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 – 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 Specific Objectives

- Helps in understanding how and why changes in gene frequencies and genotype frequencies lead to the sudden appearance of disease related recessive alleles in the population.
- To pursue career as geneticist in population study centres and various molecular labs.

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 Specific Objectives

- Aims to provide a thorough understanding on the fundamental concepts of developmental biology and introduce the students to the knowledge on early embryonic development.
- Provides variety of opportunities in career to work in various health care centres.

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					

COURSE CONTENT

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.

4.2 Multiple 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 Specific Objectives

- To study culture of fish, aquatic plants and aquatic animals in three aquatic environments – fresh water, brackish water and marine water.
- Provides job placements in central government agencies as technical officers, assistant directors, project officers and fishery officers.

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	√	√	√		√

COURSE CONTENT

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. 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 aquaculture 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 Specific Objectives

- To study the ecological concepts about ecosystems and ecosystem management.
- Provides placements in Zoological parks, biodiversity parks as wildlife educator & biologists, wildlife enforcement officers, inspectors and forensic specialist.

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 andgenotype 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 Specific Objectives

- Animal behaviour program – encompasses many areas of study including, physiology, anatomy, psychology, neuroscience and more.
- The student may have career opportunities in animal behaviour training and veterinary clinical settings as veterinary assistants, animal care takers at ex-suit conservation centres.

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			√		√

COURSE CONTENT

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

3.1 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.

3.2 Neuroendocrine regulation of reproductive processes & gametogenesis

3.3 Physiological actions of hormones of Parathyroid and Thymus glands.

3.4 Role of endocrinology in health and diseases.

UNIT – IV

4.1 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.

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

4.3 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.

4.4 Hormones in IVF, pregnancy testing, and Amniocentesis.

UNIT – V

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

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

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

5.4 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 MillanWorth 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 Specific Objectives

- Understanding important parasitic diseases, including their life cycles, vectors of transmission, distribution and epidemiology, pathophysiology and clinical manifestations, treatment and prevention and control.
- Help the student to fins a placement as medical parasitologists, veterinary parasitologists, conservation biologists, epidemiologist, and pathologist in various diagnostic centres and labs.

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.

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

C O 4: It emphasizes on the evolutionary aspect of host-pathogen interactions leading to host specificity.

C O 5: 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.

C O 7: 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.

5.2 **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 Specific Objectives

- Student acquires baseline knowledge on the various abnormalities related to the structure, number and function of chromosomes and their significance.
- The knowledge gained may help the students to get placements in medical clinics, educational institutions, government and private job facilities.

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 familie**s**

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.

LO4: 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.

LO5: 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 Specific Objectives

- Designed to equip the students with the practical knowledge of biological techniques and to inculcate in the students an entrepreneurial and problem-solving ability.
- The student may develop career opportunities as biological technicians, food scientists, environmental engineers, pharmaceuticals researchers, rural development and environmental toxicologists.

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 toendocrine 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 andnematodes).
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