

CBCS Four Semester Course of PG Programme for Zoology



**Syllabus
(Session-2017-19)**

**Nilamber-Pitamber University,
Medininagar
Palamu, Jharkhand-822 101**

Department of Zoology, Ranchi university, Ranchi
Syllabus for M.Sc. Zoology (Semester with credit based pattern) w.e.f
2017-19 academic session

Semester wise Distribution of Course
M.Sc. Programme

| Course Structure for M.Sc. Programme | | | |
|---|------------------------------|--------|---------------|
| Semester | Course | Credit | Hrs./Week |
| I | FC (Compulsory) – (FC-1) | 5 | 5 (L) + 1 (T) |
| | Core Course- 1 (CC-1) | 5 | 5 (L) + 1 (T) |
| | Core Course- 2 (CC-2) | 5 | 5 (L) + 1 (T) |
| | Core Course (P)-3 [CC (P)-3] | 5 | 10 |
| II | Elective Course (SE) (EC-1) | 5 | 5(L) + 1 (T) |
| | CC – 4 | 5 | 5(L) + 1 (T) |
| | CC – 5 | 5 | 5(L) + 1 (T) |
| | CC (P) – 6 | 5 | 10 |
| III | CC – 7 | 5 | 5(L) + 1 (T) |
| | CC - 8 | 5 | 5(L) + 1 (T) |
| | Elective (GE/DC) (EC-2) | 5 | 5(L) + 1 (T) |
| | Core Course (P) – 9 | 5 | 10 |
| IV | CC – 10 | 5 | 5(L) + 1 (T) |
| | Elective (GE/DC) (EC-3) | 5 | 5(L) + 1 (T) |
| | EC – 4 (P) | 5 | 5(L) + 1 (T) |
| | Project work | 5 | 10 |

Note :-

- GE - Generic Elective
- DC - Discipline Centric
- EC - Elective Course
- FC - Foundation Course
- CC - Core Course
- (P) - Practical
- ESUE – End semester University Examination
- SIA - Sessional Internal Assesment

Ranchi University, Ranchi
Syllabus for M.Sc. Zoology (Semester with choice based credit pattern)
w.e.f. 2016-2018 academic session.

COURSE STRUCTURE

| M.Sc. Zoology Semester I (ZOOL) | | | | | | | | | |
|---------------------------------|--|-----------------|-----------|--------|--------------------|--|-----------------------------|------------|------------|
| Code | Theory/Practical | Teaching Scheme | | Credit | Examination Scheme | | | Full Marks | Pass Marks |
| | | Theory | Practical | | Hours/ Week | Internal (SLA) 1 hour. | External (ESUE) 3hrs. | | |
| FC – 1 (Compulsory) | Systematics Evolution Bioinformatics | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC – 1 (Core course –1) | Invertebrate structure & Function Quantitative biology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC – 2 (Core course–2) | Biotechniques History & Histochemistry | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC(P) – 3 (Core course P–3) | Practical based on theory papers – CC1 and CC 2 | | ✓ | 5 | 10 | | 80 (Pt.) 20 (viva) | 100 | |
| | TOTAL | Three | one | 20 | 28 | 90 | 310 | 400 | |

A Total of eight questions will be asked in each course in ESUE. Question I will be of short answer type and compulsory. From the rest seven questions, any four are to be answered.

A Total of eight questions will be asked in each course in ESUE. Question I will be of short answer type and compulsory. From the rest seven questions, any four are to be answered.

| M.Sc. Zoology Semester II (ZOOL) | | | | | | | | | |
|----------------------------------|---|-----------------|-----------|--------|--------------------|---|-----------------------|------------|------------|
| Code | Theory/Practical | Teaching Scheme | | Credit | Examination Scheme | | | Full Marks | Pass Marks |
| | | Theory | Practical | | Hours/ Week | Internal (SLA) 1 hour. | External (ESUE) 3hrs. | | |
| EC – 1 (Elective course EC 1) | Cell biology, Molecular biology, Microbiology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC – 4 (Core course-4) | Vertebrate diversity, Ethology classical Genetics | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC – 5 (Core course-5) | Environmental and general vertebrate physiology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC (P) – 6 (Core course P-6) | Practical based on theory papers CC4, CC5 | | ✓ | 5 | 10 | | 80 (Pt.) 20 (viva) | 100 | |
| | TOTAL | Three | one | 20 | 28 | 90 | 310 | 400 | |

A Total of eight questions will be asked in each course in ESUE. Question I will be of short answer type and compulsory. From the rest seven questions, any four are to be answered.

| M.Sc. Zoology Semester III (ZOOI) | | | | | | | | | |
|-----------------------------------|--|-----------------|-----------|--------|--------------------|--|-----------------------------|------------|------------|
| Code | Theory/Practical | Teaching Scheme | | Credit | Examination Scheme | | | Full Marks | Pass Marks |
| | | Theory | Practical | | Hours/ Week | Internal (SLA) 1 hour. | External (ESUE) 3hrs. | | |
| CC – 7 (Core course-7) | Endocrinology Developmental biology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC – 8 (Core course-8) | Biochemistry Biomolecules and Metabolic regulations immunology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| EC-2 (Elective course-GE/DC) | Fish and fisheries Entomology Ecology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| CC (P) – 9 (Core course P-6) | Practical based on theory papers CC7, CC8 | | ✓ | 5 | 10 | | 80 (Pt.) 20 (viva) | 100 | |
| | TOTAL | Three | one | 20 | 28 | 90 | 310 | 400 | |

A Total of eight questions will be asked in each course in ESUE. Question I will be of short answer type and compulsory. From the rest seven questions, any four are to be answered.

| M.Sc. Zoology Semester IV (ZOOL) | | | | | | | | | |
|--|--|-----------------|------------------|--------|--------------------|--|---|------------|------------|
| Code | Theory/Practical | Teaching Scheme | | Credit | Examination Scheme | | | Full Marks | Pass Marks |
| | | Theory | Practical | | Hours/Week | Internal (SLA) 1 hour. | External (ESUE) 3hrs. | | |
| CC – 10 (Core course–10) | Mammalian Reproductive physiology Biotechnology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| EC – 3 (Elective course- GE/DC) | Fish and Fisheries Entomology Ecology | ✓ | | 5 | 5(L) + 1 (T) | 20 (exam) 05 (assign.) 05 (perform) | 70 | 100 | |
| EC (P) - 4 (Elective course-GE/DC) | Practical based on theory paper EC2 & EC3 | ✓ | | 5 | 5(L) + 1 (T) | | 80 (Pt.) 20 (viva) | 100 | |
| PROJECT WORK | | | ✓ | 5 | 10 | | 80 (ESUE) + 20 (viva) to be conducted by external ans supervisor | 100 | |
| | TOTAL | One | One + Project | 25 | 28 | 60 | 340 | 400 | |

M.Sc. Zoology Semester – I (ZOOL)

FC – 1 Foundation course (Compulsory)

Animal systematics

- Basic concept and nature of taxonomy and Systematics, contribution of systematic to biology
Different types of Classification
Numerical / Phenetic, Cladistic, Evolutionary Systematics (Phylogenetic)
Concept of Cytotaxonomy, Chemical and Molecular Taxonomy
Systemic Hierarchy, names, codes
Operative principles of nomenclature, application of important rules

Evolution

Concept of Evolution, Theories of organic evolution : Neo Darwinism
Synthetic theory of Evolution
Population, Gene frequency, Hardy weinberg's law in genetic stability
Genome evolution – Evolution of Multigene family,
Genetic Drift, Isolation,

Bioinformatics

- Principles of bioinformatics and its application
- Biological databases :
 - Nucleic acid sequence databases
 - Protein sequence databases
 - Protein structure databases
 - Literature database
- Data retrieval systems : Search engines, Entrez
- Molecular sequence analysis software package and tools :
 - BLAST, RasMol,
- Biologist's Workbench – PERL

M.Sc. Zoology Semester I (ZOOL)

CC – 1 (Core Course)

Invertebrate Diversity

- Trochophore larva and Protostomates
- Origin of coelom – Acoela, Pseudocoela, Schizocoela and Enterocoela.
- Deuterostomate groups
- Locomotion : Cilia, Flagella – Protozoa
- Hydrostatic movement – Cnidarian, Annelida and Echinoderm with reference to Locomotion
- Origin of segmentation
- Excretion and Osmoregulation : Osmoregulation in Protozoa
Nephridia and Coelomic System in Annelids
- Excretion in Arthropods
- Respiration : Arthropods, Mollusca
- Concept of Host specificity and Host parasite relationship

Quantitative Biology

Biostatistics: Samples and population, sampling designs

Probability distributions and their properties : Normal, Binomial, Poisson distribution

Hypothesis testing : Non parametric tests and parametric tests

Chi square, G - , T- , f- test, Analysis of variance, Correlation, Regression

Evaluation of Biodiversity indices : Shannon – Weiner index, index of dominance,

Similarity And Dissimilarity index, Association index : 2 x 2 contingency table

M.Sc. Zoology Semester – I (ZOOL)

CC – 2 (Core course)

Biotechniques

Analytical instruments : Spectrophotometer

Spectroscopy – Atomic Absorption, ESR and NMR Spectroscopy, Microscopy and

Cryotechnique – Scanning and Transmission electron microscopes, Fluorescence microscopy

Cryopreservation of cells, tissues and organisms, cryotechnique for microscopy

Separation techniques : different types of chromatography (Paper, TLC, GIC, Ion – exchange and HPLC)

Electrophoresis (Agarose and SDS PAGE)

Centrifugation : Basic Principles, differential and density gradient centrifugation

Immuno – cytochemistry

ELISA

Histology & Histochemistry

Fixation and tissue processing : Types of fixative, Chemistry of fixation and selection of Fixatives, Dehydration, Clearing and embedding Microtomy

Staining of paraffin sections : Principle and methods of staining, Histological stains

Histochemical identification and localization of the following: Glycogen and glycoprotein –

Protein end groups –

Mercury Bromophenol Blue, Ninhydrin – Schiff, Performic acid – Schiff and Per formic acid – Alcain Blue

Lipid moieties – by Sudan Black B method, Sudan III and Sudan IV, Nile Blue Sulphate method

Nucleic acids - DNA and RNA by methyl green pyronin – Y, DNA by Feulgen reaction.

M.Sc. Zoology Semester I (ZOOL)

CC (P) – 3 (Core course P – 3)

Practical based on theory papers CC1 and CC2

Scheme of Examinations

End terms (external) assessment

Exam Duration : 3.00 hrs

Full Marks : 80+20

| <u>ITEMS</u> | <u>MARKS DISTRIBUTION</u> |
|---|---------------------------|
| Anatomical observation | 2 x 5 = 10 |
| Preparation of permanent slide (Whole mount – 1) | 10 |
| Trimming and cutting of paraffin block / Spreading and stretching of paraffin sections/ micrometric measurement of the given sample | 05 |
| Histochemical staining of the material provided | 05 |
| Spotting [slides 05, museum specimens 05] | 10 x 2 = 20 |
| Records and Sessional work | 20 |
| Viva voce | 20 |
| Bio technique | ½ |

List of Practicals

- Invertebrate Diversity
- General anatomy of : Leech/ Prawn / Squilla/ Scorpion/ Aquatic Beetle/ *Mytilus/ Aplysia* / Sea urchin
- Museum specimens : Important representatives of different invertebrate phyla showing peculiarities/ adaptive features/ association/stages
- Specimens of connecting links and living fossils – *limulus, peripatus*
- Specimens showing mimicry and melanism
- Slides of larval stages showing recapitulation of ontogeny (Helminthes, Crustacean)
- Preparation of taxonomic key upto order of the following
 - Coelenterata – *Hydra, Obelia (medusa and polyp), Physalia, Gorgonia, Aurelia, Metridium*
 - Rotifera – *Brachionus*
 - Annelida – *Earthworm, Tubifex, Neries and Heteronereis, Arenicola, Chaetopetrus, Hirudo*
 - Arthropods – *Sacculina on crab, Crab, Prawn, Lepus, Balanus, Butterfly, Water beetle, Cyclops*
 - Mollusca - *Chiton, Pila, Unio, loligo, Sepia, Octopus, Aplysia, Dentalium*
 - Enchinodermata – *Asteria, Echinus, Antedon, Cucumaria, Holothuria*
- Study of the following using permanent slides
 - Trematode, Cestode, Nematode
 - Larval stages in the life cycle of diagenetic trematodes

Biotechniques

Use of Ph meter, wather bath, autoclave, balance, centrifuge, colorimeter, spectrophotometer
Measurement, figure drawing, and photography through microscope
Chromatographic separation of proteins (Paper TLC)
Separation of amino acids, DNA by Gel electrophoresis
Quantitative assessment of Glucose in a test solution by spectrophotometer/ auto-analyzer
Demonstration of P.C.R. Technique

Histology and Histochemistry

Preparation of fixatives for histological and different histochemical staining Paraffin sectioning
Fixation of tissue
Dehydration, clearing and embedding
Trimming and sectioning of paraffin blicks
Stretching and spreading of sections on slides

Preparation of stains for histological and different histochemical staining

Histological staining of paraffin section

Histochemical staining of paraffin section for

carbohydrate moieties using PAS, Alcian blue at different PH
lipids using sudan black B, Sudan III, Sudan IV methods

Bioinformatics

Use of search engines

Use of data bases – Gene Bank, PubmeD.

Demonstration of software package – BLAST and CLUSTUL

M.Sc. Zoology Semester II (ZOOL)

EC – 1 (Elective course – SE)

Cellular and Molecular biology

Biomembranes and cell matrix adhesion

Cell cycle : Mitosis and Meiosis

Protein Synthesis and trafficking

Cell Signalling and Cell – Cell Interaction

Replication : DNA replication, enzymes involved, Telomeric Replication,

Transcription: Mechanism of Transcription, Basic concepts of Transcription
Regulation

Translation : Ribosome, Formation of Initiation Complex. initiation factors and their
Regulation. Translational Proof reading. Translational inhibitors. Post Translational
modification of Protein

Control of Gene Expression in Prokaryotes : Operon.

Control of Gene Expression in Eukaryotes : Conserved Mechanisms in
Transcriptional regulation, Alternative splicing

Gene silencing : By Modification of Histone and DNA, RNA Interference (RNAi) : A
Major Regulatory Mechanism in Eukaryotes.

Microbiology

Pathogenic microbes : HIV, Rabies, Prions, Viroids, H₁N₁

Antibiotics & their mode of action

Vaccine preparation methodology

Environmental Microbiology : Bioremediation, Sewage treatment, Biofertilizers.

M.Sc. Zoology Semester II (ZOOL)

CC – 4 (Core Course)

Vertebrate Diversity

Neomorphic air breathing organs in fish

Electric organ & Electro – Receptors in fishes

Organs of Distance Touch Orientation in fishes

Reproductive adaptations :- Internal fertilization, Viviparity

Paedomorphosis and neoteny

Endocrine control of metamorphosis of the tadpole

Aerodynamics and energetic of flying and gliding in birds

Nest building and Parental care in Birds

Sensory system in birds – Vision, Olfaction, Hearing, Special senses used in
navigation

Dentition in mammals, Aquatic mammals.

Ethology

General concepts of Ethology :

Motivation
Fixed Action Pattern
Sign or key stimulus or releasers
Innate Releasing Mechanism
Action specific energy
Learning of Experience
Imprinting
Physiological Basis
Behavioral genetics
Evolution of Behaviour

Behaviour and its types : Individual and social interaction, Social organization, Innate and learned behavior,

Wildlife behaviour –

Reproductive behaviour –

Orientation in animals – its nature and types

Biological rhythms – occurrence and significance:

Classical Genetics

Extension of Mendelian Principles – Codominance, incomplete dominance, gene interactions, pleiotropy, sex limited and sex influenced characters

Gene mapping – linkage maps, with molecular markers, using somatic cell hybrids

Extra chromosomal inheritance – inheritance of mitochondrial and chloroplast gene

M.Sc. Zoology Semester II (ZOOL)

CC – 5 (Core course)

Environmental Physiology

- Elementary idea of stress and strain

Adaptation

Fundamental mechanisms of adaptation

Physiological responses to exposure to cold, heat, low pressure (hypobaria), high pressure, electromagnetic radiation

- Thermoregulation

Mechanism of thermoregulation in vertebrates

Ectotherms and Endotherms

Endothermy as a high – energy approach to life

Anatomical, Physiological and Behavioral adaptations in endotherms to extreme hot & extreme cold.

- Excretion / Osmoregulation
 - Patterns of excretion, organs of excretion.
 - Physiology of Urine formation.
 - Problems of salt balance in aquatic vertebrates, marine air breathing vertebrates, and terrestrial vertebrates.

General vertebrate physiology

Respiration : Respiratory pigments in animals, Transport of gases

O₂ dissociation curve, Bohr's effect, Root effect

CO₂ transport, CO₂ equilibrium curve, Regulation of acid base balance

Hb and associated diseases : sickle cell Anemia & Thalassemia, Neural and chemical regulation of respiration

Cardio – Vascular System

Contractibility / Motility

Vertebrate Striated Muscle & Its Structure.

Contractile Proteins & mechanism of their contraction

Nervous system

Origin and differentiation of neurons

Electrical potentials of Neurilemma and its molecular basis

Motor neurons in vertebrates

Propagation of impulses along myelinated nerves

Neurotransmitters

Autonomic nervous system

M.Sc. Zoology Semester II (ZOOL)

CC (P)- 6 (core course P – 6)

Practical based on theory papers CC4 & CC5

Scheme of examinations

end term (external) assessment

Exam Duration : 3:00 hrs.

Full Marks : 80 + 20

ITEMS

MARKS DISTRIBUTION

| | |
|---|-----------|
| Anatomical observation | 2x 10= 20 |
| Physiology experiments – 2 | 2x 10= 20 |
| Colorimetric estimation [Protein/ Glucose/ Cholesterol/ Triglyceride/ Na/ K / Mg/ DNA / RNA] – 1 | 20 |
| Records and Sessional work | 20 |
| Viva voce | 20 |

List of Practicals

Vertebrate diversity

Anatomical observation of :

- Accessory respiratory organs in fish – Channa, Heteropneustes, Clarias, Anabus
- Cranial nerves and blood vessels in *Labeo* / *Wallago*
- Flight muscles and air sacs in chick

Museum studies

- Models – Latimeria, *Sphenodon*, Ostrich, different types of beaks and feet in birds, nest of birds,
- Specimens – Petromyzon, Myxine, Electric ray, Acipenser, Caecilian, Hyla/Rhacophorus, Axolot larva / Salamander, Draco, Turtle, Snakes : Cobra, Krait, Rattle snake, Sea snake, Water snake, Bat
- Bones - Skeleton of a bony fish, Chelonia, Snake, Dentition in mammals

Physiology

- Measurement of metabolic rate in small animals – effect of stress on gill ventilation in fish-
- Plotting zone of resistance and zone of tolerance
- Determination of blood pressure in man with help of Sphygmomanometer by auscultation
- Method to show effects of exercise plotting time of acclimation.
- Detection of presence of blood in urine / fecal matter by Benzidine test
- Preparation and study of hemain and haemochromogen crystals
- Determination of Haemoglobin content
- Permeability of erythrocyte membrane as a function of osmolarity of salt solution
- Effect of temperature, drugs hormones, and neurotransmitters on the rate of heart beat

EC – 1 (Mid term Practical based on theory Paper EC – 1)

ITEMS

Total Marks - 20

- | | |
|--|---------|
| 1. Microbiology | 3 marks |
| 2. Molecular biology | 3 marks |
| 3. Cell Biology | 3 marks |
| 4. Spotting (2 slides – Bacteria & 2 slides mitosis & meiosis) (1x4) | 4 marks |
| 5. Records | 3 marks |
| 6. Viva – voice | 4 marks |

List of Practical

Microbiology

- Microbiological quality of fresh and stale milk
- Culture media (liquid / solid) preparation of bacteria
- Staining of bacteria

Molecular Biology

- Isolation of DNA from blood.
- Biochemical estimation of DNA : Diphenylamine reaction
- Separation of amino acid by paper chromatography

Cell Biology

- Study of different stages of mitosis and meiosis : study of permanent slides.
- Temporary slide preparation with acetocarmine stain :
To study stages of mitosis in onion root tip.
- Stages of meiosis in grasshopper testis.
- Trypan blue dye exclusion assay.



M.Sc. Zoology Semester III (ZOOL)

CC – 7 (Core course – 7)

Unit A : Comparative and molecular endocrinology

- Chemical messengers, hormones and mechanism of their action
 - Life history of a hormone – synthesis, secretion, mode of delivery, half life, entry into the target cells, actions.
 - Receptor types and structure, second messenger system, cytosolic receptors and their action via gene expression
- Pineal in vertebrates, its hormones and their function
- Mammalian endocrine glands and their hormones
 - Adenohypophysis
 - thyroid
 - Adrenal
- function of the hormones secreted from –
 - Hypothalamus (mammals only)
 - Urophysis
 - Parathyroid
 - Ultimobranchial glands
 - Corpuscles of Stannius
 - Internal and chromaffin cells
 - Gut endocrine cells, endocrinology of hunger and satiety
 - kidney
 - Heart
 - thymus
- Physiological Endocrinology :
 - Endocrinology of calcium regulation
 - Endocrinology of osmoregulation

Unit B : Developmental Biology

- Fertilization : Specialization of egg, structural specialization of sperm, species-specific binding of gametes, sperm-egg fusion, capacitation, Acrosomal reaction, prevention of polyspermy.
- Cell differentiation : Myogenesis (skeletal muscle – formation, regeneration and hypertrophy), Differentiation of erythrocytes (Stem cells and their diversification, control of haemoglobin synthesis, erythrocyte membrane)
- Post-embryonic Development : Metamorphosis – Anuran and insect
- Regeneration : morphallaxis and epimorphosis
- Sex determination in *Bonellia* : Arrhenotoky

M.Sc. Zoology Semester III (ZOOL)

CC – 8 (Core course – 8)

Biological chemistry : Biomolecules and metabolic regulations

- Water – As a biological solvent
 - Unique physical and chemical properties
 - Ionization of water
 - Equilibrium constant and ionic product of water and PH
 - Weak acids and Weak bases
 - Buffering properties of water
- Biomolecules :
 - Chemical bonds and bond energy
- Structure and signification of Biomolecules :
 - Monosaccharide, Oligosaccharides and Polysaccharides
 - Proteins – Amino acids, Primary, secondary, tertiary and quarternary structures
 - Lipids – simple and complex. Significance of Biopolymers and their formation
- Metabolism :
 - Biosynthesis and degradation of protein
 - Metabolism of fructose, glucose, and glycogen
- Enzymes :
 - Mechanism of action, regulation of enzyme activity
 - Enzyme kinetics
 - Coenzymes and isoenzyme
 - immobilised enzyme and their application
- Free Radicals and antioxidants

Immunology

Vertebrate immune system

★ Innate immune system

Organization and structure of lymphoid organs

Cells of immune system and their differentiation

Lymphocyte structure – lymphocyte traffic

MHC complex and antigen presentation

Cytokines

Hypersensitivity reaction

- Acquired immune systems

B-cells, type and receptors

T-cells, type and receptors

Antigens, antigenecity and immunogenesity

Epitopes, and Haptens types, structures. functions and diversity of antibody

M.Sc. Zoology Semester III (ZOOL)

EC – 2 (Elective course- GE/DC)

➤ **1. Fish and Fisheries**

- Nutritional value and economic importance of fishes : brief account of byproducts
- Aquaculture – Definition and classification
- Lines of fish culture in ponds
- Ornamental fishes, viviparous fishes
- Classification of living fishes up to orders
- Freshwater and important marine fishes of India
- Adaptations in teleosts – hill stream, cave dwelling, antifreeze, colouration, bioluminescence
- Migratory behaviour in fishes
- Locomotion in teleosts
- Aquatic respiration in teleosts
Structure of gills, gill areas and its significance, gas exchange and ventilation of gills
- Digestive system of teleosts
Alimentary canal and its modification in relation to food and feeding habits in teleosts

M.Sc. Zoology Semester III (ZOOL)

EC – 2 (Elective course- GE/DC)

➤ **2. Entomology**

- Classification and phylogeny of Insects
Classification of the Apterygote Orders : Thysanura, Diplura, Protura and Collembola
Classification of Exopterygote Orders : Orthoptera, Dictyoptera, Hemiptera
Classification of Engopterygote Orders : Lepidoptera, Diptera, Hymenoptera and Coleoptera
- Structures and life processes :
Integument : Structure and chemistry, cuticular modifications, Apolysis, Ecdysis and sclerotization
Head and Thorax : Its appendages and their modifications
Digestive system : Alimentary canal, salivary glands, mechanism of digestion, micro-organisms of the intestine.
Sense organs and perception : Mechanoreceptors, Auditory organs, Chemoreceptors, Thermoreceptors. Humidity receptors and visual organs
Effector organs : The sound and light producing organs
- Insect Physiology :
Respiration – Respiration in aquatic, terrestrial and endoparasitic insects
Excretion – Malpighian tubules and other organs of excretion, Metabolic pathways of nitrogenous excretion i.e. urea uric acid, ammonia and aminoacids.
- Reproductive Physiology : Oogenesis, yolk formation, ovulation and oviposition, spermatogenesis, transfer of sperms and spermatophores, Mating and fertilization, Endocrine system and hormones & pheromones

M.Sc. Zoology Semester III (ZOOL)

EC – 2 (Elective course- GE/DC)

➤ 3. Ecology

Lindeman's Trophic Dynamic concept, Energy Flow in Ecosystem, Food chain, Food web, Food pyramid

Concept of Limiting Factor : Shelford's Law of Tolerance, Liebig's Law of Minimum
Fundamentals of Limnology : Origin and Classification of Lakes, Types and significance of Freshwater Biota.

Major Biomes of the World : Marine system, Forests, Tundra, Taiga, Grassland

Pollution Ecology : Air, Water, Bioremediation, Biosensors, Bioaccumulation, Biomagnification

Population attributes,

Community Ecology : Component, Analytical and synthetic characters

Biodiversity : Status, Monitoring and documentation, Major factors for biodiversity changes, Biodiversity management approaches

- Basic Ecology

Concept of Productivity : Primary, Secondary and Tertiary : Factors and Methods of measurement

Concept of Ecological Niche : Niche Overlap, Niche Breadth, Ecological Release and Ecological Compression.

- Biome Ecology

Physico-Chemistry and Biological Characteristics of Freshwater and Marine System Characteristics of Desert, Grassland and Forest Biomes. Desert adaptation

- Population & Community Ecology

Population Growth : Exponential, Sigmoid, Time lag Model, Stochastic Model

Competition : Intra and Interspecific competition, Competitive ability, Lotka & Volterra models for competing species. Tillman's model.

Natural Regulation of Population : Theories and Model for Population Regulation

Community Ecology :- Ecological Dominants, Species Diversity, Ecotypes and Ecotone, Edge Effect, Periodicity (Seasonal, Lunar and Diel)

M.Sc. Zoology Semester III (ZOOL)

CC P – 9 (Core Course – 9)

Practical based on Theory Papers CC 7 & CC 8

Scheme of Examinations

End term (external) assessment

Exam Duration : 3:00 hrs
Full Marks : 80 + 20

| <u>ITEMS</u> | <u>MARKS DISTRIBUTION</u> |
|-------------------------|---------------------------|
| Endocrinology | 10 |
| Developmental Biology | 10 |
| Biochemistry (2 x 10) | 20 |
| Immunology | 10 |
| Spotting (2 x 10) | 20 |
| Records | 10 |
| Viva voce | 20 |

List of Practical

Endocrinology

Study of histochemical slides –

- Endocrine glands of mammals
- Ultimobranchial glands and fish

Quantitative estimation of cortisol in blood

Qualitative analysis of chorionic gonadotrophin hormone in mammals.

Development Biology

Study of permanent slides of :-

- Different stages of development in frog (cleavage, blastula, gastrula, organogenesis)
- Different stages of development in chick

Sperm motility

Sperm count

Sperm vitality study using suitable stain

Study of vaginal smear in rat by temporary mounting (methylene blue)

Biochemistry

Biochemical estimation of protein : Lowry's method

Estimation of glucose

Estimation of serum total cholesterol

Determination of glycogen content of rat liver colorimetrically

Quantitative analysis of lipid : Saponification value of fat

Immunology

Study of permanent sliders : Thymus, Spleen, lymph node

Antigen antibody interaction (Blood group analysis)

Collection of serum & plasma

Blood film preparation and identification of cell types

Demonstration of ouchterlony double diffusion (ODD)

M.Sc. Zoology Semester IV (ZOOL)

Core course – 10 (CC10)

Mammalian Reproductive Physiology & Biotechnology

Unit A :

Different mechanisms of sex determination in vertebrates (genetic, hormonal, thermal)

Testicular and ovarian hormones : sites of secretion, control and effects

Sperm maturation in male reproductive tract and the role of testicular hormones in eutherian mammals

Ovarian and uterine cycles and their control by ovarian and hypothalamic hormones in eutherian mammals

Implantation – mechanism and control. Delayed implantation

Sterility due to hormonal defects

Manipulation of mammalian reproduction : Hormonal contraceptives, super ovulation, IVF, Embryo-transfer

Environment and reproduction in mammals : Bruce effect, Lee Boot effect, Whitten effect

Biotechnology

Unit B :

Enzymes and their application

Vectors :

Cloning and expression vectors,

Properties of vectors, some important vectors : pBR322, pUC, Cosmids, BAC, YAC

Selection of recombinants

Sources of cloned DNA

Genomic DNA library

cDNA library

PCR

Application of Biotechnology : Preparation of transgenic animals.

Mechanism of production of growth hormone, insulin, interferons.

Hybridoma technology : Monoclonal antibody production

Gene Therapy

M.Sc. Zoology Semester IV (ZOOL)

EC – 3 (Elective course GE / DC)

Fish and Fisheries

Cultivable water : quality and quantity

Physical and chemical properties of water influencing fish culture.

Natural food for fish in pond

Role of plankton, blooms and benthos in fish culture

Fertilizers and their role

Supplementary feeding and artificial feeds

Sewage fed fisheries, Integrated fish culture, paddy field fish culture and cage culture.

Important reservoirs and rivers of Jharkhand – their problems and commercial

Common aquatic weed and their control

Cultivable species

Introduction of exotic species – Composite culture, extensive and intensive culture

Fish seed production.

Induced breeding _ importance, technique, physiology and new generation of commercial agents

Collection of seeds from natural resources – transport of carp seeds and breeders

Management of nursery, rearing and stocking ponds

Fishing technology – nets, crafts, gears, acoustic and other recent techniques.

M.Sc. Zoology Semester IV (ZOOL)

EC – 3 (Elective course GE / DC)

Entomology

Ecological management of the crop environment:

Sanitation, destruction or modification of alternate hosts and habitats

Tillage, irrigation and water management

Trap cropping and strip harvesting

Chemical control :

Insecticides – nomenclature, formulae and different types of formulations.

common insecticides used in pest control

Mode of action of insecticides and toxicity to humans.

Definition of Biological control, agents of Biological Control Parasites, Parasitoids,

Predators and pathogenic microorganisms. Mass production and distribution.

Advantages and disadvantages of Biological control.
Integrated Pest Management (IPM)
Other methods of insect Pest Management
Management of insect Pests by Sterile- Insect Technique (Chemosterilants)
Attractants, Repellents, Antifeedants and Pheromones.

M.Sc. Zoology Semester IV (ZOOL)

EC – 3 (Elective course GE / DC)

Ecology

Pollution Ecology
Water Pollution : Types and sources of Pollution
Biodegradable and Non degradable Polutants
Eutrophication
Air Pollution :
Sources and Effects of Air Pollutants
Ecotoxicology
Toxic and Xenobiotics
Routes and rate of administration
Environmental and behavioral factors affecting Toxicity
Effective and Response
Synergism and Antagonism
Basic Principle of Dose Response
Mechanism of action and Biotransformation of Toxicants
Translocation of Toxicants
Antidotes
Toxicity Tests

M.Sc. Zoology Semester IV (ZOOL)

EC – 4 (Elective course GE / DC)

Practical based on theory papers EC 2 & EC 3

Ecology Special

Scheme of examination

End term (external) assessment

Exam Duration : 3:00 hrs

Full Marks : 80 + 20

ITEMS

Water analysis

MARKS DISTRUBUTION

10

| | |
|---------------------------------|----|
| Soil analysis | 10 |
| Biotic analysis | 10 |
| Bio-statistical analysis | 15 |
| Adaptation Study Spotting (5x3) | 15 |
| Records and Sessional work | 20 |
| <i>Viva voce</i> | 20 |

List of Practical

Water Analysis

- Estimation of BOD of sample
- Estimation of Carbonate, Bicarbonate and Hydroxide & Chloride in sample water
- Estimation of hardness & Oxygen and Carbon of sample water
- Estimation of Magnesium and Calcium in sample water

Soil Analysis

- Estimation of OMC / Total Carbon of a soil sample
- Estimation of CaCO_3 in a soil sample
- Estimation of soil respiration rate in a sample

Biotic Analysis

- Sampling and Identification of freshwater palanktons.
- Qualitative, Quantitative assessment and working of Indices of diversity and dominance of Palankton, Benthos, Soil fauna, Soil Microbes

Biostatistical Analysis

- Analysis of correlation coefficient and simple linear regression in a set of data
- Estimation of density and relation frequency by quadrate analysis
- Analysis of similarity index in the species composition by 2x2 contingency table

Adaptation study

- Aquatic insects, Terrestrial Insects, Freshwater fish (Hill Stream fish)
- Marine fish & Higher Vertebrates
- Ecological Equipments
- Ecological significance of plants and earthworm
- Identification of Aquatic plants and Bioindicator Species

M.Sc. Zoology Semester IV (ZOOL)

EC(P) – 4 (Elective course GE / DC)

Practical based on theory papers EC 2 & EC 3

Fish Special

Scheme of Examinations

End term (external) assessment

Exam Duration : 3:00 hrs

Full Marks : 80 + 20

| <u>ITEMS</u> | <u>MARKS DISTRIBUTION</u> |
|---|---------------------------|
| 1. Anatomical observation | 10 |
| 2. Gut analysis and determination of feeding habit | 10 |
| 3. Temporary slides | 10 |
| 4. Spotting – 5 [Representative of major classes-1, histological slides – 1, Endocrine section-1, fish showing adaptation -1, exotic/ ornamental/ larvivorous fish – 1) | 15 |
| 5. Plankton identification | 05 |
| 6. Taxonomic identification of fresh water fishes | (2x5) = 10 |
| 7. Fish showing adaptive feature | (2x5) = 10 |
| 8. Records and Sessional work | 10 |
| 9. Viva voce | 20 |

List of Practical

- Anatomical observation of a bony fish
- General anatomy, Digestive system of herbivore and carnivore fishes, Reproductive system, Pituitary gland, Weberian Ossicle.
- Representatives of major groups (except teleosts)
- Taxonomic identification of important fresh water and marine fishes up to genus
- Study of histological slides of various organs
- Study of slides, related to annual breeding cycles – ovary, testis, pituitary etc.
- Study of skeletal system of bony fish
- Study of exotic, ornamental, larvicidal fishes
- Study of adaptive features hill stream fishes, fishes showing parental care, bioluminescence. adaptations – feeding, respiratory, flying, poisonous, electric organs etc.
- Haematology – blood corpuscles, T.C. , D.C., and Hb content /Haematocrit
- Study of fishing gears and ecological equipments
- Collection, identification of plankton, weeds and aquatic plant

Determination of feeding habit on the basis of gut / gut content
 Visit to fish market, landing site, fish pond, fish farm, breeding centers, fish reservoir
 and National Institutes of Fisheries Research.

M.Sc. Zoology Semester IV (ZOOL)

EC(P) – 4 (Elective course GE / DC)
Practical based on theory papers EC 2 & EC 3

Entomology Special

Scheme of Examinations

End term (external) assessment

Exam Duration : 3:00 hrs

Full Marks : 80 + 20

| <u>ITEMS</u> | <u>MARKS DISTRUBUTION</u> |
|---|---------------------------|
| 1. Adapting feature of aquatic/ Semiaquatic/terrestrial insects | 05 |
| 2. Temporary mounting of any body parts of insects | 05 |
| 3. Calculation of species diversity of insects by shnnon-weiner index from generated data | 10 |
| 4. taxonomic description of a member of any order studied | 10 |
| 5. pest studies / life cycle of beneficial insects | 05 |
| 6. Spotting | (2x10) = 20 |
| 7. Practical Records | 20 |
| 8. Viva voce | 20 |

List of Practical

Taxonomy description & indentification of following order :

Orthoptera, Dictyoptera, Hemiptera, Hymenoptera, Diptera, Coleoptera & Lepidoptera.

Study of permanent slides of body parts.

Study of Histological slides.

Pest study on affected objects.

Life history of beneficial insects like – lac & tasar.

Study of parasites, predators, parasitoids & pattrogens

Embryological study through Drosphila culture.

Study of adaptive features in some order of insects.

Minor dissection :

Temporary mounting of special type of mouth parts, wings, legs, ovpositer, sting apparatus antennae – adaptation – arista.

Calculation of species diversity by Shannon-weiner index from generated data

Study of the external morphology of an insect, wings, haltere, clytra

Study of the adpative feature of terrestrial and aquatic insects

Study of parasitic insects (Fleas and Lice)

Study of the mouthparts of the representative of the order : orthoptera, Dictyoptera, Hemiptera, Lepidoptera and Hymenoptera.

Study of respiratory structure of terrestrial, semi-aquatic and aquatic insects.

Study of the life cycles of Termites, Honeybee, Mosquitoes

Recommended Reading

Invertebrate Biology

1. Barrington E.J.W. – Invertebrate structure and function. 2nd edn. ELBS/Nelson 1973
2. Meglitsch P.A. & Schram F.R – Invertebrate Zoology. 3rd edn. Oxford univ press 1991
3. Ruppert E.E. & Barnes, R.D.- Invertebrate Zoology. 6th edn. Harcourt Asia 1994
4. Hyman L.H. – The Invertebrata vols I-VI McGraw- Hill 1940 – 1967
5. Brusca R.C. & Brusca G.J.- Invertebrates. Sinamer Assoc. inc 1990
6. Pechenik J.A. – Biology of Invertebrates. 4th edn. Tata McGraw-Hill 2002

Vertebrate Biology

1. Pough F.H., Janis C.M. & Heiser J.B. – Vertebrate Life. 6th edn. Pearson 2003
2. Romer A.S. – The Vertebrate body. 3rd edn. Vakils 1962
3. Young J.Z. – Life of Vertebrates. 3rd edn. Oxford 1982
4. Hildebrand M. – Analysis of Vertebrate Structure. John Wiley 1974
5. Kardong K.V. – Vertebrates : Comparative Anatomy, Functions, Evolution. 3rd edn. Tata McGraw-Hill 2002
6. Bellairs A.d'A – Reptiles. Hutchison University Library 1970
7. Dhawan's – How Birds Fly. National Book Trust 2002
8. Sahni A. – Dinosaurs of India. National Book Trust 2001

Microbiology

1. Pelczar Jr. M.J., Chan E.C.S. & Krieg N.R. – Microbiology. Tata MacGraw-Hill 1993
2. Prescott L.M., Harley J.P. & Klein D.A. – Microbiology. 5th edn. MacGraw-Hill 2002
3. Sullia S.B. & Shantharam S. – General Microbiology. Oxford IBH 1998
4. Heritage J., Evans E.G.V.and Killington–Introductory Microbiology. Cambridge 1996

Histology and Histochemistry

1. Pearse A.G.E.- Histochemistry – Theoretical and Applied. vols I-III Churchill
2. Bancroft J.D. & Stevens A. – Theory and Practice of Histological techniques. 4th edn. Churchill Livingstone 1996
3. Barka T. & Anderson P.J. _ Histochemistry, Theory Practice and Bibliography. Harper and Raw 1965
4. Sharma A.K. & Sharma A. – Chromosome Techniques. Theory and Practice. 3rd edn. Butterworths 1980
5. Copenhagen W.M. – Bailey's Text Book of Histology. Willian and wilkins / Scientific Book Agency Indian edn. 1964
6. Carleton H.M. & Short R.M.D. – Schafer's Essential of Histology : Descriptive and Practical. 16th edn. Longmans Green 1954
7. Verma G.P. – Fundamentals of Histology. New Age 2001

Instrumentation

1. Ambrose E.J. & Easty D.M. – Cell Biology. EIBS/ Nelson 1973
2. Skoog D.A., Holler F.J. & Crouch S.R. – Principle of Instrumental Analysis. 6th edn. Thomson 2007
3. Narayanan P.- Essentials of Biophysics. New Age 2000
4. Roy R.N. – Biophysics
5. Tembhare D.B. – Techniques in Life Science. Himalaya 2008
6. Willard H.H., Merritt Jr. L.L., Dean J.A. & Settle Jr. F.A. – Instrumental Methods of Analysis. 6th edn. CBS 1986

Quantitative Biology

1. Zar J.H. – Biostatistical Analysis. 4th edn. Pearson 2005
2. Khan I.A. & Khanum A. – Fundamentals of Biostatistics 2nd edn. Ukaaz Publ. 2007
3. Pagano M. & Gauvreau K. – Principles of Biostatistics. 2nd edn. Thomson 2007
4. Sundar RAO P.S.S. & Richard J. – An Introduction to Biostatistics. 4th edn. PHI 2006
5. Forthofer R.N., Lee E.U. & Hernanadez M. – Biostatistics : A guide to Design, Analysis and Discovery. Elsevier / Academic Press 2007

Bioinformatics

1. Attwood T.K. & Parry – Smith D.J. – Introduction to Bioinformatics. Person 2001
2. Sudarrajan S. & Balaji R. – Introduction to Bioinformatics 1st edn. Himalaya 2002
3. Murthy C.S.V. – Bioinformatics 1st edn. Himalaya 2004

Cell Biology

1. Lodish H., Berk A., Matsudaira P. Kaiser C.A. , Krieger M., Scott M.P., Zipurky S.L., & Darnell J. – Molecular Cell Biology. 5th edn. W.H. Freeman 2004
2. Sadava D.E. – Cell Biology. Organelle, Structure and Function. Jones and Bartlett 1997
3. Cooper G.M. – The Cell : A molecular approach. Asm Press 1997
4. Freifelder D. & Malacinski G.M. – Essentials of Molecular Biology 2nd edn. Panima 1993
5. Becker W.M., - Reece J.B. & Poenic M.F. – The World of the Cell. 3rd edn. Benjamin 1996
6. Twyman R.M. – Advanced Molecular Biology. Viva 2003
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8. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. – Molecular Biology of the Cell. 4th edn. Garland Science 2002

Molecular Biology

1. Lewin B. – Genes VI – XII. Oxford 2000 – 2008
2. Watson J.D. , Baker T.A., Bell S.P., Gann A., Levine M. & Losick R. – Molecular Biology of the Gane. 5th edn. Person 2004
3. Tamaria R.H. – Principles of Genetics. 7th edn. Tata McGraw – Hill 2002

Ethology

1. Manning A. & Dawkins M.S. – An Introduction to Animal Behaviour. Cambridge 1995

2. Prasad S. – Animal Behaviour. CBS 2004
3. Mathur R. – Animal Behaviour. Rastogi 2002

Physiology

1. Kay I. – Introduction to Animal Physiology. Bios Scincetific Publ Ltd 1998
2. Sherwood L., Kalandorf H. & Yancey P.H. – Animal Physiology : From Genes to Organisms. Thomson 2005
3. Schimdt- Nelson K. – Animal Physiology : Adaptation and Environment. 5th edn. Cambridge Univ. Press 1998
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5. Prosser C.L. – Comparative Animal Physiology. 3rd edn. Satish Books 1984
6. Chaudhuri S.K. – Concise Medical Physiology. 5th edn. New Central Agency 2004
7. Keele C.A. & Neil E. – Samson Wright's Applied Physiology. EIBS / Oxford 1972
8. Soper R. (edt) – Biological Science. 3rd edn. Cambridge Univ Press 1997
9. Guyton A.C. & Hall J.E. – Text Book of Medical Physiology. 9th edn. Saunders 1996
10. Talwar G.P. & Srivastava L.M. (edt.) – Text Book of Biochemistry and Human Biology. 3rd edn. Prentice Hall India 2003

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2. Nelson D.L. & Cox M.M. – Lehlinger Principles of Biochemistry. 3rd edn. 2000
3. Wilson K.& Walker J. – Principles of Biochemistry and Molecular Biology. 6th edn. Cambridge Univ. Press 2007
4. Matthews C.K., van Holde K.E. & Ahern K.G. – Biochemistry. 3rd edn. Pearson 2003
5. Voet D., voet J. & Pratt C.W. – Fundamentals of Biochemistry. Life at the Molecular Level. 2nd edn. Wiley Asia 2006
6. Metzler
7. Norris D.O. – Vertebrate Endocrinology. 4th edn. Elsevier / A.P. 2007
8. Bolander F.F. – Molecular Endocrinology. 3rd edn Elsevier / A.P. 2006
9. Hadley M.E. – Endocrinology. 5th edn. Pearson 2000
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12. Ramaswami L.S. – Vertebrate Neurosecretion : A Review. INSA 1980
13. Fry B.E. – Hormonal Control in Vertebrates. Macmillan 1967

Immunology :

1. Davey Basiro – Immunology. Open University Press 1989
2. Delves P.J., Martin S.J., Burton D.R. & Roitt I.M. – Roitt's Essential Immunology. 11th edn. Oxford 2006
3. Shetty N. – Immunology : Introductory Text Book. Revised 2nd edn. New Age 2008
4. Kuby, J. – Immunology

Evolution and ecology

1. Riddle M. – Evolution. 2nd edn. Blackwell 1996
2. Piyanka E.R.- Evolutionary Ecology 5th edn Harper Collins 1994
3. Simmons I.G. – The Ecology of Natural Resources 2nd edn EIBS / Edward Arnolds 1983
4. Dash M.C. & Mishra P.C. – Man and Environment McMillan 2001
5. Stiling P. – Ecology : Theories and Applications 4th edn Prentice Hall India 2002

Fish and Fisheries

1. Wootton R.J. – Fish Ecology Blackie 1992
2. Nikolsky G.V. – The Ecology of Fishes Academic Press 1963
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5. Pillay – Aquaculture : Principle and Practice of Fishing 1st Indian edn New Books 2006

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2. Imms A.D. – A General Text Book of Entomology 2 volsw. Asia Pubi 1997
3. Wigglesworth – Principles of Insect Physiology ELBS 1972

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2. Berril N.J. – Developmental Biology. Tata McGraw – Hill 1982
3. Primrose S.B. – Molecular Biotechnology. 2nd edn. Panima 2001
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5. Golemis E. (edt) – Protein-Protein Interactions. Cold Spring Harbor Laboratory Press 2002
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1. Austin C.R. & Short R.V. – Reproduction in mammal Books 1 to 7 Cambridge
2. Nalbandov A.V. – Reproductive Physiology Taraporevala 1970
3. Tienhoven A.V. – Reproductive Physiology of Vertebrates 2nd edn. Cornell Univ
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6. Norris D.O. – Vertebrate Endocrinology 3th edn. Elsevier / A.P. 2006
7. Bolander F.F. – Molecular Endocrinology 3rd edn Elsevier / A.P. 2006
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