volterra equations.

3.4 **Population Regulation-** Extrinsic and Intrinsic Mechanisms: Case studies in population dynamics (examples from fisheries). Ecological Modelling: Fundamentals of constructing models and testing them

UNIT IV

4.1 **Community ecology**: Community concept; Nature of communities; community structure and attributes; levels of species diversity and its measurement. Individualistic and organismic nature of communities; Qualitative and quantitative characters of community; Methods of studying vegetation; Species diversity and its measurement.

4.2 **Life history strategies-** Evolution of life history traits, longevity and theories of ageing, energy apportionment between somatic growth and reproduction, reproductive strategies, optimal body size, r and K selection. Demography construction of Life Tables and their demographic application.

4.3 **Succession and climax**: Types of succession, trends of succession; Models of succession; Mechanisms; Concept of climax community; theories on climax, ecotone and edge effect; Ecotypic differentiation; r and k strategies.

UNIT – V

5.1 **Terrestrial and aquatic communities**: Plant and animal communities in forest, grassland, desert and mangrove ecosystems; High altitude communities; Zonation and stratification of plant and animal communities.

5.2 **Biodiversity & Conservation Biology –** Overview of global environmental change, Biodiversity status monitoring and documentation, Major drivers of biodiversity change.

5.3 **Conservation Biology**: Principles of conservation, major approaches to management, Indian case studies on conservation, management strategy (Project Tiger, Biosphere reserves).

5.4 **Biogeography-** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Faunal diversity and biodiversity Hotspots in India.

Suggested Readings:

1. Koromondy, E.J. Concepts of ecology. Prentice Hall, New Delhi.
2. Clarke, G.L. Elements of Ecology, John Wiley & Sons, New York.
3. Odum, E.P. Fundamentals of Ecology. W.B. Saunders, Philadelphia.
4. Krebs, C.J. Ecology. Harper & Row, New York.
5. Chapman JL and Reiss MJ. 1995. Ecology Principles and Application. Cambridge University Press.
6. Trivedy RK, Goel and Trisa. 1997. Practical methods in Ecology & Environmental Science.
7. Agarwal KC. 1998. Biodiversity. India.
8. Peggy I. Fieldler and Perer M. Kareiva. 1997. Conservation Biology.
9. Prabodh K. Maiti and Paulami Maiti. 2011. Biodiversity: Perception, Peril and Preservation.

Course Learning outcomes:

LO 1: Understand the impact of anthropogenic activities on the environment and their societal duties.

LO 2: Acquire knowledge on the natural resources and their conservation, population growth properties and Species interactions, population strategies and population regulation.

LO 3: Know about community ecology and ecological succession.

LO 4: Develop interest in Biodiversity and Conservation biology.

LO 5: Implement and utilize the acquired knowledge for gaining entry into various NGO organizations to work on the conservation biology and to bring awareness among people on preserving biodiversity.

III SEMESTER
PAPER CODE Z/109
POPULATION GENETICS AND EVOLUTION

LIST OF EXERCISES FOR LABORATORY COURSE

1. Problems based on gene frequency – Hardy Weinberg Law, Calculating gene frequencies and genotype frequencies for autosomal dominant and autosomal recessive traits.
2. Polygenic inheritance – height in men
3. Problems based on multiple alleles – Blood groups, Rh factor
4. Multifactor inheritance – Fingerprint analysis
5. Collection of termites to observe variants
6. Phylogenetic tree construction

III SEMESTER
Paper Code Z/110
DEVELOPMENTAL BIOLOGY

LIST OF EXERCISES FOR LABORATORY COURSE

1. Estimation of shell calcium during the development of chick
2. Observation of spermatozoa in vertebrates
3. Effect of Iodine in the metamorphosis of frog.
4. Section of Testis and Ovary (Human)
5. Preparation of sperm smear from goat testis - Sperm morphology, motility, count
6. Observation of slides/ Models: Cleavage, Morula, Blastula, Gastrula (12, 24, 48,72,96 hrs.)
7. Neurulation slides: Neural plate, Neural fold, Neural tube.
8. Demonstration - Observation of living Chick embryo.
9. Models pertaining to ART (Assisted reproductive techniques), Transgenic techniques. STDs, contraception, teratogenesis.

III SEMESTER

Paper Code Z/ 111

AQUACULTURE

LIST OF EXERCISES FOR LABORATORY COURSE

1. Primary productivity - Estimation by light and dark bottle method
2. Spotters: Cultivable species of finfish and shellfish based on the theory
3. Types of feed and feed preparation.
4. Ponderal index or Condition factor.
5. Design and layout of fresh water and brackish water farms, fish and shrimp hatcheries
6. Visits to aquaculture farms, finfish and shellfish hatcheries.
7. Estimation and calculations of production costs of fish/shrimp farm.
8. Analysis of water: Turbidity, pH, Dissolved oxygen, Alkalinity, BOD, COD.

III SEMESTER

Paper Code Z/112

PRINCIPLES OF ECOLOGY & CONSERVATION

LIST OF EXERCISES FOR LABORATORY COURSE

1. Ecosystem-structure and function-demonstration.
2. Populations interactions - Animal association and communities.
3. Techniques of collection and preservation, mounting, display & indexing.
4. Identification and classification of important invertebrate groups.
5. Enumeration of Plankton.
6. Estimation of Population - Plant/Animal species by quadrant method
7. Diversity indices- Abundance, dominance and Diversity
8. Creation of Life tables

Syllabus 2021-'22
M.Sc. Zoology Programme - IV Semester
Theory Syllabus - Paper Code Z / 113
ENDOCRINOLOGY AND ANIMAL BEHAVIOUR
(With effect from 2021- '22 admitted batch)

Hours per week: 4 Semester End Examination: 80Marks
Credits: 4 Internals: 20Marks

Course Objectives:

CO 1. To impart knowledge on chemical and neural integration

CO 2. To learn about physiology of endocrine glands in vertebrates

CO 3. To have knowledge on neuro-endocrine mechanisms in invertebrates

CO 4. To know about the comparative physiology of vertebrate hormones

CO 5. To gain knowledge on animal behavior

	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	√	√	√	√	√
PO 2					
PO 3	√	√	√	√	
PO 4					
PO 5					
PO 6	√	√	√	√	
PO 7		√		√	√
PO 8	√	√	√	√	√
PO 9			√		√

UNIT-I

1.1 Scope and significance of endocrinology- Concept of neurohormones and neurotransmitters.

1.2 Mechanism of hormone action: Protein Hormones- Membrane receptors- G-proteins and control of adenylatecyclase- Cyclic AMP cascade- Other signal Transduction systems (PLC and PLA pathways)- Steroid hormones

1.3 Hypothalamo-hypophysial System: General organization- Neurohypophysialoctapeptides (Oxytocin and Vasopressin)-Hypophysiotropic hormones: Chemistry- localization and actions.

1.4 Adenohypophysial hormones- Chemistry and physiological roles ofSomatotropin and Prolacin- Glycoprotein hormones (FSH, LH and TSH)- Pro-opiomelanocortin (ACTH, MSH, β-LPH & β-endorphin)- Neural control of adenohypophysis

UNIT – II

2.1 Thyroid Gland- biosynthesis of thyroid hormones- Control of secretion- Physiological roles- Steroid hormone biosynthesis and pathways.

2.2 Testis- Organization- Physiological roles of androgens- Inhibin- Ovary- Organization- Physiological roles of Estrogen, Progesterone and Relaxin- Inhibin.

2.3 Adrenal Cortex- Organization- Control of mineralocorticoid and glucocorticoid secretions- Physiological roles of glucocorticoid and mineralocorticoid- Adrenal Medulla: Catecholamine biosynthesis, release and its physiological roles.

2.4 Role of parathormone: Calcitonin and vitamin D in calcium homeostasis- Endocrine Pancreas: Biosynthesis and physiological actions of Insulin and Glucagon

UNIT – III

2.1 Neuro-endocrine system in invertebrate groups - neuro-endocrine mechanisms of moulting, growth and reproduction in crustaceans & insects-hormonal control of reproduction in Mollusca and Echinodermata.

2.2 Neuroendocrine regulation of reproductive processes & gametogenesis

2.3 Physiological actions of hormones of Parathyroid and Thymus glands.

2.4 Role of endocrinology in health and diseases.

UNIT – IV

3.1 Physiological actions of adrenal medullary hormones - Importance of adrenocortical and adrenomedullary interaction. renin-angiotensin system, hormonal control of water and electrolyte balance, Catecholamine biosynthesis, its storage and release mechanism.

3.2 Evolution of discrete adrenal gland; Synthesis of corticosteroid, structural diversity of glucocorticoids among vertebrates, role of glucocorticoid in gluconeogenesis.

3.3 Comparative aspects of endocrine physiology in vertebrates – Structure and Function of Gastrointestinal hormones or gut hormones; Gastrin family hormones, Secretin glucagon family, GI regulatory peptides - Physiological actions of these hormones.

3.4 Hormones in IVF, pregnancy testing, and Amniocentesis.

Unit – V

4.1 Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks.

4.2 Approaches and methods in study of behaviour; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism.

4.3 Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care;

4.4 Aggressive behaviour; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

Suggested Readings

1. The Physiology of reproduction. E. Knobil& J.D. Neil. 2nd. Lippincott Williams & Wilkins, 2004
2. Endocrinology: Williams. R. H, Foster. D.W, Kronenberg. H.M, Larsen. P. R, Wilson. J. M.
3. Williams, 10th ed. W. B. Saunders Company, 2002.
4. Lehninger's Principle of Biochemistry.: Nelson Cox. 3rd ed. Mac Millan Worth Publ. 2000.
5. Endocrinology: Mac E. Hadely. 5th ed. Pearson Education, 2000.
6. General and comparative Endocrinology: E.J.W. Barington.
7. Comparative Vertebrate Endocrinology: P. J. Bentley.
8. Comparative Endocrinology: A. Gorbman et.al.

Student Learning Outcomes: On completion of this course, students

LO 1.Will be familiar with the mechanism of hormone action

LO 2: Will have knowledge of physiology of vertebrates hormones

LO 3: Will learn about neuro-endocrine mechanisms in invertebrates

LO 4: Will get an understanding of comparative aspects of vertebrate hormones

LO 5: Will be familiar with approaches and methods in study of animal behaviour

Syllabus 2021 – 2022

M.Sc. Zoology Programme - IV Semester

Theory Syllabus - Paper Code Z / 114

PARASITIOLOGY

Hours per week: 4 End **Semester End Examination: 80Marks**

Credits: 4 **Internals: 20Marks**

Preamble: The course on Parasitology has direct application with various parasitic diseases people encounter in their life. Thus, it gives student a through knowledge on the life cycle, pathology, diagnosis and prophylaxis concerned with various helminth and protozoan parasites.

Course Objectives: The successful completion of the course gives,

CO 1: An overview of biological basis of parasitic lifestyles.

CO 2: It includes host responses and parasite evasion of host defense mechanisms.

CO 3: The students are exposed to knowledge on parasites that not only infect humans but also animals.

CO4: It emphasizes on the evolutionary aspect of host-pathogen interactions leading to host specificity.

CO5: The students learn about transmission, epidemiology, diagnosis, clinical manifestations, pathology, treatment and control of major parasites.

CO 6: It includes through knowledge on the major parasitic groups like Helminthes and Protozoans.

CO7: The course has been structured in a way that the students assimilate the classroom knowledge for applied aspects of parasitology and public health.

CO 8: The student gets an insight into immune mechanisms exhibited by parasites present in various habitats and representing different groups.

CO 9: Students will be able to demonstrate a broad and diverse background in parasitology and related subjects and a strong foundation for professional programs of study or employment.

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9
PO 1	√	√	√	√	√	√	√	√	√
PO 2		√							
PO 3			√						
PO 4				√	√			√	
PO 5									
PO 6							√		√
PO 7							√		√
PO 8									√
PO 9									√

Course content:

UNIT – I: Introduction to Parasites

1.1 **Introduction to Parasitology -** Scope of the subject, definition and concept of parasitism and parasites. Types of animal associations, parasite and types of parasitism (Commensalism, Symbiosis, Predaterism, Phoresis and Mutualism). Hyper-parasitism.

1.2 **Types of Hosts**: Final, intermediate, paratenic and reservoir hosts with examples, Vectors, natural and unnatural, host parasite relationship and types of parasites

1.3 **Host-parasite relationship-** Effects of parasitism to their host - Mechanical action. Hosts response to parasitic infection. Specificity of parasites in relation to species, breed, sex of host and location in the host (organ specificity).

1.4 **Factors influencing Pathogenesis –** Host factors and Parasite factors. Mechanisms by which parasites induce pathology. Modes of transmission of parasites and methods of dissemination of infective stages of parasites

UNIT – II: Protozoa and Cestoda

2.1 Salient morphological features of diagnostic importance, life cycle, transmission, pathogenesis, symptoms, epidemiology, diagnosis and general control measures including treatment of: *Entamoeba histolytica, Giardia intestinalis, Trichomonas tenax. Trypanosoma gambiense, T. cruzi. Leishmania donovani, L. tropica, P. vivax, Plasmodium* sps. - their Differential diagnosis and *Toxoplasma gondai*

2.2 Free living amoebae: Hartmanella, Acanthamoeba and Naegleria

2.3 Cestodes: *Diphyllobothrium latum, Taenia solium, T. saginata, Hymenolepis nana, Echinococcus granulosus*

2.4 Classification of Parasitic Protozoans and Cestodes up to families

UNIT-III: Trematoda and Nematoda

3.1 General characters**,** Patterns of Life cycles and larval forms in Digenetic trematodes and Nematodes.

Salient morphological features of diagnostic importance, life cycle, transmission, pathogenesis, symptoms, epidemiology, diagnosis and general control measures including treatment of the following trematodes and nematode parasites.

3.2 **Trematodes-** *Chlonorchis sinensis, Paragonimus westermani, Schistosoma mansoni*. Schistosome species - differential diagnosis

3.3 **Nematodes-** *Ascaris lumbricoides, Enterobius vermicularis, Ancylostoma duodenale, Wuchereria bancrofti, Trichinella spiralis* and *Trichiuris trichiura*.

3.4 Classification of Parasitic Trematodes and Nematodes up to families.

Unit IV. Beyond humans: Parasites of veterinary importance.

4.1 **Parasitic insects, mites and ticks**; parasites of insects and their significance;

4.2 Nematode parasites of plants, morphology, biology, lifecycle and infection of crop plants by major plant parasitic nematodes, host parasite interactions.

4.3. Parasitic adaptations (morphological, anatomical, and larval), Mode of transmission of Parasites. Zoonosis and its significance.

4.4 General principles of control of helmithic diseases by adapting physical, chemical, biological control (Integrated Parasite Control, IPC). International regulations for control of different helminthic diseases

UNIT-V: Immune reactions to Parasitic infections & Pathology

5.1 **Resistance of host to parasitic infections**/infestation. Complete, incomplete age and reverse age resistance.

5.1 **Immunity to parasitic infections (natural and acquired)** Innate Immunity – Physical factors, Chemical and microbial factors, the acute inflammatory response and cell mediated immunity.

5.3 **Adaptive immunity –** Avoiding the host immune response, Depression of the immune System. immunity and immune evasion mechanisms, drug targets, mechanism of drug resistance, vaccine strategies.

5.4 **Immunity to Parasites –** Malarial parasites and Schistosome parasites.

Student Learning outcomes:

LO 1: Demonstrate through tests and on writing assignments an understanding of parasitism, biology behind host- parasite interactions including the diversity of symbiotic associations and their populational and dynamic nature

LO 2: Get acquainted with epidemiological concepts of parasitic infections of global importance, develops familiarity with protozoan and helminth parasites of humans.

LO 3: Understands harmful effects, pathological changes and immunological alterations associated with parasitic infections.

LO 4: Understands the role of vectors as intermediate hosts in parasite transmission and can utilize this knowledge to bring awareness in the society on control strategies.

LO 5: Analyze research challenges in diagnosis, treatment and control of parasitic infections in humans and in veterinary contexts through examination of evidence.

LO 6: Get employability and can undertake research, analyze case studies, interpret data and use evidence to address problems in parasitology, including clinical, public health and biological issues.

Suggested Readings

1. Parasitology: An Integrated Approach by Alan Gunn, Sarah Jane Pitt. Wiley – Blackwell
2. Modern Parasitology: A Textbook of Parasitology by F. E. G. Cox
3. Immunity to Parasites: How Parasitic Infections are Controlled by Derek Wakelin, Cambridge University Press.
4. Parasitic Infections and the Immune System by Felipe Kierzenbaum, Academic Press INC.
5. Manson's Tropical Diseases by Gordon Charles Cook, Alimuddin Zumla, Saunders Elsevier, Elsevier Health Sciences.
6. Parasitology in focus: Facts and trends, Heinz Mehlhorn, Danai Bunnag, Springer-Verlag.
7. General Parasitology by Thomas C. Cheng, Academic Press, College Division.

Syllabus 2021 – 2022

M.Sc. Zoology Programme - IV Semester

Theory Syllabus - Paper Code Z / 115

GENETICS AND MOLECULAR CYTOGENETICS

Preamble: The course will make the student understand the usage of various advanced molecular techniques to understand the distribution of genes and chromosomes. It also enables the student to know genetic defects and the concerned disorders.

Course Objectives:

CO1 Genetics and Molecular Cytogenetics is offered as a course with a view to provide fundamental knowledge on how organisms, populations and species inherit traits.

CO2 Apart from Mendel's laws and basic genetics, at Master's level, this course will provide some of the most incisive analytical approaches that are now being used across the spectrum of the biological disciplines.

CO3 Summarize the principles of inheritance as discovered by Mendel, and show how subsequent genetic research led to the development of linkage analysis.

CO4 Describe the different types of markers used to construct genetic maps, and state how each type of marker is scored.

CO5 Cytogenetics will impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behavior to disease context.

CO6 Student would be able to understand cytogenetic inheritance of various syndromes and their inheritance.

CO7 Overall, this course will highlight extension of Mendelian Genetics, dosage compensation, evolution of the concept of gene, its inheritance in successive generations and its amalgamation with molecular biology and the study of genetic diseases.

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7
PO 1	√	√	√	√	√	√	√
PO 2		√					
PO 3			√				
PO 4			√				
PO 5				√			
PO 6					√		
PO 7					√		
PO 8							√
PO 9							√

Course Content:

UNIT – I Genetics & Concept of gene

1.1 **Concept of gene -** Evolution of gene concept: Mendel to Beadle and Tatum; Complementation test as an operational definition of gene, cistron concept. Fine structure of gene: exons, introns, UTRs; Split genes; pseudogenes; overlapping genes and multi-gene families

1.2 **Mendelian Principles and Extension studies -** Dominance, Segregation, Independent assortment. Allele, multiple alleles, pseudo-alleles. Extensions of Mendelian principles - Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited, and sex influenced characters.

1.3 **Extra chromosomal inheritance -** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

UNIT – II DNA Structure and Chromosome Organisation

2.1 **Molecular Structure of DNA -** A, B, Z and triplex DNA structure, Central dogma, DNA as genetic material; Histones, DNA, nucleosome morphology and higher-level organization. DNA compaction, nucleosome, 10 nm "beads-on-a-string" fibre, nuclear matrix in chromosome organization and function. Repetitive and unique sequence, Satellite DNA, DNase hypersensitive regions, DNA methylation patterns & epigenetic effects.

2.2 **Chromosome organization -** Structure of eukaryotic chromosomes, Metaphase chromosome, centromere, kinetochore, telomere and its maintenance. Heterochromatin and euchromatin; position effect, variegation, functional states of chromatin and alterations in chromatin organization, chromatin remodelling.

2.3 Holocentric chromosomes and supernumerary chromosomes, Giant chromosomes polytene and lamp brush chromosomes, Chromosomal domains (matrix, loop domains) and their functional significance.

UNIT – III Chromosome segregation and Genome mapping

3.1 **Linkage, recombination and crossing over -** Crossing over as a measure of genetic distance, Recombination mapping with two-point and three-point test cross, recombination frequency and genetic map distance, Detection of linkage in experimental organisms: Tetrad analysis in fungi, balancer chromosome technique in Drosophila, centromere mapping in ordered tetrads in Neurospora, cytogenetic mapping in Drosophila, detection of linked loci by pedigree analysis in humans.

3.2 **Regulation of Gene Expression:** General introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels; Regulation of gene activity in *lac* and *trp* operons of *E. coli*.; Chromatin organization and gene expression, transcription factors, enhancers and silencers, non-coding genes.

3.3 Mechanisms of sex determination and Dosage Compensation: Human, *Drosophila* and *C. elegans*.

UNIT – IV

4.1 **Genome mapping strategies:** Overview of genome mapping **- Genetic analysis** with biochemical markers (*Saccharomyces cerevisiae*), DNA markers for genetic mapping - Restriction fragment length polymorphisms (RFLPs), Simple sequence length polymorphisms (SSLPs), Single nucleotide polymorphisms (SNPs), Linkage analysis is the basis of genetic mapping, Gene mapping by human pedigree analysis, Genetic mapping in bacteria.

4.2 Physical Mapping - Restriction mapping, Fluorescent in situ hybridization (FISH), Sequence tagged site (STS) mapping

4.3 Human Genome Project (HGP): Strategies involved, outcome and applications. Ethical, legal and social issues involved (ELSI).

UNIT –V Human Cytogenetics

5.1 **Human genetics** - Human karyotype - Karyotyping, Chromosomal banding and staining Techniques, Chromosomal nomenclature.

5.2 **Chromosomal abnormalities –** Cytogenetic implications (chromosomal non-disjunction), **structural abnormalities**: Deletions, Duplications, Inversion and Translocations. **Numerical abnormalities**: Autosomal and Sex chromosomal syndromes, Sex determination in *Caenorhabditis elegans*, *Drosophila melanogaster* and mammals. Dosage compensation in *Drosophila melanogaster* and mammals.

5.3 Molecular cytogenetic techniques in human chromosome analysis - Spectral karyotyping (SKY); Chromosome Painting; Comparative genomic hybridization (CGH), GISH, FISH, DNA Finger Printing and Flow Cytometry.

Suggested Readings:

1. Concepts of Genetics, Klug WS and Cummings MR – Prentice Hall
2. Genetics: Analysis of Genes and Genomes, Hartle DL and Jones EW – Jones and Bartlett
3. Principles of Genetics, Snustad DP and Simmons MJ – John Wiley & Sons
4. An introduction to Genetic Analysis, Griffith AF et al., - Freeman Genetics, Strickberger MW – Prentice Hall
5. Principles of genetics, Gardner, E.J., M.J.Simmons & D.P.Snustads. John Wiley & sons An introduction to genetic analysis. Griffith, A.J.f., J.H. Miller, D.T. Suziki, R.C. lewontin and W.M. Gellbart. AW.H. Freeman and Company, New York.
6. Molecular Biology of Gene. J. D. Watson, N. h. Hopkins, J. W. /Roberts, J. A. Steitz and M. Weiner. The Benjamin/ Cummings Pub. Co. Inc., California.
7. Genes IX by Lewin, International edition, Oxford University Press, U.K.

Student Learning outcomes:

LO 1: Genetics and Cytogenetics course will open up several avenues for students in terms of research and employability.

LO 2: Summarize the principles of inheritance as discovered by Mendel, and show how subsequent genetic research led to the development of linkage analysis.

LO 3: Genetics has made extensive use of model organisms, many of which will be used to teach this course. By observing genetic mutations in Drosophila, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.

LO 4: Read genome mapping, able to explain why a map is an important aid to genome sequencing, describe the different types of markers used to construct genetic maps, and how each type of marker is scored, explain how linkage analysis is used to construct genetic maps, giving details of how the analysis is carried out in various types of organism, including humans and bacteria.

LO 5: The knowledge acquired can be utilized for employability and research positions in laboratories working on the occurrence of cytogenetic defects responsible for various autosomal and Sex chromosomal syndromes in humans.

Syllabus 2021 – 2022

M.Sc. Zoology Programme - IV Semester

Theory Syllabus - Paper Code Z / 116

BIOTECHNOLOGY AND APPLIED BIOLOGY

Hours per week: 4 **Semester End Examination: 80Marks,**

Credits: 4 **Internals: 20Marks**

Preamble: The course on Biotechnology and Applied Zoology is a practical and skill-based course where the student will get an opportunity to get hands on experience on the usage of various biotechnological tools like PCR, Ultracentrifuge etc. It will also help him to understand various practical applications and commercial applications of the subject zoology.

Course Objectives: The successful completion of the Course, enable the students to

CO 1: To understand concept of rDNA technology and genetic engineering

CO 2: To acquaint the student with the application of recombinant technology

CO 3: To impart knowledge on gene amplification and sequencing techniques

CO 4: Connect the knowledge acquired with its application in the field of health and agriculture

CO 5: Utilize the acquired knowledge for the improvement of animals and crops

CO 6: To understand the role of microbe in fermentation and their industrial usage.

CO 7: To show the student how Bioremediation can be an effective tool for monitoring pollutants present in different habitats.

CO 8: To understand the importance of biosensors and biofertilizers for the management of crops and toxicants.

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 7
PO 1	√	√	√	√	√	√	√	√
PO 2		√	√					
PO 3							√	
PO 4				√				
PO 5					√			
PO 6					√			
PO 7						√		
PO 8								√
PO 9								√

Course Content

UNIT – I Recombinant DNA technology & Genetic engineering

1.1 **Outlines of recombinant DNA technology**. Restriction endonucleases, Isolation of gene fragments using restriction endonucleases, cDNA, PCR, RACE PCR.

1.2 **Cloning vectors** – plasmids, bacteriophages, cosmids, Ti - plasmid. Expression vectors, CRISPR-Cas 9 technology. Construction of gene libraries – cDNA library, genomic library, YAC, BAC library. Cloning strategies – shot gun experiments, cDNA cloning in bacteria. Screening of libraries

1.3 **Chemical synthesis of genes**. Ligation of fragments. RFLP, restriction maps. Mapping genes – chromosomal walking, chromosomal jumping

UNIT –II: Gene Amplification & Sequencing

2.1. Gene Amplification - Basic PCR and its modifications (inverse PCR, anchored PCR, PCR for mutagenesis, asymmetric PCR); Application of PCR in biotechnology and genetic engineering. 2.2 **DNA sequencing methods** - Major landmarks in DNA sequencing - Maxam-Gilbert sequencing, Chain-termination methods, Advanced methods and de novo sequencing, Shotgun sequencing, Next-generation sequencing, Massively Parallel Signature Sequencing (MPSS), Polony sequencing, pyrosequencing, Illumina Solexa) sequencing, SOLiD sequencing, Ion semiconductor sequencing, DNA nanoball sequencing, Heliscope single molecule sequencing, Single molecule real time (SMRT) sequencing.

2.3 Genomics and its application to health and agriculture, including gene therapy.

UNIT – III:

2.1 **Animal Breeding -** Principles, Structure of livestock breeding – poultry, sheep and cattle. Marker - assisted selection. Artificial insemination (AI) techniques, in vitro fertilization. Preservation of endangered species. Germplasm bank.

2.2 **Production of transgenic animals and their applications**: Mice, sheep and fish. Molecular farming and animal cloning.

2.3 **Somatic cell nuclear transfer in humans** – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders.

UNIT – IV: Microbial fermentations

3.1 **Types of fermentation and fermenters** – Solid state and liquid-state (stationary and submerged) fermentations, Microbial growth kinetics in batch, continuous and fed-batch (eg. baker's yeast) fermentation process.

3.2 **Microbial production of industrial products** - Microbial preparation of Tempeh, Miso, Yogurt, Probiotics, Single cell protein. Microbiology and production of alcoholic beverages (wine & beer), organic acids (acetic and gluconic acids), amino acids (glutamic acid, lysine and tryptophan), vitamins (riboflavin and vitamin A) & Enzymes (Protease, Lipase).

UNIT – V: Bioremediation

4.1 **Bioremediation** - Bioremediation using naturally occurring microorganism - removal of spilled oil and grease deposits. Bioremediation using Genetically Engineered Microbes (GEM) – detection of PAHs in the soil, treating oil spills, and for sequestering heavy metals. Bioleaching – Microbial recovery of metals and acid mine drainage.

4.2 **Biosensors** - Biosensor to detect environmental pollutants (In situ bioremediation of both soil and ground water contamination, Bioremediation of contaminated soil and contaminated surface waters (pits, ponds and lagoons). Treatment of toxic wastes before they reach environment, Conservation of soil city wastes, SPCI's strategy on biotreatment.

4.3 **Biofertilizers** – Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizal biofertilizers, bacterial fertilizers. Biopesticides in agricultural production.

Suggested Readings:

1. Principles of Gene manipulation: An Introduction to genetic Engineering. R.V. Old and B. Primrose (Blackwell Scientific Publications).
2. Biotechnology by B. D. Singh (Kalyani).
3. Molecular Biology and Biotechnology by Meyers, RA, A comprehensive Desk reference (VCH Publishers).
4. Biotechnology by U. Satyanarayana (Books & Allied (P) Ltd).
5. Bioethics and Biosafety in Biotechnology by V. Sree Krishna, New Age International Publishers.
6. Elements of Biotechnology by Gupta, P.K. Rastogi Publications.

Student Learning outcomes:

LO 1: Learn how the knowledge of genetic engineering can be utilized for gene manipulation.

LO 2: Learn how Vectors used for rDNA Technology can be designed and utilized.

LO 3: Learn to use PCR and related techniques for gene amplification and diagnosis.

LO 4: Get insight into various DNA sequencing methods and their significance.

LO 5: Understands about animal breeding experiments and production of transgenic animals.

LO 6: Acquires knowledge about types of fermentation and the role of microbes in the production of industrial products, bioremediation, biosensors and biofertilizers.

LO 7: Understands the application of various techniques and can utilize the knowledge for research and employability.

IV SEMESTER
Paper Code Z 113

ENDOCRINOLOGY & ANIMAL BEHAVIOUR

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE

1. Dissection of endocrine glands in a suitable host – Fish, Cockroach, Prawn, Crab, Sepia
2. Determination of insulin level using spectrophotometer
3. Study of slides of endocrine material from different animals - Histological slides pertaining to endocrine glands.
4. Histology of ovary and testes.
5. Study of male and female reproductive systems in some reproductive animals.
6. Identification of chemical structures of peptides and steroid hormones
7. Estimation of hormones in blood
8. Study of Comparative structure of endocrine glands of selected vertebrates and invertebrates.
9. Diagnosis of pregnancy by the presence of HCG in urine (Acheim Zondek test).

IV SEMESTER
Paper Code Z 114

PARASITIOLOGY

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE

1. Smear preparation for protozoa
2. Host examination for collection and preservation, of parasites (trematodes, cestodes and nematodes).
3. Staining, mounting and identification of helminth parasites - Preparation of whole mount.
4. Study of permanent slides: Microscopic examination and taxonomic studies of all representative groups of parasites.
5. Microscopical Examination of blood smears for microfilariae.
6. Examination of fecal samples for parasite eggs.

IV SEMESTER
Paper Code Z 115

GENETICS AND MOLECULAR CYTOGENETICS

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE

1. Numerical problems on basic Genetics.
2. Study the mitotic complement of chromosomes in *Allium cepa*
3. Preparation of polytene chromosome slides from salivary glands of *Drosophila melanogaster*
4. Study of Barr body using buccal smear.
5. Karyotyping of mitotic metaphase chromosomes for cytological characterization ofchromosomes in the genome - Human chromosomes – karyotyping
6. Ideogram preparation of Human chromosome set
7. Numerical and structural abnormalities of human chromosomes- syndromes – Preparation ofkaryotypes.
8. Development of physical linkage maps.

IV SEMESTER
Paper Code Z 116

BIOTECHNOLOGY AND APPLIED BIOLOGY

Project work in the place of practical