

Detailed Syllabus

**M.Sc. –2 Year Semester System
w.e.f 2008-09**



**University of Kalyani
Department of Zoology**

Outline syllabus of M.Sc. Zoology course for 2 year Semester System

I. Course structure:

- A) Core Subjects : Compulsory for all
- B). Optional Subjects: Each student will opt 2 optional subjects (one must be related with his / her Elective paper) out of the courses listed below in each of the 3rd, and 4th semester.
- C) Elective Subjects: Specializations (Optional). Each student has to opt only one elective subject out of six listed in the course for both 3rd and 4th Semesters.

II. Marks and Credit Distribution

	Marks				Credit			
	Theo.	Pract.	Seminar	Total	Theo.	Pract	Seminar	Total
1st Semester	200	100		300	16	8		24
2 nd Semester	200	100		300	16	8		24
3 rd Semester	220	80		300	18	6		24
4 th Semester	200	80	20	300	16	7	1	24
	820	360	20	1200	66	29	1	96

III. Break up of Papers

	Core papers		Optional Papers	Elective Papers		
	Theory Papers X Marks	Practical Papers X Marks	Theory Paper X Marks	Theory Paper X Marks	Practical Paper X Marks	Seminar Paper X Marks
1 st Semester	8 X 25	4 X 25				
2 nd Semester	8 X 25	4 X 25				
3 rd Semester	4 X 25	2 X 25	2 X 20	2 X 40	1 X 30	
4 th Semester	4 X 25	2 X 25	2 X 20	2 X 30	1 X 30	1 X 20

IV. Name and Marks Distribution of Each Paper

FIRST SEMESTER		
Core subjects	Marks	Credit
Theory (ZCT-101 to ZCT-108)		
ZCT-101. Structure and Functions of Non-Chordates	25	2
ZCT-102. Biosystematics and Taxonomy	25	2
ZCT-103. Parasitology	25	2
ZCT-104. Ecology	25	2
ZCT-105. Developmental Biology	25	2
ZCT-106. Animal Physiology	25	2
ZCT-107. Cytogenetics	25	2
ZCT-108. Biochemistry and Metabolic Processes	25	2
Practical (ZCP-101 to ZCP- 104)		
ZCP-101. Non Chordates and Parasitology	25	2
ZCP-102. Biosystematics and Taxonomy and Ecology	25	2
ZCP-103. Biochem. and Metabolic Processes & Animal Physiol.	25	2
ZCP-104. Cytogenetics and Developmental Biology	25	2
Total	300	24

SECOND SEMESTER		
Core subjects	Marks	Credit
Theory (ZCT- 209 to ZCT- 216)		
ZCT-209 Structure and Functions of Chordates	25	2
ZCT-210 Quantitative Biology	25	2
ZCT-211 Environment, Conservation and Biodiversity	25	2
ZCT-212. Insect Organization	25	2
ZCT-213. Cell physiology	25	2
ZCT-214. Immunobiology	25	2
ZCT-215. Human Population Genetics	25	2
ZCT-216. Advanced Parasitology	25	2
Practical (ZCP -205 to ZCP -208)		
ZCP- 205. Chordates and Quantitative Biology	25	2
ZCP-206. Environment, Conservation & Biodiversity and Human Population Genetics	25	2
ZCP-207. Insect organization and Advanced Parasitology	25	2
ZCP- 208. Immunobiology and Cell Physiology	25	2
Total	300	24

THIRD SEMESTER		
	Marks	Credit
Core Subjects - Theory (ZCT- 317 to ZCT- 320)		
ZCT -317. Fish Biology	25	2
ZCT- 318. Arthropods of Economic Importance	25	2
ZCT- 319. Endocrinology	25	2
ZCT- 320. Environmental Toxicology	25	2
Optional (Any two out of six -One must be related with Elective paper) Subjects - Theory (ZOT- 301 to ZOT- 306)		
ZOT- 301. Applied Ichthyology ZOT- 302 Developmental Dynamics ZOT- 303 Forest Entomology ZOT- 304 Human Molecular Genetics ZOT- 305 Medical and Veterinary Parasitology ZOT- 306 Reproductive Biotechnology	20 X 2	4
Elective Subjects - Theory (ZET- 301 to ZET 302)		
ZET- 301. Elective – I	40	3
ZET- 302. Elective - II	40	3
(Any one out of six) Cell and Developmental Biology Cytogenetics and Molecular Biology Endocrinology and Reproductive Physiology Entomology Fish and Fisheries Parasitology		
Core Subjects Practical (ZCP-309 to ZCP- 310)		
ZCP -309. Fish Biology and Endocrinology	25	2
ZCP-310. Arthropods of Economic Importance and Environmental Toxicology	25	2
Elective Subjects Practical (ZEP-301)		
ZEP 301. Cell and Developmental Biology Cytogenetics and Molecular Biology Endocrinology and Reproductive Physiology Entomology Fish and Fisheries Parasitology	30	2
Total	300	24

FOURTH SEMESTER		
	Marks	Credit
Core subjects Theory (ZCT - 421- ZCT 424)		
ZCT - 421 Animal Behavior	25	2
ZCT- 422 Experimental Embryology	25	2
ZCT- 423 Molecular Biology and Biotechnology	25	2
ZCT- 424 Tools & Technique	25	2
Optional (Any two out of six- One must be related with Elective paper) Subjects Theory - (ZOT- 407 to ZOT- 412)		
ZOT- 407. Aquaculture Technology ZOT- 408 Agricultural Entomology ZOT- 409 Applied Parasitology ZOT- 410 Cancer Biology ZOT- 411 Hormone and Signal Transduction ZOT- 412 Medical Embryology	20 X 2	4
Elective Subjects Theory (ZET-403 to ZET-404)		
ZET- 403. Elective – I	30	2
ZET- 404. Elective – II	30	2
(Any one out of six) Cell and Developmental Biology Cytogenetics and Molecular Biology Endocrinology and Reproductive Physiology Entomology Fish and Fisheries Parasitology		
Core Subjects Practical (ZCP-411 to ZCP- 412)		
ZCP-411 Animal Behavior and Mol. Biology & Biotech.	25	2
ZCP- 412 Experimental Embryology and Tools & Techniques	25	2
Elective Subjects Practical (ZEP-402)		
Cell and Developmental Biology Cytogenetics and Molecular Biology Endocrinology and Reproductive Physiology Entomology Fish and Fisheries Parasitology	30	2
Seminar Paper (ZSP 401)		
ZSP- 401. Seminar	20	2
Total	300	24

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF KALYANI DETAILED SYLLABUS

FIRST SEMESTER

Total Marks 300

Total Credit 24

Theory :

8 Core Papers [ZCT- 101 to ZCT-108]

Marks 200

Practical:

4 Papers [ZCP-101 to ZCP-104]

Marks 100

INSTRUCTIONS TO THE PAPER SETTERS

1st Semester :

Full Marks - 25

- Each theory paper is of 25 marks comprising of 4 questions of compulsory nature. It may please be noted that Q. No.1 will be of objective type (short answers, True/False- rewritten type, Fill up blanks etc.) each carrying 1mark.
- Number of questions & division of marks will be as follows:

Q. No. 1.	Total Marks : 5	Five questions: 5 X 1 = 5	No Alternative
Q. No. 2.	Total marks : 4	Two questions: 2X2 = 4	No. of Alternatives : 3
Q. No. 3.	Total marks : 6	Two questions: 2X3 = 6	No. of Alternatives : 3
Q. No. 4.	Total marks : 10	Two questions: 2X5 = 10	No. of Alternatives : 3

- The questions in each paper / unit should be fairly distributed over the whole course in that paper.

CORE PAPERS

ZCT-101. Structure and Function of Non Chordates	Marks 25
	Lectures
1. Cell organelles in protozoa : - Golgi, Mitochondria, Kinetoplast, Pellicle and Cuticle	3
2. Functional morphology of protozoa	2
3. Cell association and cellular differentiation in protozoa	2
4. Larval forms of helminths	2
5. Insect blood : composition, functions, morphology of circulatory system	3
6. Morphology of excretory organs and their function in insects	2
7. Insect flight: structure concerned, functional mechanism.	3
8. Insect visual organs, their structure and functional mechanisms	2
9. Structure and function of sound producing organs in insects, significance of sound production. Uses of sound in plant protection.	3
10. Photogenic organs in insects : structure, mechanism and significance of light production	3

ZCT-102. Biosystematics and Taxonomy	Marks 25
	Lectures
1. Species concept : Evolutionary and biological species concept; difficulties in application of biological species concept.	4
2. Theories of biological classification: classification and phylogeny, types of classification , hierarchic classification; Zoological nomenclature, basic knowledge of naming genus and species.	3
3. Phenetic method of classification, numerical phenetics and numerical taxonomy, preparation of data matrix and similarity matrix using distance method (Manhattan distance and Euclidian distance). Cluster analysis (different methods).	4
4. Cladistic method of classification, difference in the application of phenetic and cladistic classification; cladistic and cladogram, cladistic methods, application of parsimony, cladistic and classification	6
5. Recent trends in taxonomy : Cytotaxonomy, Biochemical taxonomy, immunotaxonomy.	5

ZCT-103. Parasitology	Marks 25
	Lectures
1. Classification of Protozoa and Helminths.	3
2. Mode of transmission of (<i>Plasmodium, Trypanosoma, Piroplasm</i>)	4
3. Zoonosis with particular reference to <i>Toxoplasma, Balantidium, Entamoeba, Schistosoma</i> .	6
4. Microspora: Structure and life history of <i>Nosema bombycis</i> – impact on sericulture.	4
5. Life cycle, biology, pathogenesis, epidemiology and control of important human and veterinary helminthes – <i>Diphyllobothrium latum, Paragonimus westermani, Trichinella spiralis</i> .	4
6. Salient features of plant parasitic nematodes and life cycle patterns of i) <i>Heterodera rostochiensis</i> , ii) <i>Meloidogyne hapla, Anguina tritici</i> .	4

ZCT-104. Ecology	Marks 25
	Lectures
1. The Ecosystem : concept, Gaia hypothesis, cybernetic nature and stability of the ecosystem, ecosystem management and optimization.	6
2. Niche theory : Niche concepts, niche width, niche overlap, niche dynamics.	5
3. Ecological energetics: Law of conservation, The entropy law, concept of productivity and energy subsidy, complexity theory, energy flow model.	5
4. Population attributes : Growth forms and mathematics of growth, Life Table – (Cohort and Static); survivorship curves , generation time, net reproductive rate	9
Life history strategies : Evolution of life history traits, strategies related to longevity; clutch size; life history optimization	

ZCT-105. Developmental Biology	Marks 25
	Lectures
1. Basic concepts in Developmental Biology	1
2. Sex, Gametes and Fertilization:	
i) Germ cell migration	1
ii) Gametogenesis	4
i) Gamete recognition, contact and fertilization, prevention of polyspermy.	3
3. Egg organization: Egg polarity, Mosaic and Regulative egg.	2
4. Axis specification in vertebrates:	5
i) Early patterning in vertebrates – Symmetry breaking, Nieuwkoop center.	
ii) Left- right asymmetry in vertebrates – Asymmetric gene expression	
5. The vertebrate Organizer – The amphibian organizer, Early organizer inducing centers, Organizer’s role, Organizer maintenance.	5
6. Key molecular components:	4
a. Cell adhesion molecules	
b. Extra-cellular matrix components	

ZCT-106. Animal Physiology	Marks 25
	Lectures
1. Basal metabolism, Homeostasis and Stress physiology:	6
a) Concept of homeostasis and homeostatic mechanism	
b) Basic concept of environmental stress and strain	
c) Physiological responses to stress, acclimation and acclimatization	
2. Respiratory function of blood:	5
a) Respiratory pigments – distribution and brief chemistry	
b) Function of hemoglobin-i) in adult and ii) during embryonic life	
c) Environmental influences.	
3. Physiology of muscles:	4
a) Chemical nature of contractile elements	
b) Role of structural and regulatory proteins in muscular contraction	
c) ATP and signal molecules in muscular contraction	
4. Physiology of excretion:	5
Formation of urine: glomerular filtration; tubular function; counter current mechanism and urine formation	
5. Synaptic and junctional transmission;	5
a) Pre-and postsynaptic structure and function	
b) Chemical transmission of synaptic activity	

ZCT-107. Cytogenetics	Marks 25
	Lectures
1. Genome organization in eukaryotes: complexity, pseudogenes; satellite DNA, C-value paradox, molecular organization of chromatin structure;	4
2. Prokaryotic genome; split genes; overlapping genes; super coiling of DNA.	4
3. Eukaryotic cell cycle: cell cycle phases; regulator of cell cycle progression; events of M phase.	5
4. Mitochondrial genome organization: protein import and mitochondrial assembly; peroxisome assembly; function of peroxisome.	6
5. DNA replication: nature, enzymology of replication, replication fork; leading and lagging strands; Okazaki fragments; termination of replication	6

ZCT-108. Biochemistry and Metabolic Processes	Marks 25
	Lectures
1. Proteins: Amino acid composition of proteins. Primary and higher order of proteins. Protein folding and protein stability.	3
2. Bioenergetics and oxidative metabolism:	5
i) Thermodynamic principles and steady-state conditions of living organism; standard free energy change in a reacting system; energy change for ATP hydrolysis.	
ii) Oxidation of glucose and fatty acids (Palmitic Acid) to CO ₂ Gluconeogenesis	
iii) Pentose-phosphate pathway	
3. Amino-acid metabolism:	3
a) Urea Cycle	
b) incorporation of nitrogen into amino-acid	
4. Purine and Pyrimidine nucleotide metabolism	3
a) Structure of nucleotide	
b) Deoxyribonucleotide formation	
5. Biosynthesis of transport of cholesterol	3
6. Enzymes:	4
a). Kinetic analysis of enzyme-catalyzed reaction	
b). Regulation of enzyme activity	
c). Allosteric control of enzyme activity	
7. Brief knowledge of growth factors and their mechanism of action in normal and abnormal cell growth.	2
8. Apoptosis: the concept, mechanism and importance.	2

PRACTICAL – FIRST SEMESTER

CORE PAPERS (ZCP 101- 104)

ZCP-101. Non Chordates and Parasitology	Marks 25
Dissection : 1. Grasshopper : Reproductive; Air sacs 2. Cockroach: Male reproductive 3. Crab : Digestive and Nervous 4. Honey bee: Poison apparatus	9
Parasitology 5. Collection, fixation, staining and preservation of protozoa by wet and dry method. 6. Staining urceolarid ciliate by Kelin’s silver impregnation technique 7. Collection, fixation and preservation of nematodes 8. Collection and preservation of endohelminthes of vertebrates.	9
Laboratory records	3
Viva voce	4

ZCP-102. Biosystematics & Taxonomy and Ecology	Marks 25
Biosystematics & Taxonomy 1. Preparation of materials for taxonomic study: Identification of nematodes 2. Identification, preparation of taxonomic keys and taxonomic studies of insects. 3. Collection, fixation and staining of protozoa for taxonomic study. 4. Spot identification	9
Ecology 5. Determination of Primary Productivity of water 6. Determination orthophosphate of water 7. Determination of organic carbon of soil	9
Laboratory records	3
Viva voce	4

ZCP-103. Biochemistry & Metabolic Processes and Animal Physiology	Marks 25
Biochemistry & Metabolic Processes 1. Action of insulin on blood glucose level in rat 2. Kinetic study of an enzyme – urease, catalase 3. Determination of activity of marker enzyme for liver (Alkaline phosphatase)	9
Animal physiology 4. Blood pressure and pulse rate – Effect of exercise. 5. Estimation of rate of O ₂ consumption, CO ₂ release and RQ in cockroach/mice 6. Determination of activity of amylase.	9
Laboratory records	3
Viva voce	4

ZCP-104. Cytogenetics and Developmental Biology	Marks 25
Cytogenetics 1. Study and identification of meiotic stages of the testicular cells of grasshopper / Chrysocoris 2. Chromosome preparation from mice bone marrow cells- demonstration 3. DNA extraction.	9
Developmental Biology 1. Preparation of Whole mounts of 24 and 48 hrs. Chick/ Koel embryos. 2. Study of serial section of chick embryo of 48 & 72 hrs (emphasis to be given on Brain , Eye, Gut and tail bud region). 3. Identification of different developmental stages of Amphibia.	9
Laboratory records	3
Viva voce	4

Suggested Reading:

Structure and Function of Non Chordates:

Foundations of Parasitology- Roberts and Janovy

Parasitology- Kudo

Parasitology- Noble and Noble

The Insects structure and function- Chapmann

Text book of Entomology- Gillot

Imms' Text Book of Entomology- Richard and Davis

Biosystematics and Taxonomy

Principle of Systematic Zoology- Ernst Mayr and Peter D. Ashlock

Principles of Animal Taxonomy – G.G.Simpson

Principles and Techniques of Contemporary Taxonomy- Donald L.J.Quicke

Parasitology

Parasitology- Kudo

Parasitology- Noble and Noble

Parasitology- Chang

Ecology

Ecology- Molles

Fundamentals of Ecology- Odum

Concepts of Ecology- Karmondy

Developmental Biology

Principles of Development- Wolpert

Developmental Biology- Gilbert

Essential Developmental Biology- Slack

Animal Physiology

Review of Medical Physiology- Ganong

Human Physiology- Fox

Cytogenetics

The Cell – Cooper

The Cell – Alberts

Molecular Biology –Karp

Gene IX- Lewis

Biochemistry and Metabolic Processes

Biochemistry- Voet

Clinical Biochemistry- Beckett

Biochemistry- Campbell

SECOND SEMESTER

Total Marks 300

Total Credit 24

Theory :

1. 8 Core Papers [ZCT-209 to ZCT-216]

Marks 200

Practical

4 Papers [ZCP-205 to ZCP-208]

Marks 100

INSTRUCTIONS TO THE PAPER SETTERS

2nd Semester :

Full Marks - 25

2. Each theory paper is of 25 marks comprising of 4 questions of compulsory nature. It may please be noted that Q. No.1 will be of objective type (short answers, true/false- rewritten type, Fill up blanks etc.) each carrying 1mark.

2. Number of questions & division of marks will be as follows:

Q. No. 1.	Total Marks : 5	Five questions: 5 X 1 = 5	No Alternative
Q. No. 2.	Total marks : 4	Two questions: 2 X 2 = 4	No. of Alternatives : 3
Q. No. 3.	Total marks : 6	Two questions: 2 X 3 = 6	No. of Alternatives : 3
Q. No. 4.	Total marks : 10	Two questions: 2X5 = 10	No. of Alternatives : 3

3. The questions in each paper / unit should be fairly distributed over the whole course in that paper.

THEORY

CORE PAPERS

ZCT-209. Structure and Function of Chordates	Marks 25
2. Feeding: Mechanism of food intake, Cranial Kinesis; Physiology of digestion and regulation of digestive secretion.	7
3. Body fluids and Circulation: Role of somatic muscle in circulation of body fluids; Lymph channel, respiratory pigments of blood, function of hemoglobin.	7
4. Respiration: Respiratory organs (a) aquatic and aerial (b) basic mechanism of ventilation.	5
5. Skeletal System: Comparative account of jaw suspension, limb girdles.	6

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ZCT-210. Quantitative Biology	Marks 25
	Lectures
1. Probability: Definition ; Important terms and concepts ; Mutually exclusive events and the additive rule; Conditional probability events and the Multiplicative Law, independent events ; The Law of “at least one” .	4
2. Probability Distributions: Normal distribution; Binomial distribution; Skewness and Kurtosis.	3
3. Test of Hypothesis & Test of Significance: Formulating the hypothesis; Types of errors in testing hypothesis; Level of significance; Test for one mean and two means.	6
4. Analysis of Variance (ANOVA): Concept of ANOVA; One way and two way lay out.	4
5. Correlation: Types of correlation; Measure of correlation- Scatter diagram, Pearson’s Correlation Coefficient, Spearman’s Rank correlation; Testing of Correlation Coefficient.	5
6. Regression: Types of Regression; Regression equation; Regression Coefficient	3

ZCT-211. Environment, Conservation and Biodiversity	Marks 25
	Lectures
1. Concept of Environment: Structure, radiation balance, climate cycle.	2
2. Anthropogenic impact on environment: Green house gases, global warming, ozone depletion, UN movements on environment.	5
3. Environment and agriculture: Green revolution and its impact on environment, organic farming, participatory approach in agriculture.	4
4. Natural resources: Concept of renewable and non-renewable resources a) Forest as a renewable resource, distribution and structure of tropical rain forest, faunal composition and productivity of tropical rain forest; comparison with temperate forest.	3
b) Wild life: Categories of wild life, threats and risks of extinction; Red data book	2
c) Biodiversity : Concept of Biodiversity, mega-biodiversity countries, hotspot, endemism; biodiversity profile in India,	2
5. Conservation : Objectives and significance of forest and wild life conservation; methods of conservation, biopiracy, Biodiversity Act, PBR, Wild life trade, CITES, biodiversity related international convention, treaties and organizations.	6

ZCT-212. Insect Organization	Marks 25
	Lectures
1. Evolution of insect classification and modern classification of insects	2
2. General organization, segmentation, division of body:	
i) Head and mouthparts in general	2
ii) Thorax and thoracic appendages. Modification of legs and wings.	3
iii) Abdomen and abdominal appendages.	2
3. Integument: Basic structure and functions.	2
4. Digestive organs: Structure and functions; Peritrophic membrane, Filter chamber	4
5. Morphology of respiratory organs and mechanism of respiration	3
6. Morphology of central nervous system.	2
7. Metamorphosis: Basic concept (e.g. House fly),	1
8. Exocrine glands: Lac gland, Wax gland, Silk gland, Labial gland.	4

ZCT-213. Cell Physiology	Marks 25
	Lectures
1) Biomembranes: a) Molecular composition and arrangement of functional consequences.	2
b) Transport across cell membrane-diffusion; carrier bound transport; active transport and pumps; uniport, symport and antiport.	3
2) Mitochondrial electron transport and oxidative phosphorylation.	2
3) Cell-to-cell Signaling: a) Cell surface receptor b) Second messenger system c) MAP kinase pathways	4
4) Cell-to-cell adhesion: a) calcium dependent homophilic and calcium – independent homophilic cell-to-cell adhesion. b) Gap junctions, connexin and related molecules.	5
5) Intracellular protein traffic for secretory and non-secretory cells: protein synthesis, intracellular transport, packaging, storage and release	5
6) Cell cycle:	
a) Cyclins and cyclin-dependent kinases (cdks)	2
b) Regulation of cyclin-dependent kinase activity	2

ZCT-214. Immunobiology	Marks 25
	Lectures
1. Basic concepts of immunology	2
2. Cellular basis of immunity: Innate and Adaptive; Primary and Secondary response.	3
3. The nature of antigen : Haptens, B Lymphocytes, T Lymphocytes	4
4. The Humoral immune response: Structure and assembly of antibodies/immunoglobulin; antibody response and antigen-antibody interactions.	4
5. The Complement system: The classical pathway and the alternative pathway	4
6. Major Histocompatibility Complex: T Cell receptors, MHC genes and gene products	4
7. Vaccination and immunization: Natural and artificial immunization; active immunization, vaccines.	4

ZCT-215. Human Population Genetics	Marks 25
	Lectures
1. Cell and Environment: Effects of radiations and chemicals; DNA repair and retrieval.	5
2. Basic concept of human genetics: Human karyotype; chromosomal abnormalities and human syndromes; molecular aspects of sickle-cell anemia, thalassemia.	6
3. Genetics in practice: Prenatal diagnosis; genetic counseling and gene therapy; amniocentesis technique.	5
4. Molecular population genetics: quantifying genetic variability; estimation of heritability.	5

ZCT-216. Advanced Parasitology	Marks 25
	Lectures

1. Physiology of parasitic amoeba of man.	2
2. Primary Amoebic Meningo-ephalitic causative agent and pathology	3
3. Immunity in human trypanosomiasis	3
4. Physiology, immunopathology of <i>Plasmodium sp.</i> ; immunity of <i>Plasmodium sp.</i> ;	4
5. Smaller <i>Piroplasma, Babesia, Anaplasma Theilerar</i> -Structure and Pathobiology	5
6. Mode of Transmission of pathogenic protozoa by vectors(<i>Plasmodium, Trypanosoma, Piroplasma</i>)	4
7. Immunopathology of helminth disease with reference to schistosomiasis	2
8. Zoonosis with reference to filariasis and schistosomiasis	2

LABORATORY COURSES- SECOND SEMESTER

CORE PAPERS (ZCP - 205 to ZCP - 208)

ZCP-205. Chordates and Quantitative Biology	Marks 25
Dissection of Chordates	7
1. V, VII, IX, Xth Cranial nerves of teleost fish.	
2. Olfactory organs of teleost fish	
3. Accessory respiratory organs of Singhi, Magur, Koi.	
Quantitative Biology	7
4. Fitting of Binomial Distribution.	
5. Test for mean of Univariate & Bivariate distribution.	
6. Test for one way and two way lay out (RBD) design	
7. Analysis of Correlation Coefficient & linear Regression	
Excursion and collection of specimens	4
Laboratory records	3
Viva voce	4

ZCP-206. Environment, Conservation & Biodiversity and Population Genetics	Marks 25
Environmental Biology	9
1. Wastewater analyses: Determination of Hardness and COD of water	
2. Diversity indices from soil and aquatic fauna.	
Population Genetics	9
3. Chromosome aberration, micronuclei, sperm head anomaly study	
Laboratory records	3

Viva voce	4
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ZCP-207. Insect Organization and Advanced Parasitology	Marks 25
Insect Organization	9
1. Mosquito : Head ,mouth parts and wing	
2. Housefly: Head , mouth parts and wing	
3. Honey bee : Pollen basket	
4. Drosophila : Arista	
Advanced Parasitology	
5. Staining and mounting of platyhelminth parasites	
6. Protozoan parasites of freshwater fish and insects of economic importance.	9
7. Identification of some parasitic protozoa.	
Laboratory records	3
Viva voce	4

ZCP-208. Immunobiology and Cell Physiology	Marks 25
Immunobiology	
1. Analysis of blood group A,B,AB, O and Rh factor	9
2. Antigen antibody reaction- immunodiffusion –Ouchterlony plate test	
3. Raising of antibody	
4. Identification of lymphoid organs	
Cell Physiology	9
1. Hemoglobin. and Arneht count of blood.	
2. Determination of acid number of lipids.	
Laboratory records	3
Viva voce	4

Suggested Reading:

Structure and Functions of Chordates

Comparative Anatomy- Weichert

Comparative anatomy of Vertebrates- Kent

The Vertebrate body- Romer

Vertebrate- Young

Quantitative Biology

Biostatistics- N.G.Das

Statistics in Social Sciences - D.Das

Statistics- Sakkal

Statistics step by step- Christensen

Statistics in Biology- McClury

Environment, Conservation and Biodiversity

Ecology- Begon, Herper, Townsend

Insect Organization

Imm's Text book of Entomology- Richards and Davis

Text book of Entomology- Gillot

Insects- Chapman

Cell physiology

The cell – A molecular approach- Cooper and Hansman

Immunobiology

Immunobiology- Todd

Immunology- Gordon

Cellular and Molecular immunology- Abbas

Human Population Genetics

Human genetics- Lewis

Advanced Parasitology

Foundations of parasitology- Roberts & Janovy

Parasitology- Noble and Noble

THIRD SEMESTER

Total Marks 300

Total Credit 24

Theory :

- | | |
|--|-----------|
| 1. 4 Core Papers [ZCT 317 to ZCT 320] | Marks 100 |
| 2. 2 Optional Papers out of [ZOT-301 to ZOT-306] | Marks 40 |
| 3. 2 Elective Papers [ZET-301 to ZET-302] | Marks 80 |

Practical:

- | | |
|---------------------------------------|----------|
| 1. 2 Core Papers [ZCP-309 to ZCP-310] | Marks 50 |
| 2. 1 Elective Paper (ZEP-301) | Marks 30 |

INSTRUCTIONS TO THE PAPER SETTERS

3rd Semester : **(ELECTIVE)** **Full Marks – 40**

1. Each theory **ELECTIVE** paper for unit (s) is of 40 Marks comprising of 4 questions of compulsory nature.
2. Number of questions & division of marks will be as follows:

Q. No. 1.	Total Marks : 10	Five questions: 5 X 2 = 10	No. of Alternatives : 7
Q. No. 2.	Total marks : 9	Three questions: 3 X 3 = 9	No. of Alternatives : 5
Q. No. 3.	Total marks : 8	Two questions: 2 X 4 = 8	No. of Alternatives : 3
Q. No. 4.	Total marks : 13	Two questions: 2 X 6½ = 13	No. of Alternatives : 3

3. The questions in each paper / unit should be fairly distributed over the Whole Course in that paper .

(Core Papers) **Full Marks- 25**

3. Each theory paper is of 25 marks comprising of 4 questions of compulsory nature. It may please be noted that Q. No.1 will be of objective type (short answers, True/False- rewritten type, Fill up blank(s) etc.) each carrying 1 mark.
2. Number of Questions & Division of Marks will be as follows:

Q. No. 1.	Total Marks : 5	Five questions: 5 X 1 = 5	No Alternative
Q. No. 2.	Total marks : 4	Two questions: 2X2 = 4	No. of Alternatives : 3
Q. No. 3.	Total marks : 6	Two questions: 2X3 = 6	No. of Alternatives : 3
Q. No. 4.	Total marks : 10	Two questions: 2X5 = 10	No. of Alternatives : 3

3. The questions in each paper / unit should be fairly distributed over the Whole Course in that paper.

**Instruction to paper setters
(Optional papers)**

Full Marks – 20

1. Each theory optional paper is of 20 marks comprising of 4 questions of compulsory nature. It may please be noted that Q. No.1 will be objective type (short answers, True/False- rewritten type, Fill up blanks etc.) each carrying 1 mark.

2. Number of Questions & Division of Marks will be as follows:

Q. No. 1.	Total Marks : 4	Four questions:4 X 1 = 4	No Alternative
Q. No. 2.	Total marks : 5	Two questions:2X2½ = 5	No. of Alternatives : 3
Q. No. 3.	Total marks : 6	Two questions:2 X3 = 6	No. of Alternatives : 3
Q. No. 4.	Total marks : 5	One question: 1X5 = 5	No. of Alternatives : 2

3. The questions in each paper / unit should be fairly distributed over the whole course in that paper.

THEORY

CORE PAPERS

ZCT- 317. Fish Biology	Marks 25
	Lectures
1. Excretion and osmoregulation in fish.	2
2. Reproduction in fish : reproductive strategies, oviparity, viviparity, ovo-viviparity, parental care, maturity stages, breeding cycle.	5
3. Structure and physiology of endocrine glands in fishes	2
4. Electroreception in fish	2
5. Fish growth: methods of measurement; biochemical methods patterns of growth (absolute, relative, isometric, allometric), condition factor, exogenous and endogenous control.	2
6. Determination of age of fish by scale and hard parts.	5
7. Poisons and venoms in fish.	2
8. Migration of fish : Types, Theories and Significances.	2
	3

ZCT-318. Arthropod of Economic Importance	Marks 25
	Lectures
1. Insect pests:	5
a) Pest fauna (names only) of stored grains.	
b) Morphology, bionomics and control of	
i) Stored rice grain moth (<i>Corcyra cephalonica</i>)	
ii) Stored pulse beetle (<i>Callosobruchus chinensis</i>)	
2. Pest management	2
a) Mechanical; b) Chemical ; c) Biological ; d) Integrated	
3. Lac culture: Life-history of lac insect, culture method, lac processing, lac products, natural enemies of lac insect and their control.	5
4. Sericulture:	5
a) Indigenous races, pure races and commercial races of mulberry silk moth.	
b) Rearing of mulberry silk moth (moriculture excluded)	
5. Parasitic insects and Acarines	
a) General remarks on <i>Phlebotomous</i> , <i>Glossina</i> , <i>Tabanus</i> and head louse in relation to morphology, habit, habitat, life-cycle and disease caused by them, mode of transmission.	4
b) General remarks on ticks in relation to morphology, habitat, life-cycle and diseases caused by them.	4

ZCT-319. Endocrinology	Marks 25
	Lectures
1. Endocrine, paracrine and autocrine system. Hormone trafficking. Feedback system in endocrine regulation. Prohormones and Antihormones.	2
2. Phylogeny of Endocrine Glands: Pituitary and Adrenal.	3
3. Biosynthesis, secretion and regulation of hormones:	6
a). Biosynthesis of protein and peptide hormones (Growth Hormone, and Insulin), Post-translational event and release.	
b). Biosynthesis of steroid hormones and their regulations.	
c). Biosynthesis of T ₃ and T ₄ and their regulation	
4. Neuroendocrine system and neurosecretion	4
a). Neural control of glandular secretion	
b). Hypothalamic pituitary unit	
5. Physiological role of hormones	8
a). Hormonal regulation of mineral metabolism and fluid volume	
b). Pineal gland hormones and their role in photoperiodic response in vertebrates	
c). Hormones and reproduction	
d). Hormones in growth and development	
6. Mechanism of hormone action	2
a). Hormones that acts at the cell surface-properties of the hormones- receptor interaction: cellular mechanism of action.	

ZCT- 320. Environmental Toxicology	Marks 25
	Lectures
Environmental Toxicology	
1. Basic concept of toxicology : Scope, division, toxicants and toxicity, factors, dose- response relationship.	2
2. Toxicity testing : Bioassays, LC50, LD50, ED50, Synergism, Antagonism, Additive Effect	3
3. Toxicants of public health hazards: Pesticides, Heavy metals, Radiation, food and additives	4
4. Toxicokinetics : Absorption, distribution, elimination	4
5. Organ toxicity : Hepato, Nephro, Respiratory, Reproductive.	3
6. Plant Allelochemicals on physiology, development and behaviour of phytophagous insects.	3
7. Resistance of plants against insects: (i) plant signaling chemicals, mechanism of action, chemical signal of bio communication. (ii) defense mechanisms. (iii) anti-insect plant compounds.	4
8. Plant chemicals as bioindicators of plant feeding arthropods to their natural enemies	2

OPTIONAL PAPERS- (ZOT - 301 to ZOT- 306) (One must be related to Elective paper)

ZOT-301. Applied Ichthyology	Marks 20
	Lectures
1. Biology and importance of finfish and shellfish Finfish: Indian major carps, freshwater catfish, oil sardines, Hilsha, Bombay Duck, Trouts, Shellfish: Prawns and shrimps , Crabs and oysters.	5
2. Composition and nutritive value of of fish, fish as source of protein in developing countries.	2
3. Nutrition of fish : Anatomical modification in relation to feeding habits, natural foods, prepared feed, types of feed, feed storage, energy and growth, food conversion ratio and food conversion efficiency.	5
4. Aquaculture methods : concept and significance : Different systems of aquaculture for carps and shrimps : Extensive, Semi-intensive, Intensive,	4
5. Ornamental fish culture : background of ornamental fish culture and trade, classification, culture and breeding of ornamental fish, common diseases and control.	4

ZOT-302. Developmental Dynamics	Marks 20
	Lectures
1. Common features of development : Genomic equivalence; Cloning of animals;	3
2. Developmental processes : Cellular differentiation ; Pattern formation ; Induction; Apoptosis.	4
3. Techniques for the study of development :	3
i) Study of gene expression by biochemical methods	
ii) Study of gene expression by <i>in situ</i> methods	
4. Model organism : <i>Xenopus</i>	5
i) Embryonic development, fate maps	
ii) Experimental methods - for establishing gene product in development	
iii) Regional specification	
iv) Inductive interactions	
5. Stem cells:	5
i) Embryonic stem cells,	
ii) Stem cell niches	
iii) Skin, Intestine, Hematopoietic system	
iv) Mesenchymal stem cells and transdifferentiation	

ZOT -303. Forest Entomology	Marks 20
	Lectures
1. Forest insects (Pests) – damage and sign categories	1
2. Insect pests of Timber yielding trees (Sal - <i>Shorea robusta</i> ; Teak – <i>Tectona grandis</i> ; Mahogany- <i>Swietenia macrophylla</i>) Bionomics and nature of damage of Borers – <i>Haplocerambyx spinicornis</i> , <i>Hypsiphla robusta</i> ; Defoliators – <i>Hapalia machaeralis</i> , <i>Hyblaea puera</i>	7
3. Management of forest insect pest	3
4. Dispersal and migration of forest insects	3
5. Soil insects and their damage to forest plants and their management	3
6. Defensive mechanism against natural enemies	3

ZOT-304. Human Molecular Genetics	Marks 20
	Lectures
1. Structure of human genome: Amount of DNA; single sequence DNA; intermediate DNA and highly repetitive DNA; CpG islands; number size and spacing of human genes; mini-satellite and micro-satellite	12
2. Human genome project and the age of genomics: Brief history; genome sequencing; SNPs; nanomedicine.	8

ZOT-305. Medical and Veterinary Parasitology	Marks 20
	Lectures
1. <i>Leishmania donovani</i> and Leishmaniasis	3
2. Structure, Pathobiology prophylaxis and diagnosis of <i>Babesia</i> , <i>Anaplasma</i> and <i>Theileria</i>	5
3. Generic Differentiation of Intestinal <i>Amoeba</i> of man, <i>Trypanosoma cruzi</i> and Chagas disease, <i>Tricomonas foetus</i> in cattle	5
4. Malarial parasites of man, <i>Eimeria</i> sp., <i>Toxoplasma gondii</i> – outline structure and life cycles.	3
5. Life cycle, biology, pathogenesis, epidemiology and control of important human and veterinary helminthes – <i>Diphyllobothrium lactum</i> , <i>Paragonimus westermani</i> , <i>Trichinella spiralis</i> .	4

ZOT- 306. Reproductive Biotechnology	Marks 20
	Lectures
1. Gametogenesis: Genes and markers associated with gametogenesis	3
2. <i>In vitro</i> gamete maturation	2
3. <i>In vitro</i> fertilization, cryo-preservation and frozen egg transfer, embryo transfer, Intra Cytoplasmic Sperm Injection (ICSI)	3
4. <i>In vitro</i> embryo culture	2
5. Assisted Reproductive technology	3
6. An overview of Cloning techniques	3
7. Gene Replacement and Transgenic Technology	2
8. Gene knock-out model system and their utility	

ELECTIVE PAPERS

ZET-301. ELECTIVE – I	Marks 40
Fish and Fisheries	Lectures
Unit – I	
Inland capture Fisheries Resources of India	
1. Introduction to inland capture fisheries resources; estuarine fisheries with special reference to biology and fluctuation of <i>Tenualosa ilisha</i>	5
2. Fisheries of Lakes and reservoirs: Distribution , commercial exploitation of major freshwater lakes and reservoirs, brackishwater lakes, lagoons and backwaters, problems and management	7
3. Cold water fisheries: Definition, principal zones of cold water fisheries of India, important cold water fisheries of India, food and feeding habit; reproduction and seed resources of Mahaseers	8

<p>Unit-II Limnology</p> <p>1. Limnological characteristics of lentic and lotic water systems, morphoedaphic index</p> <p>2. Biological characteristics of inland waters: common planktonic forms, algal blooms, zooplankton, zoobenthos, significance.</p> <p>3. Biology and culture of some important fish food organisms: Blue green algae, diatoms, rotifers, chironomids, tubifex, brine shrimps.</p>	<p>5</p> <p>7</p> <p>8</p>
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ZET-301. ELECTIVE – I	Marks 40
Cell and Developmental Biology	Lectures
<p>Unit – I Separation & Estimation of macromolecules</p> <p>1. Separation and identification of materials</p> <p> i) Chromatography : Gel chromatography, Ion – exchange Chromatography, Affinity chromatography, High-performance liquid chromatography.</p> <p> ii) Electrophoresis: PAGE, SDS-PAGE, Agarose Gel Electrophoresis of double stranded DNA, Isoelectric Focusing , Immunoelectrophoresis.</p> <p>2. Spectroscopic methods : Colorimetry, Spectrophotometry, Atomic Absorption Spectrophotometry</p> <p>3. Sedimentation : Instrument for Ultra centrifugation, Zonal Centrifugation through Density Gradients.</p> <p>Unit – II Tools & Techniques</p> <p>1. Direct observation:</p> <p> i) Light microscopy, Phase contrast microscopy, Interference Microscopy, Polarization microscopy, Fluorescence Microscopy.</p> <p> ii) Electron microscopy: i) Transmission ii) Scanning</p> <p>2. Fixation & staining:</p> <p> i) Solutions : Definition, Composition, Expression, Ideal & non-ideal Solution</p> <p> ii) Chemical & physical effects of some primary fixatives : Formalin, alcohol, picric acid, acetic acid.</p> <p> iii) Source and chemical composition of some dyes: Basic fuchsin, carmine, hematin, eosin.</p> <p>4. Special application: Finger printing, Southern, Northern &</p>	<p>6</p> <p>4</p> <p>6</p> <p>4</p> <p>5</p> <p>3</p> <p>3</p> <p>3</p> <p>3</p> <p>3</p>

Western transfers.	
ZET-301. ELECTIVE – I	Marks 40
Cytogenetics and Molecular Biology	Lectures
<p>Unit I.</p> <p>Genome organization and gene expression</p> <ol style="list-style-type: none"> 1. Eukaryotic chromosome organization: Packaging of DNA in eukaryotic cell; chromatin structure; histones and nonhistones; nucleosome; higher order structure of chromatin; domains and scaffold; organization of active chromatin and assembly of chromatin during replication. 8 2. Regulation of gene expression: RNA polymerases, promoters, Cis-elements and transacting factors; termination and anti-termination; regulation at transcriptional and translational level; anti-sense RNA. 6 3. Protein folding and processing: Chaperones and folding; enzymes and protein folding, protein cleavage, glycosylation, attachment of lipids. 6 <p style="text-align: center;">Unit II</p> <p>Genome and signaling</p> <ol style="list-style-type: none"> 1. Current development of chromosome banding techniques and SCE. 4 2. Microbial genetics: organization of prokaryotic genome; single stranded DNA phages; RNA phages; cycle and gene expression in SV40 virus; Lytic and lysogenic phage morphogenesis; bacterial conjugation, transduction and transformation. 8 3. Cell signaling: Modes of cell-cell signaling; steroid hormones and steroid hormone superfamily, neurotransmitters; peptide hormones and growth factors; eicosanoids, functions of cell surface receptors; G-protein coupled receptors, tyrosine kinases, cytokine receptors; pathways of intercellular signal transduction , camp, C GMP pathways; Phospholipids and Ca ion, Ras, Raf and MAP kinase pathway, JAK/STAT pathway. 8 	

ZET-301. ELECTIVE – I	Marks 40
Endocrinology and Reproductive Physiology	Lectures
Unit-I	
Hormone chemistry and metabolism	
1. Chemical nature of hormone	2
2. Prohormones and post-transcriptional regulation of peptide hormone production, signal hypothesis	3
3. Hypophysial regulation of steroid hormone biosynthesis and thyroid auto regulation	5
4. Prostaglandin type, chemical nature, biosynthesis and major action	3
5. Hypothalamo-hypophysial unit- structure and mechanism of action of physiologically important neuropeptides	7
a). Vasopressin	
b). Oxytocin	
c). Neuropeptides in the regulation of GH, TSH, Gonadotropin and Prolactin	
Unit-II	
Hormonal control of growth and calcium homeostasis	
1. Physiological action of GH and other hormones regulating growth	3
2. Peptide growth factors: Chemical nature, function and mechanism of action of EGF, IGFs, FGF, TGF- α and TGF- β .	6
3. Hormonal regulation of calcium and phosphate metabolism: Parathyroid gland, related to kidney, bone and intestine; mechanism of action of PTH.	4
4. Calcitonin(CT): chemical nature, site of synthesis and physiological action in calcium metabolism; mode of action of CT .	4
5. Calciferol in the regulation of calcium homeostasis	3

ZET-301. ELECTIVE – I	Marks 40
Parasitology	Lectures
Unit – I	
Classification and General organization	
1. Classification of Apicomplexa	2
2. Origin of parasitic protozoa	2
3. Some general consideration of protozoan parasites:	10
a) Population & Communities	

<ul style="list-style-type: none"> b) Ecological niche c) Temperature and Climate d) Mutualistic intestinal Protozoa <p>4. Arthropods as blood suckers and disease transmitters</p>	6
Unit- II	
Protozoology & Host-parasite interaction	
5. Host-parasite relationship and effect of parasitism in protozoa.	6
6. Parasite -host specificity with reference to protozoan parasites	5
7. Immunity & resistance with reference to protozoan infection	5
8. Leishmaniasis	4

ZET-301. ELECTIVE – I	Marks 40
Entomology	Lectures
Unit I	
Classification and structural organization	
1 Classification up to order in general and up to families of selected orders : Coleoptera, Homoptera, Orthoptera and Hymenoptera; Characters of important families of insects of economic importance.	8
2. Origin of insects: Different theories	
3. Insect fossils:	2
a) Source of evidence:	2
b) Extinct insect orders and their characters:	
4. Origin and Evolution of wings-couplings	
5. Integument: a) Chemical properties, functions;	3
b) Changes during moulting.	3
6. Mechanoreceptors	
7. Chemoreceptors	1
	1
UNIT II :	
Anatomy and physiology	
1. Digestion a) Microorganisms: Types, their role and transmission	6
b) Digestion of special substances;	
c) Nutritional requirements	
2. Structure and function of neuroendocrine system	3
3. Composition of urine, mechanism of excretion through malpighian tubules.	3
4. Pheromones: Source, chemical nature, transmission, perception and application	3
5. Osmoregulation	3

ZET-302. ELECTIVE – II	Marks 40
Fish and Fisheries	Lectures
Unit-I	
Aquaculture	
1. Different systems of aquaculture: Monoculture, polyculture, extensive and intensive fish farming .	4
2. Qualities of culturable and exotic and indigenous fishes.	3
3. Design, criteria and construction of fish farms (carps) : principles of selection, soil characteristics and other parameters	5
4. Preparation and management of ponds for culture: use of chemical fertilizers and organic manures, control of weeds, pests and predators, fish toxicants, control of aquatic insects.	4
5. Fish pathology: Immune system of fish; environment and fish health; fin fish diseases and their control.	4
Unit-II	
Fin fish breeding and biotechnology	
6. Role of pituitary and gonadotropins, natural breeding, environmental control of spawning, natural collection of fish seeds, bundh breeding. b) Induced breeding care of brood fish, secondary sex characters, hypophysation, HCG, pheromones, GnRH, LH-RH and their analogues, new generation drugs, induced breeding and multiple breeding, environmental factors, limitations-inbreeding depressions.	12
7. Concept of biotechnology; biofertilization; bioprocessing and biofiltration in aquaculture; cryopreservation of gamets ; transgenesis	8

ZET-302. ELECTIVE – II	Marks 40
Cell and Developmental Biology	Lectures
Unit – I	
Cell Synchronization	
1. Physiology of cell division: Cell Cycle, synchrony in cell division, inhibition of cell division, source of energy.	6
2. Cell signaling: General principles, role of cell surface receptors in cell signaling.	6
3. Cancer: Characteristics of tumor cells; Oncogenes and their proteins, classification and characteristics of chemical carcinogen; role of radiation and DNA repair in carcinogenesis.	8

Unit – II Neurobiology	
1. Cell –cell adhesion: types of cell binding, adhesive proteins, their role in cell-cell interaction, morphogenesis, differentiation movement of leucocytes into tissues.	8
2. Molecular neuron biology; General organization of nerve fibers, Axon Ultra structure, Neurotubules and neurofilaments.	6
3. Neurosecretary cell : Occurrence, staining behavior, neurosecretion in invertebrates.	6

ZET-302. ELECTIVE – I I	Marks 40
Cytogenetics and Molecular Biology	Lectures
Unit I. Cancer mutagenesis and DNA repair	
1. Cancer monoclonal origin; differences of normal cells and cancer cells; cell transformation and factors for cell proliferation; DNA and RNA tumor viruses; concept of oncogene and their role in cancer; tumor suppressor and apoptotic genes. Chromosomal basis of human cancer	8
2. Mutations and mutagenesis types of mutation; biochemical basis of mutations; mutagenesis; spontaneous and induced mutation; reversion as a means of detecting mutagens and carcinogens.	6
3. DNA repair and retrieval; repair of spontaneous and induced mutations; mechanism of DNA repair; repair by direct reversion; excision repair; SOS response.	6
Unit II	
Human cytogenetics and behavioral genetics	8
1. Human genetics: karyotype and sex chromosomes; sex determination; role of Y-chromosome; sex mosaics; sex chromosome anomalies; influenced alleles; sex limited genes and hormonal influence; haemoglobinopathy; genetic counseling.	8
2. Behavioral genetics influence of single defects on behavior; Genetic analysis of behavior in experimental animals, chromosome anomalies and insight into human behavior.	4
3. Environmental effects and gene expression: effects of external and internal environment; phenocopies; twin studies; concordance and discordance; identical and fraternal twins.	

ZET-302. ELECTIVE – I I	Marks 40
Endocrinology and Reproductive Physiology	Lectures
Unit-I Endocrine techniques	
1. Principles and applications of High Performance Liquid Chromatography (HPLC), Ultra-centrifugation, Ion-exchange chromatography and gel electrophoresis in endocrine research.	7

2. Recombinant DNA technology- its application in endocrine research A). Principles and techniques of Southern, Northern and Western Blotting B). Polymerase Chain reaction (PCR), definition, technique and application 3. Principles of radio-immuno Assay (RIA) and ELISA	7 6
Unit-II	
Molecular Biology of endocrine signaling	
1. Signaling of peptide hormone and epinephrine a). G-protein coupled receptors and their effectors- mechanism of receptor binding, bacterial toxin that modify the G-protein b). Activation of Adenylate-cyclase system	3
2. Receptor Tyrosine kinases (RTKs), Ras and Raf a). Auto-phosphorylation of RTKs b). Role of adapter protein and guanine nucleotide exchange factor in activation of Ras	3 2
3. MAP kinase pathway, multiple MAP kinase pathways.	4
4. Second Messengers and activation of protein kinases A). Protein kinase A B). Protein kinase C C). Calcium-calmodulin signaling D). cGMP	2
5. Signaling of cytokines and growth hormones.	1
6. Ion channel receptor, orphan receptors	2
7. Steroid and thyroid hormone signaling	2
8. Signaling pathway for gene expression by peptide hormones.	1

ZET-302. ELECTIVE – I I	Marks 40
Parasitology	Lectures
Unit-I	
Classification and life cycle	
1. Classification of helminth.	4
2. Origin and evolution of parasitic helminth	4
3. Life cycle pattern in trematoda, cestoda, and nematode	6
4. Biology, pathogenesis and control of : <i>Diphyllobothrium latum</i> , <i>Echinococcus granulosus</i> and <i>Loa loa</i>	6
Unit-II	
Immunoparasitology	
5. Immunity to helminth pattern	4
6. General considerations and specific amplification of DNA probes – Lymphatic filariasis	4
7. Electron transport in parasitic helminth.	6
8. Treatment and prevention of nematode diseases	6

ZET-302. ELECTIVE – I I	Marks 40
Entomology	Lectures

Unit I: Reproduction and Development	
1. Different types of reproduction and accessory reproductive organs.	3
2. Castration, oviposition, factors controlling fertility and fecundity	4
3. Metamorphosis a) Types of metamorphosis, b) Role of hormones in metamorphosis, c) Reversal of metamorphosis, d) Prothetely and metathetely.	6
4. Hormonal control of reproduction	4
5. General idea (Up to the formation of three germinal layers) on embryonic development	3
UNIT II : Insect response and behavior	
1. Parental care: Types; examples.	2
2. Polymorphism: a) Polymorphism and polyphenism; examples from different orders; significance.	3
b) Polymorphism in aphids: significance; factors controlling polymorphism.	3
3. Insect predation and parasitism:	6
a) Prey and host location, B) acceptance, c) manipulation, d) selection and specificity of host/prey.	
4. Insect societies: a) Subsociality and eusociality: b) Evolution of eusociality	3
5. Insect defence: Defence by hiding, secondary lines of defence, mechanical defence; chemical defence (classification, nature and source of chemicals); defence by mimicry; collective defence.	3

PRACTICAL

CORE PAPERS (ZCP - 309 to ZCP- 310)

ZCP-309. Fish Biology and Endocrinology	Marks 25
Fish Biology	9
1. Reproductive system in teleost fishes (Two)	
2. Study of scales and otolith in fish age determination	
3. Dissection of pituitary gland of fish	
4. Histological study of endocrine glands of fish (from prepared slides)	
Endocrinology	9
5. Performance of castration and ovariectomy in rat /mice & effect of castration on accessory reproductive organs.	
6. <i>in vitro</i> study of motility of epididymal spermatozoa.	
7. Evaluation of hypothyroidic stages of rat/ chick comb biopsy.	
Laboratory records	3
Viva- voce	4

ZCP – 310. Arthropods of Economic Importance and Environmental Toxicology	Marks 25
<p>Arthropods of Economic Importance</p> <ol style="list-style-type: none"> 1. Techniques for preparation and identification of insect pests and parasitic arthropods. 2. Identification of pests and their damage symptoms of agricultural crops and stored grains from theoretical course. 3. Identification of arthropod parasites of man and domestic animal from theoretical course. 4. Estimation of pest population and crop losses 5. Sericulture (Mulberry) : Silk worm, silk cocoon. 	9
<p>Environmental Toxicology</p> <ol style="list-style-type: none"> 6. Determination of LC50 / LD50 and 95% Confidence limit of any toxicant to a selected aquatic/ terrestrial organism. 7. Effects of toxicants on blood parameters of fish. 8. Sensitivity test during early life (embryonic) stages. 9. Instrumentation AAS/ HPLC for residue analyses of toxicant 	9
Laboratory records	3
Viva Voce	4

ELECTIVE PAPERS (ZEP 301)

ZEP 301:FISH AND FISHERIES	30
<ol style="list-style-type: none"> 1. Assessment of Field studies (Fish Farm, Market, Co-operative societies etc.) 2. Limnological parameters of water: Organic carbon, Plankton, Algal Bloom, Bottom Biota 3. Preparation of pituitary extracts and induced breeding. 4. Identification of fish 5. Laboratory records 6. Viva Voce 	
ZEP 301: CELL AND DEVELOPMENTAL BIOLOGY	30
<ol style="list-style-type: none"> 1 Separation methods: <ol style="list-style-type: none"> a) Electrophoresis: SDS-PAGE for separation of proteins. b) Agarose gel electrophoresis separation of RNA 2. Methods of measurement (Colorimetric) 	

- i) Estimation of carbohydrates by anthrone method
- ii) Quantitative estimation of glycogen
- iii) Quantitative estimation of proteins by Folin-Lowry method:
 - a) Preparation of standard curve
 - b) Estimation of unknown protein
- 3. Nucleic acid isolation :
 - a) Isolation of RNA and its quantitative measurement
 - b) Isolation of DNA and its quantitative measurement
- 4. Determination of viscosity of unknown solution
- 5. Laboratory records
- 6 Viva-voce

ZEP 301: CYTOGENETICS

30

- 1. Somatic meiotic chromosome preparation of mouse and/or fish by air drying technique and study of chromosome aberration.
- 2. Setting up of genetic crosses and solving genetical problems.
- 3. PCR analysis, RFLP/RAPD- genetic polymorphism (demonstration)
- 4. DNA gel, Southern blot (demonstration)
- 5. Laboratory records
- 6. Viva-voce.

ZEP 301: ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY

30

- 1. Preparation of cryo-cut sections and histochemical demonstration of lipid / cholesterol / 3 β -HSD in adrenal of mammal / bird
- 2. Biochemical assay of 3 β -HSD/ 17 β -HSD / aromatase activity in gonads/adrenal tissue or Estimation of thyroid peroxidase activity
- 3. Chromaffin reaction in the section of adrenal gland of bird.
- 4. Effect of epinephrine on blood glucose levels in rat.
- 5. Demonstration of steroid RIA
- 6. Demonstration of radioreceptor assay/ELISA
- 7. SDS-PAGE for separation of protein
- 8. Assay of protein phosphorylation catalysed by cAMP dependent protein kinase.
- 9. Laboratory records
- 10. Viva-Voce

ZEP 301: ENTOMOLOGY

30

- 1. Dissection: Cockroach (male reproductive, sympathetic), Blue bottle fly (digestive, nervous), Grasshopper (nervous, reproductive), Chrysocoris (digestive, nervous, reproductive), Honey bee (digestive, nervous, reproductive, sting apparatus), wasp (digestive, nervous, sting apparatus), Butterfly (digestive, nervous, reproductive), Housefly (digestive, nervous), Mosquito (digestive). Termite (digestive) (subject to availability of specimens).

2. Mounting: Types of antenna, genitalia, wings, legs, mouth parts, tympanum, internal organ system of available insects.
3. Morphometry: I) use of micrometers, ii) use of camera lucida.
4. Taxonomy: Key preparation and general identification.
 - i) Collection methods: nets, traps, samplings etc.
 - ii) Preparation of different types of taxonomic keys.
 - iii) Determination of phena and taxa.
 - iv) Preparation of diagrams and relationship of taxa (Phenograms, Cladogram, Phylogram).
 - v) Identification of common insect up to family level.

5. Laboratory records

6. Viva-Voce

ZEP 301: PARASITOLOGY

30

1. Standardization of Microscope; Drawings of protozoan to scale: measurements of protozoan specimen.
2. Fixation, staining and identification of a cephaline gregariana of annelid
3. Fixation, staining and identification of cephaline, gregarians of insect.
4. Blood parasites of birds and fishes
5. Myxozoan parasites of fishes.
6. *Trichodinid ciliophorus* of fishes.
7. Coccidia of birds
8. Parasitic ciliates of toads and frogs
9. Disease transmitting arthropod parasites
10. Identification
11. Laboratory records
12. Viva-voce.

Suggested Reading:

Fish Biology

Fish Processing and preservation- Cutting
 Economics Fisheries management- Korlandy
 Freshwater fish culture- Sarkar

Arthropods of Economic Importance

Biotech and insect pest management- Ignacimuthu
 Tropical forest insect pest – Econ. Importance- Nair
 Evolution of the insects- Grimaldi & Engel

Endocrinology

Vertebrate Endocrinology- Norris
 Neurobiology- Mathews

Endocrinology- Voit & Voit
Insect hormones – Novak, V.J.A.

Environmental toxicology
Principles of Environmental Toxicology- Chadwick

FOURTH SEMESTER

Total Marks 300

Total Credit 24

Theory :

- | | |
|--|-----------|
| 1. 4 Core Papers [ZCT421 to ZCT424] | Marks 100 |
| 2. 2 Optional Papers out of [ZOT 407 to ZOT-412] | Marks 40 |
| 3. 2 Elective Papers [ZET-403 to ZET-404] | Marks 60 |
| 4. 1 Seminar Paper | Marks 20 |

Practical:

- | | |
|---------------------------------------|----------|
| 1. 2 Core Papers [ZCP-410 to ZCP-411] | Marks 50 |
| 2. 1 Elective Paper (ZEP-402) | Marks 30 |
| 3. Seminar (ZSP - 401) | Marks 20 |

INSTRUCTIONS TO THE PAPER SETTERS

4th Semester : **(ELECTIVE)** **Full Marks - 30**

- Each theory **ELECTIVE** paper for unit (s) is of 30 marks comprising of 4 questions of compulsory nature.
- Number of questions & division of marks will be as follows:

Q. No. 1.	Total Marks : 8	Four questions: 4 X 2 = 8	No. of Alternatives : 6
Q. No. 2.	Total marks : 5	Two questions: 2 X 2½ = 5	No. of Alternatives : 3
Q. No. 3.	Total marks : 6	Two questions: 2 X 3 = 6	No. of Alternatives : 3
Q. No. 4.	Total marks : 11	Two questions: 2 X 5½ = 11	No. of Alternatives : 3

- The questions in each paper / unit should be fairly distributed over the whole course in that paper .

(Core Papers) **Full Marks- 25**

- Each theory core paper is of 25 marks comprising of 4 questions of compulsory nature. It may please be noted that Q. No.1 will be of objective type (short answers, true/false- rewritten type, Fill up blanks etc.) each carrying 1 mark.
- Number of questions & division of marks will be as follows:

Q. No. 1.	Total Marks : 5	Five questions: 5 X 1 = 5	No Alternative
Q. No. 2.	Total marks : 4	Two questions: 2X2 = 4	No. of Alternatives : 3
Q. No. 3.	Total marks : 6	Two questions: 2X3 = 6	No. of Alternatives : 3
Q. No. 4.	Total marks : 10	Two questions: 2X5 = 10	No. of Alternatives : 3

- The questions in each paper / unit should be fairly distributed over the whole

**Instruction to paper setter
(Optional papers)**

Full Marks – 20

2. Each theory optional paper is of 20 marks comprising of 4 questions of compulsory nature. It may please be noted that Q. No.1 will be objective type (short answers, true/false- rewritten type, Fill up blanks etc.) each carrying 1 mark.
2. Number of questions & division of marks will be as follows:

Q. No. 1.	Total Marks : 4	Four questions:4 X 1 = 4	No Alternative
Q. No. 2.	Total marks : 5	Two questions:2X2½ = 5	No. of Alternatives : 3
Q. No. 3.	Total marks : 6	Two questions:2 X3 = 6	No. of Alternatives : 3
Q. No. 4.	Total marks : 5	One question: 1X5 = 5	No. of Alternatives : 2

3. The questions in each paper / unit should be fairly distributed over the whole course in that paper.

THEORY

CORE PAPERS

ZCT-421. Animal behavior	Marks 25
	Lectures
1. Introduction to animal behavior : History, foundation, approaches and methods	3
2. Learning and memory : Forms of learning, learning and habitat selection – migration, navigation and orientation	5
3. Kinship: Relatedness, inclusive fitness, selfishness, altruism	4
4. Conflict : Sexual selection, aggression, competition dominance, Infanticide.	4
5. Communications: Channels, functions, origin and modification of signal, signal receiving mechanism.	5
6. Evolution of feeding behavior: optimal foraging theory.	4

ZCT- 422. Experimental Embryology	Marks 25
	Lectures
1. General problems of Development: Totipotency, Cloning of animals, Nuclear transfer experiments, Spemann's Experiment.	4
2. Experimental embryology: i) Normal development ii) The fate map iii) Developmental commitment iv) Acquisition of commitment	4
3. Techniques for the study of development: i) Microscopy ii) Microinjection iii) Cell sorting iv) Cell labeling methods	4
4. Proteins during development : Lens crystalline, ontogeny in different groups, Hemoglobin structure, heterogeny.	5
5. Regeneration of missing parts : Distribution of regenerative capacity, Hydra regeneration, Vertebrate limb regeneration, Autotomy.	4
6. Stem cells & Embryo transplantation, Transgenesis.	2
7. Genes in Development: Homeotic genes , HOX genes.	2

ZCT- 423 Molecular Biology and Biotechnology	Marks 25
	Lectures
1. Transcription : Initiation; elongation and termination; RNA polymerases; post transcriptional processing- exons and introns; structural characteristics of different types of RNA	6
2. Regulation of gene expression in pro and eukaryotes	4
3. protein synthesis: Translation ; Post translational changes; signal and leader sequences	4
4. Recombination of DNA technology: Detection and isolation of specific genes restriction enzymes; determination of nucleotide sequence; cloning of genes; cDNA technology; vectors of gene transfer; expression of foreign genes in host.	9
5. Biotechnology: Importance and scope of application.	2

ZCT- 424 Tools and Techniques	Marks 25
	Lectures
1. Techniques for cell study :	
i) Fluorescent microscopy, Phase contrast microscopy, Dark field microscopy	3
ii) Electronic imaging systems- Electron microscopy, TEM vs SEM.	2
2. Cell fractionation methods :	4
i) Preparative ultracentrifugation	
ii) Gradient Centrifugation	
3. Separation of cell constituents:	4
i) Gel filtration chromatography	
ii) Electrophoresis – PAGE, SDS – PAGE (One & Two dimensional).	
4. Spectroscopy : Spectrophotometer, Diode- array, NMR Spectroscopy	6
5. Blotting Methods : Southern, Northern and Western blotting	3
6. Tracer technique and Autoradiography	2
7. Pesticide formulation	1

OPTIONAL PAPERS

ZOT-407. Agricultural Entomology	Marks 20
	Lectures
1. Important insect pests (names only) of : Tea, Vegetables ,Paddy and Sugarcane and damages caused by them	1
2. Basic idea on the methods of insects pest management, their merits and demerits	2
3. Morphology, bionomics and management of :	9
i) Ricebrown plant hopper (<i>Nilaparvata lugens</i>)	
ii) Sugar cane top borer (<i>Scirpophaga nivella</i>)	
iii) Tea mosquito bug (<i>Helopeltis theivora</i>)	
iv) Brinjal fruit and shoot borer (<i>Leucinodes orbonalis</i>)	
4. Plant protection techniques	8

ZOT-408. Aquaculture Technology	Marks 20
	Lectures
I. Stock Improvement Induced breeding and bundh breeding, sex reversal and sterility, Selective breeding, Androgenesis and Gynogenesis, Polyploidy, Hybridization Shell fish reproduction : Endocrine control of reproduction , role of neurotransmitters.	6
II. Non conventional aquaculture technology Raceways and recirculatory system Cages and pen culture Wastewater aquaculture Organic aquaculture	6
III. Coastal aquaculture: Status of coastal aquaculture in India Culture of prawn : major cultivable species, techniques of larval rearing, growout Technology. Culture of shrimp: major cultivable species Reproduction and rearing Growout of shrimp	8

ZOT-409. Cancer Biology	Marks 20
	Lectures
1. Major causes of cancer: carcinogens; chromosome and genetic abnormalities associated with cancer	5
2. Oncogenes and genetic causes of cancer; tumor suppressors and apoptotic genes	5
3. Diagnosis and treatment: Gene therapy; drug delivery problems;	5
4. Concept of nanotechnology and nanomedicine	5

ZOT-410. Hormonal and Signal Transduction	Marks 20
	Lectures
1. Overview of endocrine signaling	2
2. Signaling molecules and cell surface receptors	2
3. Subclasses of nuclear receptor ligand, Nuclear Receptor Signaling Mechanism	4
4. G-protein coupled receptors and their signaling	4
5. Receptor Tyrosine Kinase	2
6. Cytokine Receptor	2

7. MAP kinase pathway, multiple MAP kinase pathway	2
8. Defects in signaling pathway and consequences	2

ZOT-411 Medical Embryology	Marks 20
	Lectures
1. Medical implications : Infertility- Diagnostic infertility, causes of infertility.	2
2. Assisted Reproductive Technologies : Sperm and ova bank; Artificial Insemination donor (AID); <i>in vitro</i> fertilization (IVF), procedures, variations of IVF, Success rates and complications; Gamete Intrafallopian transfer (GIFT), Intracytoplasmic sperm Injection (ICSI), Surrogate mothers.	5
3. Genetic errors of human development- Down syndrome, Fragile X syndrome.	2
4. Future of medicine: Differentiation therapy, gene therapy (<i>Ex Vivo</i> and <i>In vivo</i>), germ line gene therapy.	3
5. Techniques used in Medical Embryology : i) Amniocentesis ii) Chorionic villus sampling iii) Ultrasonography iv) DNA Finger printing	3
6. Developmental toxicity : Principles, Mammalian Embryology overview, Critical periods, Teratogens - non-chemical teratogen; Testing protocol; FDA guidelines for reproduction studies for safety evaluation of drugs; International Conference of Harmonization (ICH) approach.	5

ZOT-412. Parasites and Diseases	Marks 20
	Lectures
1. Malarial parasites of man, <i>Eimeria</i> sp. and coccidiosis in fowl.	4
2. Important Myxozoan genera of fishes – Structure and life history of any <i>Myxobolus</i> sp.	4
3. <i>Balantidium coli</i> and Balantidiasis of man. Important genera of fish parasitic ciliates – <i>Icthyophthirius</i> sp.	4
4. Some common helminthes of freshwater fishes and their life cycle patterns: a) <i>Proteocephalus</i> sp., b) <i>Camallanus</i> sp.	4
5. Structure, Pathobiology prophylaxis and diagnosis of causative agents of filariasis and schistosomiasis.	4

ELECTIVE PAPERS

ZET-403. ELECTIVE – I	Marks 30
Fish and Fisheries	Lectures
Unit-I	
Fishing crafts and gears	
1.Crafts: Terminology of fishing boats; Inland and Marine crafts, types, mechanization of crafts, trawlers, techniques of trawling.	6
2.Gears: Basic knowledge of mesh and knots, fishing gear materials, different types of nets and their operation, Rods and lines.	6
3. Responsible fish harvesting system.	3
Unit-II	
Post harvest technology	
1.Spoilage of fish- microbial changes, changes in amino acids, protein, oil, Breakdown products, rigor mortis.	6
2.Preservation, processing and curing of fish.	6
3.Fish by products.	3

ZET-403. ELECTIVE – I	Marks 30
Cell and Developmental Biology	Lectures
Unit – I	
Paradigm of gene expression	
1. Differential gene expression and differentiation	3
2. Nucleocytoplasmic interaction in	
i) Unicellular organisms	2
ii) In early development; Importance and role of cytoplasm, biochemical evidence for functional state of genome, hybridization experiments, nature of changes in nuclei, cell hybridization and nuclear transplantation experiments	8
3. Biological specificity : Transplantations and rejection	2
Unit – II	
Growth and regeneration	
1. Growth: Definition, Relative growth of parts, growth gradients	3
2. Regeneration: origin of regenerating cells and their potentialities, Field action in regeneration	3
3. Proteins during development:	6
i) Lens crystalline: Classification, ontogeny of crystalline in fish, chick and mammals	
ii) Hemoglobin: structure, heterogeny and ontogeny	
iii) LDH : structure, function, ontogeny, heterogeny, control of isozyme patterns	

4. Statistics in biology : i) Test of hypothesis: Chi- square test, Paired 't' – test ii) Non-parametric tests : Spearman's Rank correlation, Wilcoxon Signed Rank test.	3
ZET-403. ELECTIVE – I	Marks 30
Cytogenetics and Molecular Biology	Lectures
Unit I	
Recombinant DNA technology	
1.Recombinant DNA technology: enzymes used in molecular cloning; cloning vectors; construction, screening and expression of genomic and cDNA libraries; identification of recombinant clones; RFLP and RAPD; gene cloning in eukaryotes; gene transfer in animals and transgenic animals	6
2. Plasmids: plasmid borne genes; plasmid transfer plasmid DNA replication; cosmids	4
3. Application of recombinant technology: In research, medicine, agriculture other commercial and industrial application; application against AIDS	5
Unit II	
Transposons and Extra-nuclear inheritance	
1. Mobile genetic elements: Characteristics of transposable elements in prokaryotes and eukaryotes; AC/DS system in maize; P element in <i>Drosophila</i> ; Salmonella phase variation; retrospoons	8
2. Extra-nuclear inheritance: Streptomycin resistance in chlamydomonus; Kappa particles; criteria for extra-chromosomal inheritance, infectious heredity	7

ZET-403. ELECTIVE – I	Marks 30
Endocrinology and Reproductive Physiology	Lectures
Unit-I	
1. Kinetics of spermatogenesis.	3
2. Hormonal regulation of spermatogenesis	2
3. Suppression of testicular activity by steroidal and non-steroidal agents.	3
4. Role of carbohydrate and lipids in sperm energetics.	3
5. Microscopic anatomy and physiology of the epididymis.	2
6. Biosynthesis and regulation of testosterone.	2
Unit – II	
1. Structural organization of mammalian ovary; physiology, hypothalamic regulation and function.	3
2. Synchrony of ovarian function in relation to the menstrual and estrous cycle ; Hormonal regulation in menstrual and estrous cycle.	3

3. Regulation of ovarian follicular development in primates: follicular growth; factors regulating follicular growth; pattern of follicular atresia; follicular selection and dominance.	3
4. Endocrine role in normal development of breast and lactation.	2
5. Biology of implantation and associated early pregnancy factors in implantation.	2
6. Endocrinology of pregnancy	2

ZET-403. ELECTIVE – I	Marks 30
Parasitology	Lectures
Unit-I Biology of Parasitic Protozoa	
1. Structure and biology of <i>Trichomonus vaginalis</i>	3
2. Structure and biology of <i>Trypanosoma evansi</i> and Surra disease	3
3. Structure, life-cycle, pathology and Control of Myxozoa in fishes and Microspora in insects	3
4. General consideration of amoebae in man	3
5. Coccidia and coccidiosis in birds (with special reference to <i>Eimeria tenella</i>)	3
Unit-II Zoonosis and vector biology	
6. Avian and simian malarial parasites.	3
7. Comparative characterization of human malaria parasites	3
8. Zoonoses with special reference to Balantidiasis and Toxoplasmosis	3
9. Ultrastructure of Trypanosomes	3
10. Structure, biology and control of : Sandfly , anopheles, tick.	3

ZET-403. ELECTIVE – I	Marks 30
Applied Entomology	Lecture
Unit-I Insects of Agricultural and Medical Importance	
1. Morphology, life history and control of major pests of (two of each): Cotton, mango	2
2. Morphology, biology of gall insects (only two sp.) and their control; mechanism of gall formation; significance of gall formation; gall –insects association	3
3. Locust: different sp., their distribution, biology and control	2
4. Role of insects and acarine in transmission of human diseases	2
5. Life history, structures involved and mode of transmission of	3

diseases by the <i>Xenopsylla cheopis</i> .	
6 Medicinal insects.	1
7 Biological note on Dengue (Vector and pathogen); Mode of transmission and symptoms	2
Unit –II	
Insect management	
1. Chemical insecticides: classification, properties, pharmacology and mode of action of some commonly used insecticides.	2
2. Chemosterilants and hormonal analogues	2
3. Fumigants: Chemical nature, properties, toxicity , mode of action, application and operational precautions.	2
4. Biological control : classification, ecological consideration, bioagents, method of bioagent introduction; examples: merits, demerits	3
5. Resistance to insecticides: types, mechanism, solution.	2
6. Antifeedants, attractants, repellents and biopesticides: uses, advantages and disadvantages.	2
7. Integrated pest management: importance; components;phases;method of implementation; Example; merits and demerits	2

ZET-404. ELECTIVE – II	Marks 30
Fish and Fisheries	Lectures
Unit-I	
Marine Fisheries	
1.Survey of marine fisheries: offshore, deep sea, divisions	5
2.Coastal fisheries: Coastal zones, features, EEZ,CRZ.	5
3.Bionomics and production of Sardines, Mackerel, Pomfret and Bombay ducks	5
Unit-II	
Marketing and conservation	
1.Marketing: fish markets in India, strategy, structure, price formation.	5
2.Cooperative societies: principle, organization and function.	4
3.Conservation of fisheries: Declining stock, endangered fish fauna of India, causes of decline, methods of conservation, fisheries act, environment act.	6

ZET-404. ELECTIVE – II	Marks 30
Cell and Developmental Biology	Lectures
Unit – I	
Developmental ramifications	
1. Morphogenesis: Meaning of morphogenesis, morphogenetic processes, cell shape, Cell death, morphogenetic movements, cell sorting, morphogenetic field, regionalization.	7
2. Teratogenesis : Genetic teratology, Environmental teratology, Developmental mechanism, Contribution of teratology to Developmental Biology.	4
3. Ageing : Cellular basis of aging , Causes of aging, Free Radical Theory of Aging , Ageing of connective tissue	4
Unit – II	
Differentiation	
4. Differentiation:	7
i) Processes, determination, induction, competence, mechanism of differentiation.	
ii) Reversibility of differentiated state, criteria for dedifferentiation , metaplasia and transdifferentiation, modulation.	
5. Embryonic adaptations:	4
a. Extra embryonic membranes in birds- structure and physiology	
b. Placenta in eutherian mammals- structure and –physiology	
4. Cartilage:	4
a. Structure, differentiation.	
b. Experimental induction of cartilage and proteoglycan synthesis.	

ZET-404. ELECTIVE – II	Marks 30
Endocrinology and Reproductive Physiology	Lectures
Unit-I	
1. Infertility in males and females and their remedial measures.	3
2. Induction of ovulation and spermeation: Oocyte and sperm maturation substances ; their probable mode of action.	4
3. Role of anti-estrogen and anti-androgen in the induction of ovulation and spermeation.	4
4. Fertility control i) ovulation suppression by oral and injectable steroidal contraceptive ii) use of implants and IUDs.	4
Unit - II	
1. Impacts of temperature, photoperiod and other factors in the growth, development and functions of gonads.	3
2. Role of pineal in the mediation of photothermal effects on reproduction.	3
3. Status of thymus as an endocrine organs : chemical nature and biosynthesis of thymic hormone and their probable role.	2
4. Neuro endocrine-immune interactions: chemical nature and signaling of cytokines; neuron endocrine regulations of immune processes.	4
5. Immunoregulatory effects of some endocrine substances :Glucocorticoids, HCG and neuropeptides	3

ZET-404. ELECTIVE – II	Marks 30
Cytogenetics and Molecular Biology	Lectures
Unit I	
Genomics and Proteomics	
1. An overview of genomics and proteomics	2
2. Structural genomics: High resolution chromosome map-RFLP RAPD, fluorescence in situ hybridization; radiation hybrid mapping ; physical mapping of genomes ; genome sequencing	7
3. Functional genomics: Study of gene interaction by the yeast two hybrid system; study of developmental regulation by using DNA-chips	6
Unit II	
Population genetics	
1. Inbreeding and heterosis: measurement of inbreeding; panmictic index, inbreeding depression; heterosis; theories of heterosis.	4
2. Genetic structure of populations: Fisher’s fundamental theorem of natural selection; genetic variability in natural population; genetic homoeostatis; genetic load and genetic death.	4
3. Speciation and evolution at the molecular level: evolution of proteins and nucleotide sequences; regulatory genes and some evolutionary consequences; molecular evolution in the test tube;	4

evolution of genetic systems. 4. Gene frequencies and equilibrium: gene frequencies ; gene frequencies, gene pool, conservation of gene frequencies.	3
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ZET-404. ELECTIVE – II	Marks 30
Parasitology	Lectures
Unit- I Helminthology	
1. Human lymphatic filariasis and its transmission.	4
2. Structure of scolex in cestodes	4
3. Larval form of helminthes	4
4. Ultra structure of important helminthes cuticle	3
Unit-II Epidemiology and Zoonosis	
5. Epidemiology of Trichonosis, Filaria	4
6. Nematode induced gall and their histopathology.	4
7. Origin and evolution of parasitic helminthes	4
8. Myiasis and Zoonosis	3

ZET-404. ELECTIVE – II	Marks 30
Applied Entomology	Lectures
Unit- I Plant protection and insect host relationship	
1. Plant protection appliances: sprayers and dusters; heir merits and demerits	3
2. Insect and plant diseases: insect as vector , insect borne viruses causing plant diseases; insect vector-plant virus relationship.	3
3. Insect plant interaction: a) mechanism of host selection (host habitat finding, host finding, host recognition; host acceptance); b) role of nutritional component in host selection; c) allelochemicals and host selection; d) role of phytochrome in host selection.	5
4. Co-evolution in insect and plant: types; co-evolution with pollinating insect; mimicry; introduced species; gall formation; significance	4
Unit- II Population, forensic and soil entomology	
1. Principles of population studies : sampling, objectives and practical application.	3

2. Factors controlling population: abiotic (temperature, moisture, rain fall and photoperiodism), biotic (food and natural enemies)	3
3. Forensic entomology: types; importance of medico legal forensic entomology, stages of death; importance of insects in medico criminal investigation; estimation of time of death using insects; common arthropods associated with dead body; application and case study.	3
4. Population study method: intrinsic rate of increase (rm) ; life table construction and its application.	3
5. Soil insects: types; important role of edaphic factors (moisture , temperature and pesticide) on soil insects.	2
6. Insect migration: factors, significance and examples.	1

PRACTICAL

CORE PAPERS (ZCP -411 to ZCP- 412)

ZCP-411. Animal Behavior and Molecular Biology and Biotechnology	Marks 25
Animal Behavior	9
1. Demonstration of behavioral change of fish /chick in relation to toxicant / chemicals.	
2. Study of habituation to light stimulus in the earthworm.	
3. Demonstration of photo tactic response of house fly.	
Molecular Biology and Biotechnology	9
1. Setting up and solving of genetic crosses	
2. Demonstration of human chromosomes and preparation of karyotypes	
3. Demonstration of short term tissue culture.	
4. Identification of meiotic and mitotic stages of mice, Drosophila mutants.	
Laboratory records	3
Viva- voce	4

ZCP-412. Experimental Embryology and Tools & technique	Marks 25
Experimental Embryology	9
4. <i>In vitro</i> culture of chick embryo.	
5. Experimental studies on programmed cell death in chick embryo.	
6. Demonstration of chorio-allantoic grafting	
7. Germ cell identification and staining in mice	
Tools and Technique	9
5. Centrifugation technique: Differential centrifugation for separation of nuclei, cell debris, mitochondria.	
6. Colorimetric estimation of Protein, DNA/RNA	
7. Demonstration of PAGE	
Laboratory records	3
Viva- voce	4

ELECTIVE PAPERS (ZEP 402)

ZEP 402: Fish and Fisheries	30
<ol style="list-style-type: none">1. Physico-chemical analyses of soil: pH and available phosphate2. Gut content analyses of fish3. Feed formulation4. Laboratory records5. Viva Voce	
ZEP 402: Cell and Developmental Biology	30
<ol style="list-style-type: none">1. Study on development of chick embryo2. Examination and submission of slides of chick liver, kidney, testis / ovary, brain of different stages of development.3. Determination of enzyme activity: Effect of pH, Temperature, Substrate concentration and Time (Titration or Colorimetric method).4 Study of proteins during embryonic development.5. Review on recent developments in cell and developmental biology or dissertation work.6. Submission of Laboratory Note Book7. Viva - voce.	
ZEP 402: Cytogenetics	30
<ol style="list-style-type: none">1. Localization of Ag- NORs, C-heterochromatin in mouse chromosomes2. Isolation of membrane proteins from mammalian cells through different chromatographic techniques. Separation of proteins using native and SDS gel electrophoresis.3. Demonstration of ELISA, tissue culture, cancer cell line4. Model scientific paper writing general rules5. Lab Records7. Viva-voce.	
ZEP 402: Endocrinology and Reproductive Biology	30
<ol style="list-style-type: none">1. Bio-assay of LH by OAAD test2. Bioassay of estrogen using uterotrophic vaginal response or Analysis of ovarian / adrenal lipids by TLC3. Protein synthesis as a prerequisite for E₂-induced initiation of estrous cycle.4. Oocyte maturation in fish using germinal vesicle breakdown test by the induction of maturation-inducing steroid	

5. Determination of the stages of spermatogenesis in rat testis by PAS-Haematoxyline technique. or Cyclic changes in the exfoliate cytology of vaginal epithelium in rat

6. Examination and submission of slide testis, ovary, epididymis, prostate and uterus and seminal vesicles

7. Laboratory note book

8. Viva-voce

ZEP 402: Entomology

30

1. Study of field and stored grain insects (at least 10 examples)

2. Ecology:

i) Ecological instruments

ii) Soil insects: a) Methods of extraction b) Sorting of material and their identification c) Plotting of results in tables and diagrams.

iii) Terrestrial insects : a) light trap b) net sweeping c) Aspirator method

iv) Determination of minimum size of a sample and number of samples for an experiment.

v) Estimation of population, frequency, relative density, abundance using Quadrate and Mark and release methods

vi) Determination of Diversity index of a field population.

vii) Estimation of nature of damage and loss of plants and produce.

3. Biology and Life cycle:

i) Insect culture and life cycle studies and experiments

ii) Experimental designing, data analysis and observations.

4. Physiological experiments:

i) Estimation of digestive and other enzymes

ii) Studies on haemocytes.

iii) Determination of chitin.

5. Toxicology: i) Toxicological appliances (Sprayers, dusters etc.)

6. Visits to some Entomological Institutes, Farms and Laboratories.

7. Submission of field reports, Life cycles, specimens.

8. Laboratory Records

9. Viva-Voce.

ZEP 402: Parasitology

30

1. Collection fixation, mounting of different helminth parasites from vertebrate (Nematode, Trematode and Cystode).

2. Collection fixation and mounting of different helminthes (Nematode)

3. Histochemical demonstration of alkaline phosphatase activity in tissues of parasitic helminthes

4. Identification: a) spot b) with reasons

5. Deposition of collected materials and laboratory note book

6. Viva voce

SEMINAR

ZES 401. Seminar

20

- a) A hard copy on topic selected by the concerned teacher to be submitted
- b) Seminar Lecture to be delivered

Suggested Reading:

Animal Behavior

Animal Behavior- Alcock
Animal Behavior- Alan & Dugatin
Animal Behavior-Drichamer
Animal Behavior- Ranga
Animal Behavior-Gundevia

Experimental Embryology

Biological Development- Kalthoff
Principles of Development- Wolpert
Developmental Biology- Gilbert
Basic Principles of Development- Hake

Molecular Biology and Biotechnology

Cell & Mol. Biol- Concepts & Expt.-Karp
Biotechnology- Purohit
Mol. Biotech- Principle & application of Recombinant DNA- Glick & paternack
Biomedical Applications of Nanotechnology- Lavaschour & Pelecky

Tools & Technique

The cell – Karp
Cell- De-Robertis & DeRobertis
Cell Biology- Pollard