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 central universities 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 will be 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. **Chaitanya 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 shortduration. If their past learning outcome in excellent they are fit for doing any job in biomedicalfield.
- 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 carry four 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

Program outcomes (POs):

After successfully completing the M.Sc. Zoology program students will be able to:

PO1. **Zoology knowledge**: Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena and equip with recent advances in Zoology from organismic to reductionist biology.

PO2. **Problem analysis**: It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Reproductive health, Parasitology, Cancer Biology, Microbiome and their ecology, Genetics and Cytogenetics and their roles in health and diseases, etc.

PO3. **Design/development of solutions**: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and ICT tools for understanding of the subject.

PO6. **The Postgraduate and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional practice.

PO7. **Environment and sustainability**: Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates and vertebrates and justify their conservation.

PO8. **Communication**: Communicate effectively on complex life activities with the scientific community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO9. **Project management and finance**: Demonstrate knowledge and understanding of Zoology and management principles and apply these to one's own work, as a member and leader in a project team.

Programme Specific Outcomes (PSOs):

PSO 1. It is expected that a student after successfully completing four semesters of **M.Sc. in Zoology Programme** would sufficiently be skilled and empowered to solve the problems in the realms of Zoology and its allied areas.

PSO 2. They would have plethora of job opportunities in the education, environment, Aquaculture, disease based, and health related sectors.

PSO 3. The bright and ignited mind may enter into research in the contemporary areas of Zoological/ Life Sciences.

PSO 4. The broad skills and the deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the biological sciences.

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 Specific Objectives

- The aim if the study is to discover and describe new biological diversity and equip the student in understanding evolutionary and biogeographic origins and relationships.
- Career options available as interns' natural science managers, park rangers, specimen collector, teachers research-based jobs both in private and public sector as JRF and SRF etc.,

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					

COURSE CONTENT

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.

2.3 Trends 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 Specific Objectives

- A skill-oriented course which will enable the students to arrange and analyse large data sets collected from various sources and infer results based on assumptions.
- The knowledge in bioinformatics helps the students to find employability in biological labs dealing with large biological datas

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 Specific Objectives

- A skill-oriented course where students equip themselves with new methods and techniques for microscopy, chromatography, ultracentrifuge, SEM, TEM etc., which will help in studying fine structure and composition of various organisms
- The knowledge gained may help them to find a placement in some technological labs.

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					

COURSE CONTENT

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 Specific Objectives

- To gain a better picture of the cellular environment with greater understanding of how cellular processes are regulated at the molecular level
- This knowledge helps in finding placement opportunities in research labs, and also in R&D departments of various biological fields

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 101

BIOSYSTEMATICS, BIODIVERSITY AND TAXONOMY

LIST OF EXERCISES FOR LABORATORY COURSE

1. A practical approach towards Biosystematics and taxonomy - Examples representing differenttaxa 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 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 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 ofcolumn 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 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.

Course Specific Objectives

- The course provides an insight in understanding the body's defence mechanism and various immunological alterations leading to infections and diseases.
- The knowledge gained help the student in finding a placement in in scientific and research institutes and disease diagnostic labs as immune-therapists, health care professionals etc.

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

Syllabus 2021-'22

M.Sc. Zoology Programme - II Semester

Theory Syllabus - Paper Code Z / 106

GENERAL AND COMPARATIVE PHYSIOLOGY

(With effect from 2021- '22 admitted batch)

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

Credits: 4 **Internals: 20Marks**

Course Specific Objectives

- Focuses on how organisms survive, work and function and help in understanding how interaction of biological, physical and chemical aspects are necessary for the survival of the organisms.
- Provides placements as a physiologist in fitness centres for health monitoring.

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					

COURSE CONTENT

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 Specific Objectives

- Provides insights into the mechanism on the structure and role of RNA & DNA molecules and their significance
- Molecular biologist finds find opportunities in various molecular biology research labs and R&D departments of various private companies.

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 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 Specific Objectives

- Major objective is to study the cellular processes of living organisms and how these processes relate to the functioning of an organism.
- Help to explore areas where it is very essential to understand the role of these various biomolecules in building the structure and function of the body.

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	√	√	√	√	√

COURSE CONTENT

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 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 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 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 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.