University of Rajasthan

SYLLABUS

Faculty of Science

M.Sc. ZOOLOGY

(Semester Scheme)

I\textsuperscript{st} & II\textsuperscript{nd} Semester Exam 2016-17

III\textsuperscript{rd} & IV\textsuperscript{th} Semester Exam 2017-18
MAX. MARKS: 100  

THEORY PAPER DURATION: 3 HRS.  

PASS MARKS: 36  

PRACTICAL: 4 HRS

SCHEME OF EXAMINATION ZOOLOGY (2016-2017)

- As per discussion of academic council, the student will require to earn 120 credits for PG course out of total 144 credits.
- In theory, 15 hrs of teaching is equal to one credit.
- In practicals, 45 hrs of laboratory works is equal to 2 credits.
- Each Semester of PG course shall have 36 credits.
- Each Semester will have continuous assessment which will include internal assessment in theory and practical by internal examination /seminar/oral examination- Viva voce etc. and the maximum marks will be 30.
- Each theory paper shall carry 100 marks. It will be of 3 (three) hrs duration.
- Part A of question paper shall contain 10 (Ten) very short answer type questions covering the entire syllabus. Each question will carry 2 (two) marks i.e. part A will be of total 20 marks.
- In part B, there will be 4 questions, one per unit with internal choice. Each question will carry 20 marks i.e. total of 80 marks.
- Each practical examination will be of 4 hrs duration and will involve laboratory experiments / exercises and Viva –voce examination.

SCHEME OF PRACTICAL EXAMINATION

For first, second, third and fourth Semesters, the scheme of practical examination is as follows:

MM: 100  

Duration: 4 hrs

1. Major Exercise  
   26 Marks
2. (a) Minor Exercise  
   10 Marks
   (b) Minor Exercise  
   10 Marks
3. Spotting (8 x 3)  
   24 Marks
4. Seminar  
   10 Marks
5. Viva Voce  
   10 Marks
6. Record  
   10 Marks

Registrar (Acad.)
### First Semester (With Laboratory Work)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Course Title</th>
<th>Course Category</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>ZOL 101</td>
<td>Biosystematics &amp; Taxonomy</td>
<td>CCC</td>
<td>4</td>
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<tr>
<td>2.</td>
<td>ZOL 102</td>
<td>Biology of Invertebrates</td>
<td>CCC</td>
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<td>3.</td>
<td>ZOL 103</td>
<td>Biochemistry</td>
<td>CCC</td>
<td>4</td>
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<tr>
<td>4.</td>
<td>ZOL 111</td>
<td>Lab (Based on ZOL 101, ZOL 102 and ZOL 103)</td>
<td>CCC</td>
<td>6</td>
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<tr>
<td>5.</td>
<td>ZOL 1A01/</td>
<td>Fundamentals of Computers and Bioinformatics</td>
<td>ECC</td>
<td>4</td>
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<tr>
<td></td>
<td>ZOL 1B01</td>
<td>Toxicology</td>
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<td>6.</td>
<td>ZOL 1A02/</td>
<td>Genetics</td>
<td>ECC</td>
<td>4</td>
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<tr>
<td></td>
<td>ZOL 1B02</td>
<td>Biosafety &amp; Bioethics</td>
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<tr>
<td>7.</td>
<td>ZOL 1A03/</td>
<td>Applied Zoology</td>
<td>ECC</td>
<td>4</td>
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<tr>
<td></td>
<td>ZOL 1B03</td>
<td>Parasitology</td>
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<tr>
<td>8.</td>
<td>ZOL 112A/</td>
<td>Elective Lab (Based on ZOL 1A01, ZOL 1A02 and ZOL 112B/ ZOL 1B01, ZOL 1B02 and ZOL 1B03)</td>
<td>ECC</td>
<td>6</td>
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### Second Semester (With Laboratory Work)

<table>
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<tr>
<th>S. No.</th>
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<th>Course Title</th>
<th>Course Category</th>
<th>Credit</th>
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<tbody>
<tr>
<td>1.</td>
<td>ZOL 201</td>
<td>Physiology</td>
<td>CCC</td>
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<tr>
<td>2.</td>
<td>ZOL 202</td>
<td>Molecular Biology</td>
<td>CCC</td>
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<td>3.</td>
<td>ZOL 203</td>
<td>Biostatistics</td>
<td>CCC</td>
<td>4</td>
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<tr>
<td>4.</td>
<td>ZOL 211</td>
<td>Lab (Based on ZOL 201, ZOL 202 and ZOL 203)</td>
<td>CCC</td>
<td>6</td>
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<tr>
<td>5.</td>
<td>ZOL 2A01/</td>
<td>Immunology</td>
<td>ECC</td>
<td>4</td>
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<tr>
<td></td>
<td>ZOL 2B01</td>
<td>Applied Biology</td>
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<td>6.</td>
<td>ZOL 2A02/</td>
<td>Environmental Management</td>
<td>ECC</td>
<td>4</td>
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<tr>
<td></td>
<td>ZOL 2B02</td>
<td>Histology and Histopathology</td>
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<td>7.</td>
<td>ZOL 2A03/</td>
<td>Wildlife: Its Management &amp; Conservation</td>
<td>ECC</td>
<td>4</td>
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<tr>
<td></td>
<td>ZOL 2B03</td>
<td>Population Genetics</td>
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<td>8.</td>
<td>ZOL 212A/</td>
<td>Elective Lab (Based on ZOL 2A01, ZOL 2A02 and ZOL 212B/ ZOL 2B01, ZOL 2B02 and ZOL 2B03)</td>
<td>ECC</td>
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### Third Semester (With Laboratory Work)

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<tbody>
<tr>
<td>1.</td>
<td>ZOL 301</td>
<td>Biology of Chordates</td>
<td>CCC</td>
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<tr>
<td>2.</td>
<td>ZOL 302</td>
<td>Gene and Differentiation</td>
<td>CCC</td>
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<td>3.</td>
<td>ZOL 303</td>
<td>Evolution</td>
<td>CCC</td>
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<td>4.</td>
<td>ZOL 311</td>
<td>Lab (Based on ZOL 301, ZOL 302 and ZOL 303)</td>
<td>CCC</td>
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<tr>
<td>5.</td>
<td>ZOL 3A01</td>
<td>Cancer and Radiation Biology</td>
<td>ECC</td>
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<td>ZOL 3B01</td>
<td>Cell and Molecular Biology</td>
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<tr>
<td></td>
<td>ZOL 3C01</td>
<td>Entomology</td>
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<tr>
<td>ZOL 3D01</td>
<td>Environmental Biology</td>
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<tr>
<td>ZOL 3E01</td>
<td>Reproductive Biology</td>
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| 6. ZOL 3A02 | Cancer and Radiation Biology |
| ZOL 3B02 | Cell and Molecular Biology |
| ZOL 3C02 | Entomology |
| ZOL 3D02 | Environmental Biology |
| ZOL 3E02 | Reproductive Biology |

| 7. ZOL 3A03 | Cancer and Radiation Biology |
| ZOL 3B03 | Cell and Molecular Biology |
| ZOL 3C03 | Entomology |
| ZOL 3D03 | Environmental Biology |
| ZOL 3E03 | Reproductive Biology |

| 8. ZOL 312A | Elective Lab Based on:  |
| ZOL 312B | ZOL 3A01, ZOL 3A02 and ZOL 3A03 |
| ZOL 312C | ZOL 3B01, ZOL 3B02 and ZOL 3B03 |
| ZOL 312D | ZOL 3C01, ZOL 3C02 and ZOL 3C03 |
| ZOL 312E | ZOL 3D01, ZOL 3D02 and ZOL 3D03 |

### Fourth Semester (With Laboratory Work)

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<tr>
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<tbody>
<tr>
<td>1.</td>
<td>ZOL 401</td>
<td>Ecology</td>
<td>CCC</td>
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<tr>
<td>2.</td>
<td>ZOL 402</td>
<td>Ethology</td>
<td>CCC</td>
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<td>3.</td>
<td>ZOL 403</td>
<td>Tools &amp; Techniques</td>
<td>CCC</td>
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<td>ZOL 411</td>
<td>Lab</td>
<td>CCC</td>
<td>6</td>
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</table>
  (Based on ZOL 401, ZOL 402 and ZOL 403)
| 5.     | ZOL 4A01 | Cancer and Radiation Biology |
| ZOL 4B01 | Cell and Molecular Biology |
| ZOL 4C01 | Entomology |
| ZOL 4D01 | Environmental Biology |
| ZOL 4E01 | Reproductive Biology |
| 6.     | ZOL 4A02 | Cancer and Radiation Biology |
| ZOL 4B02 | Cell and Molecular Biology |
| ZOL 4C02 | Entomology |
| ZOL 4D02 | Environmental Biology |
| ZOL 4E02 | Reproductive Biology |
| 7.     | ZOL 4A03 | Cancer and Radiation Biology |
| ZOL 4B03 | Cell and Molecular Biology |
| ZOL 4C03 | Entomology |
| ZOL 4D03 | Environmental Biology |
| ZOL 4E03 | Reproductive Biology |

| 8.     | Elective Lab Based on:  |
| ZOL 412A | ZOL 4A01, ZOL 4A02 and ZOL 4A03 |
| ZOL 412B | ZOL 4B01, ZOL 4B02 and ZOL 4B03 |
| ZOL 412C | ZOL 4C01, ZOL 4C02 and ZOL 4C03 |
| ZOL 412D | ZOL 4D01, ZOL 4D02 and ZOL 4D03 |
| ZOL 412E | ZOL 4E01, ZOL 4E02 and ZOL 4E03 |

| GCC | 4 |
| ECC | 6 |
M. Sc. ZOOLOGY I SEMESTER
CORE PAPER
ZOL 101: BIOSYSTEMATICS AND TAXONOMY

Max. Marks: 100

Total Hours: 60

UNIT-I
1. Taxonomy: Definition and basic concept of biosystematics and taxonomy.
2. History, scope and application of biosystematics.
3. Taxonomic diversity: Definition and types of various taxonomic categories, micro and macro taxonomy.
4. Dimension of speciation: Species category, sub-species and other intraspecies categories.
5. Kingdom of life: General outline of kingdom including Monera and Protista; broad outline and diversity in kingdom Animalia.

UNIT-II
Modern trends in taxonomy:
1. Behavioral taxonomy
2. Chemotaxonomy
3. Cytotaxonomy
4. Molecular taxonomy
5. Neo-taxonomy

UNIT-III
1. Taxonomic procedures: Collection, preservation, curetting and process of identification.
2. Taxonomic character of different kinds-quantitative and qualitative analysis of variation.
3. Theories of biological classification: Hierarchy of categories.
4. Interpretation and application of important rules and formation of scientific names of different taxa.

UNIT-IV
1. Interpretation and application of important rules of Zoological nomenclature, formation of scientific names of the various taxa.
2. Taxonomic keys: Their merits and demerits.
3. International code of zoological nomenclature (ICZN).
4. Systematic publications and different kinds of publications.

PRACTICALS
1. Identification, classification and study of the animals from major invertebrate groups (Protozooa to Hemichordata including minor phyla) using museum specimens, microscopic slides, models or charts.
2. Preservation techniques of selected invertebrates.
3. Museum specimens and slides:
   • PROTOZOA: Gregarina, Monocystis, Ceratium, Euplotes, Noctiluca, Radiolarian, Stentor, Oposina
   • PORIFERA: Museum specimen of Hyaalonema and Euspongea, Sectional view of Sycon (T. S. & L. S.), Grantia (T. S.)

- HELMINTHES: Slides of Temnocephala.
  Museum Specimens of Ascaris lumbricoides, Taenia solium, Planaria.

- ANNELIDA: Slides of Ozobranchus, Glossiphonia.
  Museum specimens of Eunice, Polynoe, Terebella, Eurythoe.

- ARTHROPODA: Slides of Cyclops, Daphnia, Chelicera, Section of Peripatus.
  Museum specimen of Balanus, Lepas, Palinurus, Uca princeps, Pycna, Emerita, Gongylus, Belostoma, Limulus, Squilla, Eupagurus.

- MOLLUSCA: Museum specimens of Dolobella, Pteria, Nerita, Sanguinolaria, Chicoreus, Ficus, Lambis, Tridacna, Onchidium, Oliva, Murex, Turritella, Bulla, Cardium.

- ECHINODERMATA: Museum Specimens of Linckia, Echinodiscus, Holothuria, Antedon.

- MINOR PHYLA: Slides of Bugula, Plumatella, Cristatella, Pectinella.
  Museum Specimen of Phoronis, Dendrostoma.

- LARVAE: Planula, Redia, Cercaria, Metacercaria, Trochophore, Nauplius, Zoea, Mysis, Phyllosoma, Trilobite larvae of Limulus, Antilae, Veliger, Bipinnaria, Ophiopluteus and Echinopluteus, Auricularia, Tornaria.

Visit to a river/pond/sea: Collection, preservation, curetting and identification of animals.

SUGGESTED BOOKS

10. The Biology of Biodiversity, M. Kato: Springer.
M. Sc. ZOOLOGY I SEMESTER

CORE PAPER

ZOL 102: BIOLOGY OF INVERTEBRATES

Max. Marks: 100
Total Hours: 60

UNIT-I
1. Origin of Protozoa, parazoa and metazoa.
2. Origin of radiata and bilateria.
3. Origin, characters and types of metamerism.
5. Evolution of reproductive and non-reproductive units (evolution of sex) division of labour and social evolution.

UNIT-II
1. Locomotory organs and mechanisms of locomotion in invertebrates, flight mechanism of Insects, modification of foot organelles in Mollusca.
2. Feeding and digestion in invertebrates.
3. Excretory and osmo-regulatory organs and their mechanisms in invertebrates

UNIT-III
1. Respiration in invertebrates.
2. Nervous system in invertebrates (i) primitive nervous system- Coelenterata and Echinodermata and (ii) advanced nervous system- Annelida, Crustacea, Insecta and Mollusca.

UNIT-IV
1. Introduction to minor phyla, their salient features and characters
2. Origin and significance of mesozoa, ctenophora and rynchocoela.
3. Larval forms and their significance, free living, marine & freshwater protostome and deuterostome larval forms (including trophophore), crustacean, mollusc and insect larval forms, their strategies and significance, parasitic larva, larvae of parasitic forms.

PRACTICALS
I. Anatomy:
   1. Leech : Alimentary canal, nephridial and reproductive system
   2. Crab: Nervous system.
   3. Cockroach: Nervous system and reproductive system.
   5. Sea Urchin – Aristotle’s lantern.

II. Collection, culture, live study & permanent mounting:
   1. Amoeba, Paramecium
   2. Hydra.
   3. Trematodes, Cestodes and Nematodes.
4. Permanent Mounting - Obelia, Sertulria, Companularia, Cercaria, Daphnia, Cyclops, Zoea, Megalopa, Mysis, Lucifer
5. Mouth parts and salivary glands of cockroach, nephridia of leech.

** Dissections may be demonstrated using computer software.

SUGGESTED BOOKS
2. Invertebrate Zoology, R. S. K. Barnes.

M. Sc. ZOOLOGY I SEMESTER

CORE PAPER

ZOL 103: BIOCHEMISTRY

Max. Marks: 100

UNIT-I

Scope of biochemistry: Bio molecules Chemical bonds, pH, Acid, base, buffer, Concept of free energy.

Proteins:
2. Secondary and tertiary structures of proteins, peptides and peptide bonds, Ramchandaran plots and amino acid propensities, common secondary structures, protein tertiary structure and folding patterns, common tertiary structural motifs, role of packing constraints in tertiary structure patterns.
3. Globular and fibrous protein, water and hydrophobic effect, tertiary and quaternary effect, motifs in globular proteins, fibrous proteins (keratin, fibrin, collagen and elastin).
4. Protein folding and thermodynamics, the Levinthal paradox, condensation and molten globules, chaperon assisted protein folding.
5. Amino acid sequences variation and protein misfolding diseases allostery (Hemoglobin), myoglobin structure and oxygen binding.
6. Hemoglobin subunits cooperatively, the Hill coefficient. Quaternary structural change and sickle cell and other molecular diseases

UNIT-II

Carbohydrates: Structure and biological importance of:
1. Monosaccharides
2. Oligosaccharides
3. Polysaccharides (Storage and structural polysaccharides, glycosaminoglycans)
4. Glycoconjugates (glycoprotein and proteoglycans).

Lipids:
1. Fatty acids: Structure, nomenclature, acyl glycerols, wax, phospholipids, sphingolipids, glycolipids, lipoproteins.
2. Terpenoids and sterols: Structure, properties and functions.
3. Functions of lipids.

UNIT-III

Vitamins:
1. Classification, structure, occurrence and functions and fat soluble vitamins
2. Classification, structure, occurrence and biological function deficiency symptoms of water soluble vitamins.

Enzymes:
1. Enzyme as biocatalyst, the kinetics of enzyme catalysis, principles of enzyme catalysis, proteases, polymerases and other examples.
3. Enzyme inhibition, allosteric enzyme.
4. RNA catalysis, chemistry and structure of ribozymes, evolutionary implications, enzymes as biosensor.

UNIT-IV

Metabolism:
1. Catabolism, anabolism, metabolic pathway, regulation, concept of free energy
2. Carbohydrate metabolism: Enzymatic reactions, regulation importance of Glycolysis, Citric acid cycle, Pentose phosphate pathway, glycogenolysis, glycogenesis
3. Lipid metabolism: Fatty acid oxidation and biosynthesis, Beta-oxidation.
4. Amino acid metabolism: Catabolism of amino acid, transamination, deamination, biosynthesis of non essential amino acids, fate of carbon skeleton
5. Nucleotide metabolism: Degradation of purine and pyrimidine nucleotides, biosynthesis (de novo, salvage pathways) of purine and pyrimidine nucleotides.
Metabolic disorders:
1. Carbohydrate – Galactosemia, Glycogen storage disease (Von Gierke disease), Hereditary fructose intolerance and Diabetes mellitus.
2. Protein – Phenyl ketonuria, Maple syrup urine disease, Carbamoyl phosphate synthetase I deficiency, Alkaptonuria.
3. Lipid – Lipid storage disorder (Gaucher’s disease, gangliosidoses), Diabetic ketoacidosis, Coenzyme A dehydrogenase deficiencies, Carnitine related deficiencies.
4. Nucleotide- Lesh-Nyhan syndrome, Gout immunodeficiency diseases associated with defects in purine degrade.

PRACTICALS
1. Identification protein, carbohydrate and lipid in various tissues/food material
2. Identification of different kinds mono-di and poly saccharides in biological /food materials
3. Verification of Beer Lambert’s Law using any colour solution
4. Determination of absorption maxima of a coloured solution
5. Standard curve –cholesterol, protein
6. Determination of pH of different solution.
7. Quantities estimation of the following in various tissues.
   - Carbohydrates: Glycogen, & Glucose
   - Proteins: Total protein.
   - Lipids: Total Lipid & Cholesterol
   - Nucleic Acid: DNA and RNA
   - Enzymes; Acid and Alkaline Phosphatase

SUGGESTED BOOKS
8. Biochemistry, Donald Voet, Judith G. Voet.
ZOL 111: PRACTICAL-I
(BASED ON ZOL 101, ZOL 102 and ZOL 103)

Scheme for Practical Examination

Max. Marks: 100  Time: 4 hrs

1. Major Exercise  26
2 (a) Minor Exercise  10
(b) Minor Exercise  10
3. Spotting (8 × 3)  24
4. Seminar  10
5. Viva Voce  10
6. Record  10

Notes:
1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of charts/models/CD-ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.
2. It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

M. Sc. ZOOLOGY I SEMESTER

ELECTIVE (GROUP A)

ZOL 1 A01: FUNDAMENTALS OF COMPUTERS AND BIOINFORMATICS

Max. Marks: 100  Total Hours: 60

UNIT-I

Fundamentals of computers:
1. Types of computers
2. Basic components of a computer
3. Generations of computer
4. Number system: Interconversion between binary, octal, decimal and hexadecimal
5. Softwares: System & application softwares
6. Operating systems: MS DOS, MS Windows, Unix/Linux
7. MS Office: MS Word, MS Excel, Power Point
8. Elementary idea of Adobe Photoshop
9. Internet: Physical and logical topologies, types of networking (LAN, MAN and WAN)
10. Web search engines: Yahoo, Google, MSN and Entrez (including Pubmed).

UNIT-II

Introduction of bioinformatics:
1. History, definitions & scope of bioinformatics
2. Related fields and areas of bioinformatics
3. Applications of bioinformatics
4. Bioinformatics in India.

Biological database:
1. Classification: Primary, secondary and composite databases
2. Nucleotide sequence databases: GenBank, EMBL and DDBJ
3. Protein sequence databases: SWISS-PROT, TrEMBL, UniPROT and PROSITE
4. Structural databases: Protein Data Bank (PDB), Molecular Modeling Database (MMDB), Nucleic Acid Database (NDB), Structural Classification of Proteins (SCOP) and Class Architecture Topology Homology (CATH).

UNIT-III

Sequence analysis:
1. Types of sequence alignment: According to sequence number and sequence length, homologous sequences
2. Methods of sequence alignment: DOT PLOT or DOT MATRIX, Dynamic programming, Heuristic methods (FASTA and BLAST)
3. Scoring scheme: Point accepted mutations (PAM) matrices, Blocks amino acid substitution matrices (BLOSUM)
4. Gaps and gap penalties

UNIT-IV

Genomics and proteomics:
1. Genomics: Definition, history and classification (structural, functional and comparative)
2. Proteomics: Definition, metabolomics, classification (protein expression profiling, functional and structural), data mining
3. Significance of genomics and proteomics

Phylogenetic analysis:
1. Graphical representation, molecular clock theory
2. Monophyletic, paraphyletic and polyphyletic
3. Gene/Protein Versus species trees
4. Methods for inferring molecular phylogenies
5. Software packages for phylogenetic analysis.

PRACTICALS
1. Exercises related to operating systems.
2. Exercises related to word processing (file formatting, page layout, mailing, printing etc.) using MS Word.
3. Use of MS Excel sheet for data processing.
4. Use of MS Power point for slide preparation.
5. Use of search engines.
6. Retrieve the sequence for the database.
7. Genome sequencing techniques.
8. Exercise based on various methods of sequence alignment.
10. Gene bank flat file format.
11. Data mining in proteomics.
12. Web based tools for sequence searchers and homology screening.

RECOMMENDED BOOKS

M. Sc. ZOOLOGY I SEMESTER

ELECTIVE (GROUP A)

ZOL 1A02: GENETICS

Max. Marks: 100

Total Hours: 60

UNIT-I

2. Laws of Inheritance, Modified Mendelian Ratios, Lethal Genes, Co-dominance, incomplete dominance.
3. Pedigree analysis
4. Multiple allelism.
5. Pleiotropism
UNIT-II

Sex determination and sex-linked inheritance:
2. Sex linked Inheritance: Hemophilia, colour blindness, baldness in man.
3. sex chromatin and drum sticks

Linkage and crossing over:
4. Crossing over: Concept and significance, Linkage disequilibrium and recombination.
5. Linkage: Concept & history, complete & incomplete linkage, Bridge’s experiment, coupling & repulsion, recombination frequency, Basic concept of dosage compensation, linkage maps based on two factor crosses.

UNIT-III

1. Genetic code; repetitive and unique DNA sequences, split genes, overlapping genes and pseudo genes.
2. Gene interactions: Lethal alleles, penetrance and expressivity, pleiotropism, modifiers, atavism, phenopoiies.
3. Genetic control of cell division; Proto-oncogenes, Oncogenes and Tumor suppressor genes.
4. Transposable genetic elements.
5. Molecular mechanism of mutation, forward and reverse genetic mutations at DNA and protein level, frame shift mutation, extragenic suppression, physiological suppression.
6. Extranuclear inheritance, maternal effect, organelle heredity, infection heredity.

UNIT-IV

2. Inbreeding and related disorders; Other genetic diseases.
4. Elementary idea of Gene therapy.
5. Behavioral genetics, circadian rhythm in Drosophila.
6. Human genome project.

PRACTICALS
2. Construction of linkage map based on recombination frequency data obtained from a two point cross from real life data.
3. Chi-square analysis of a dihybrid F2 population data.
4. Study of meiosis in testes of grasshopper.
5. Pedigree analysis of hemophilia in Royal family of Great Britain.
7. Study of the following with the help of photographs: Sex chromosome in Melandrium/ Coccinia, multivalent, inversion Bridge, laggards, translocation ring (Rhoeo), human genetic syndromes (Down’s, Turner’s, Klinefelter’s), Barr bodies.
8. Preparation of Chromosome plate from bone marrow of laboratory mice.

SUGGESTED BOOKS:
5. Genetics of populations, Hedrick, R. W. Jones and Bartelt publisher, Sudbury, Massachusetts.

M. Sc. ZOOLOGY I SEMESTER

ELECTIVE (GROUP A)

ZOL 1A03: APPLIED ZOOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I
1. Economic importance of beneficial and harmful Protozoa, helminthes, mites and ticks, crustaceans and spiders.
2. Insects as pollinators, ornamental insects; insects as food.
3. Industries related to Lac insect, Honey bees and Silk worm.
4. Disease causing insects (in man and animals) and their control.

UNIT-II
1. Pisciculture and products of fishing industry.
2. Freshwater fish culture.
3. Common freshwater and marine food fishes of India.
4. Freshwater aquarium, common freshwater aquarium fishes.
5. Fishing methods in India.
6. Products of fish industry.
7. Larvicidal fishes of India.
8. Prawn culture, Pearl culture.

UNIT-III
1. Poultry keeping and Duck poultry.
2. Dairy farming and Piggery.
3. Leather industry, wool industry, fur and fur industry.

UNIT-IV
1. Pharmaceuticals from animals.
2. Economic importance of snakes
3. Economic importance of mammals.
4. Crop pests, storage pests, pests of fruits and vegetables.

PRACTICALS
1. General introduction to stains, preservatives and fixatives.
2. Museum specimens
3. Protozoa- Selected species of economic importance
4. Platyhelminthes- Selected species of economic importance
5. Arthropoda- Mites, Ticks, Spiders, Insects
6. Molluscs, Echinoderms, fishes, snakes and mammals
7. Poultry and dairy animals
8. Permanent preparations- Whole mounts, various body parts/Appendages
9. Industries mentioned in the syllabus.
10. Study of protozoan, Helminth parasites and arthropod vectors associated with human disease.

RECOMMENDED BOOKS

M. Sc. ZOOLOGY I SEMESTER

ELECTIVE (GROUP B)

ZOL 1 B01: TOXICOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

Fundamentals of toxicology:
1. Definition, scope and basic divisions of toxicology.
2. Basic concept of Toxicology: Toxicants and toxicity; Factors affecting environmental concentrations of toxicants; Factors influencing toxicity.
3. Dose; Effect and response; Dose-response relationships; Statistical concepts of toxicity; Margin of safety (Slope); Toxicity curves; Cumulative toxicity.
4. Toxicological testing methods: General test design; Single species tests; Multispecies tests; Acute, Subacute and Chronic toxicity tests.
5. Concept of QSAR, Toxicogeomics, Metabolomic technology, Molecular toxicology and Chronotoxicology.

UNIT-II

Toxicants of public health:
1. Toxic chemicals and their effects: Pesticides; Heavy metals; Fertilizers; Food additives;
2. Radioactive substances; Automobile emissions.
3. Membrane permeability and mechanisms of chemical transfer; Absorption and Translocation of xenobiotics; Membrane barriers, binding of xenobiotics and storage depots; Excretion of xenobiotics.
4. Toxic chemicals in the environment; Bioconcentration and Biomagnification.
UNIT-III

Biotransformation of toxicants:
1. Definition and Biotransformation sites.
2. Phase I reactions: Oxidation, Reduction and Hydrolysis.

UNIT-IV

Natural Toxins and their health effects
1. Microbial toxins: Anthrax, Botulism, Staphylococcal Enterotoxin, Mycotoxicosis, Mushrooms.
4. Neurotoxic plants: Hemlock (Conium maculatum), Water hemlock (Cicuta virosa), Curare (Chondrodendron tomentosum).
5. Cyanogenic plants: Hydrangea (Hydrangea paniculata), Apricot, Cassava (Manihot esculenta).
6. Poisonous plants: Castor (Ricinus communis), Rosary pea (Abrus precatorius), Oleander (Nerium oleander), Azalea (Rhododendron)

PRACTICALS
1. Determination of LC50/LD50 of any toxicant using organisms.
2. Study the effects of toxicants on blood cells and blood biochemistry.
3. Study the effects of toxicants on liver function enzymes such as, Alkaline phosphatase, SGPT and SGOT.
4. Study the effects of toxicants on kidney function.
5. Study the effects of toxicants on enzyme Acetylcholinesterase.
6. Study the effects of toxicants on chromosome of various organisms.
7. Study the protein profile of various tissues of toxicant exposed animals.
8. Histopathological/histochemical study of live, kidney, brain and GIT after exposing suitable experimental organisms exposed to various toxicants.
9. Study of various natural toxins producing organisms (microbes, plants and animals) based on syllabus.
10. Writing report on any one type of occupational hazardous event in the past.

SUGGESTED BOOKS
1. Fundamentals of Toxicology, Casseret and Doulls; Curthis Klassen 1997.
2. Environmental Pollution, Health and Toxicology. S. V. S Rana, Narosa Publishing House, New Delhi.
4. Environmental Biology and Toxicology. P. D. Sharma. Rastogi Publications.
M. Sc. ZOOLOGY I SEMESTER

ELECTIVE (GROUP B)

ZOL 1 B02: BIOSAFETY AND BIOETHICS

Max. Marks: 100 Total Hours: 60

UNIT-I

Bio-safety:
1. Definition, requirement, bio-safety containment facilities.
2. Bio-safety against infectious agents/microorganisms; bio-safety levels for infectious agents and infected food/animals.
3. Introduction to biological safety cabinets; biohazards, biosafety for human health and environment.
4. Designing and management of laboratory and culture room as per the norms of GLP, GMP and FDA.

UNIT-II

Bio-safety issues:
2. Ethical issues: Somatic and germ line gene therapy, clinical trials, ethical committee function, social and ethical issues.
3. Issues related with GMOs, the risk of introducing genetically engineered organisms to environment- ecological safety.
4. Indian government bio-safety guidelines, role of RCGM (review committee on genetic manipulation), role of GEAC (genetic engineering approval committee).
5. Role of IBSC (institute bio-safety committee) in research and development of GMOs (transgenics), in medicine, food and agriculture; guidelines for environmental release of GMOs; risk assessment, risk management.

UNIT-III

Bioethics:
1. History, development of discipline, objectives and scope.
3. Medical ethics.
4. Perspectives and methodology.

Biotechnology ethics:
1. Human problems.
3. Biotechnology and experimental animals, ethical issues of transgenic animals.
4. Religious views of transgenic animals.
UNIT-IV

Ethics in animal research:
1. Research areas of medicine and biology based on animal experiments.
3. Issues related to animal experiments, the 3Rs.
4. Scenario in India.
5. Institutional Animal Ethics Committee (IAEC), composition and function.

PRACTICALS
1. Study of biosafety equipments (biosafety cabinets, etc.).
2. Study of laminar flow hood and sterilization equipments (dry air oven, autoclaves, sterilisers, etc.).
3. Handling of laboratory animals.
4. Study of transgenic organisms.
5. Study of laboratory and culture rooms.
6. Visit to laboratory animal facilities.
7. Study of important cases related to ethical issues.

SUGGESTED BOOKS
M. Sc. ZOOLOGY I SEMESTER
ELECTIVE (GROUP B)
ZOL I B03: PARASITOLOGY

Max. Marks: 100
Total Hours: 60

UNIT-I

Introduction to parasitology:
1. History of parasitology.
2. General idea of life cycle of parasites.
3. Types of development of parasitic forms and alternation of generation.
4. Development of parasite in tissue system.
5. Mechanism of pathogenicity.
6. International Zoological Nomenclature as applicable to parasites.
7. Economic importance of taxonomic study of parasites.

UNIT-II

Parasitic Protozoa:
1. Classification of parasitic protozoa.

UNIT-III

Parasitic Helminthes:
1. Classification of the parasitic helminthes.
2. Structure, life history, pathogenicity, treatment and management of: Fasciola hepatica, Fasciola buski, Schistosoma haematobium, Schistosoma mansoni and Schistosoma japonicum.

UNIT-IV

Parasitic Annelids and Arthropods:
1. Classification of parasitic Annelids and Arthropods.
2. Structure, life history, pathogenicity, treatment and management of: Glossiphonia, Pontobdella and Hirudo medicinalis.
3. Structure, life history, pathogenicity, treatment and management of: Pediculus humanus capitis, Pediculus humanus corporis, Phthirus pubis, Cimex lectularius, Mites, Ticks, Cattle louse and Xenopsylla cheopis.
PRACTICALS
1. Examination of blood for parasites.
2. Detection of exflagellation (microgamete formation in Plasmodium).
3. Examination of blood for microfilarial infection (Papanicauo-hematoxylin and eosin).

SUGGESTED BOOKS
2. Parasitology. Chatterjee K.D.

ZOL 112A/112B: PRACTICAL-II
(BASED ON ZOL 1 A01, ZOL 1 A02, ZOL 1 A03/ ZOL 1B01, ZOL 1 B02, ZOL 1 B03,)

Scheme for Practical Examination

Max. Marks: 100

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Marks</th>
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<tbody>
<tr>
<td>1. Major Exercise</td>
<td>26</td>
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<tr>
<td>2 (a) Minor Exercise</td>
<td>10</td>
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<tr>
<td>(b) Minor Exercise</td>
<td>10</td>
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<tr>
<td>3. Spotting (8 × 3)</td>
<td>24</td>
</tr>
<tr>
<td>4. Seminar</td>
<td>10</td>
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<tr>
<td>5. Viva Voce</td>
<td>10</td>
</tr>
<tr>
<td>6. Record</td>
<td>10</td>
</tr>
</tbody>
</table>

Time: 4 hrs

Notes:
1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of charts/models/CD- ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.
2. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.
M.Sc. ZOOLOGY II SEMESTER

CORE PAPER

ZOL 201: PHYSIOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

Digestive system:
1. Nature of food-stuff
2. Various types of digestive enzymes and their action in alimentary canal
3. Absorption and assimilation of food
4. Nervous and hormonal control of digestion
5. Energy balance

Circulatory system:
1. Composition and function of blood
2. Haemopoiesis, blood clotting
3. Blood volume, blood volume regulation
4. Comparative anatomy of heart structure
5. Myogenic heart, ECG – its principle and significance, cardiac cycle
6. Heartbeat, blood pressure and blood groups

Respiratory system:
1. Respiratory organs (gills, trachea and lungs), respiratory pigments
2. Mechanism of breathing
3. Physiology of respiration, control of breathing
4. Aerodynamics and BMR

UNIT-II

Excretory system:
1. Comparative physiology of excretion
2. Functional architecture of kidney and nephron
3. Nitrogenous end products, formation of urine and its hormonal control
4. Role of kidney in osmoregulation, urine concentration
5. Waste elimination, micturition
6. Electrolyte balance, acid-base balance

Muscular system:
1. Types and properties of muscles
2. Functional architecture of skeletal muscles
3. Biophysical and biochemical events during muscular activity

Nervous system:
1. Functional architecture of neurons
2. Origin and propagation of nerve impulse through axon
3. Action potential, synaptic transmission
4. Reflex arc and reflex action
5. Gross neuroanatomy of the brain and spinal cord
6. Central and peripheral nervous system
7. Neural control of muscle tone and posture
UNIT-III

Sense organs:
1. Structural architecture and functioning of eyes and ears
2. Tactile response

Thermoregulation and cold tolerance:
1. Heat balance and exchange, endotherms Vs ectotherms
2. Counter-current heat exchanger
3. Torpor, hibernation and aestivation
4. Adaptations to extreme climate
5. Comfort zone, body temperature- physical, chemical and neural regulation

Stress:
1. Basic concepts of environmental stress and strain
2. Homeostasis, physiological response to body exercise
3. Meditation, yoga and their effects

UNIT-IV

Endocrinology:
1. Endocrine glands in vertebrates, hormones and related diseases

Reproduction:
1. Reproductive cycle,
2. Reproductive processes (implantation, parturition and lactation), neuroendocrine regulators in insects and mammals, pheromones.

PRACTICALS
1. Photometric determination of haemoglobin in blood sample.
2. Determination of MCV, MCH, MCHC and colour index of the given sample of blood.
3. Demonstration of the blood clotting time and erythrocyte sedimentation rate,
4. Determination of the urea in urine
5. Determination of the glucose in urine.
6. Study of digestive enzymes in different parts of the alimentary canal.
7. Study of histological slides of endocrine glands
8. Study of estrus smear
9. Study of location of endocrine glands
10. Measurement of human blood pressure
11. Demonstration of haemolysis and crenation
12. Demonstration of Kymographic recording of the frog heart beat and the study of the effect of electrical stimulation, hot and cold, drugs, etc*
13. Kymographic recording of muscle twitch, summation of twitches, chronic contractions, tetanus, fatigue and stair-case phenomenon from the sciatic nerve gastronemius muscle preparation of frog.*
14. Study of spinal and convulsive reflexes in frog*

*In case, frogs become available students may be asked to perform the various exercises. Otherwise following CAL exercise may be included (please see E-pharm programme).

The effect of K+, Ca++, ACh and Epinephrine on the isolated heart of frog and conclude your data with the graphic representation.

The effect of various doses of ACh and Nor-epinephrine on Blood pressure, Heart Rate and Respiratory Rate of the dog.

The effects of Atropine, Epinephrine, Ephedrine and Eserine on Rabbit's eyes and other such exercise can be framed from the E-Pharm software.
SUGGESTED BOOKS

M. Sc. ZOOLOGY II SEMESTER

CORE PAPER

ZOL 202: MOLECULAR BIOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

DNA:
1. Equivalence rule.
2. Primary & secondary structure.
3. Unusual secondary structure (slipped & cruciform structure; triple helix DNA; tetraplex) and G-quadruplex.
4. Types (A-, B- & Z-DNA) and flexibility.
5. Forces stabilizing the structure: Denaturation & renaturation; base pairing, hydrophobic interactions & ionic interactions.
6. Tertiary structure (super coiled DNA, twisting number, writh, linking number & topoisomerases).

**DNA replication:**
1. Prokaryotic and Eukaryotic replication.
3. Enzymes and accessory proteins involved in DNA replication.
4. Drugs that effect replication.

**UNIT-II**

**RNA and transcription:**
1. Types & structural features (mRNA, tRNA & rRNA).
2. Prokaryotic transcription.
3. Eukaryotic transcription.
4. Regulatory elements and mechanisms of transcription regulation.
5. Transcription termination-attenuation and antitermination.
6. Drugs inhibiting transcription.

**Post-transcriptional modifications in RNA:**
1. 5' Cap formation.
2. End processing and polyadenylation.
3. Splicing and editing.
4. Nuclear export of mRNA.
5. RNA stability.
6. Inhibitors of RNA synthesis.

**UNIT-III**

**Translation:**
1. Genetic code.
2. Prokaryotic and eukaryotic translation.
3. Regulation of translation.
5. Inhibitors of protein synthesis.

**Organelles and protein sorting:**

- Endoplasmic reticulum
  (i) Targeting proteins to and across ER membrane.
  (ii) Insertion of membrane proteins into ER.
  (iii) Protein modification, folding and processing in ER.

- Mitochondria & Chloroplast
  (i) Targeting of proteins.

- Golgi apparatus
  (i) Glycosylation.
  (ii) Protein sorting & export.
  (iii) Mechanism of vesicular transport.

- Lysosomes

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[Handwritten note: Signatures]
(i) Endocytosis and lysosome formation, phagocytosis & autophagy.

5. Peroxisomes
   (i) Assembly.
   (ii) Sorting of peroxisomal proteins.

UNIT-IV

Recombination and repair:
1. Homologous recombination-Holliday model & ds break repair model
2. Homologous recombination protein machinery – Rec BCD pathway, RecA, Ruv AB complex & Ruv C.
4. FLP/FRT and Cre-Lox recombination.
5. DNA repair mechanisms- Radiation damage, Direct reversal, Oxidative damage, Alkylation, Base excision repair, Nucleotide excision repair, Mismatch repair, ds break repair, SOS response and Translation DNA synthesis.

Eukaryotic genomes:
1. C-value paradox.
2. Reassociation kinetics.
3. Non repetitive DNA complexity.
4. Repetitive sequences.
5. Structural genes (as present in mRNA)- Existing gene number by kinetics of RNA driven reactions.
6. Structural genes- Internal organizations.

PRACTICAL
1. Squash and smear preparation of testes of cockroach / grasshopper using acetocarmine and Fuelgen staining.
3. Identification of mitochondria and Golgi body from cells of testes of insect /mammal using vital or supravital stains (Neutral Red & Janus Green B).
4. Smear preparation of spermatozoa from cauda epididymis (vital staining).
5. Preparation of multipolar nerve cells from the spinal cord of mammals.
6. Electrophoresis:
   (i) DNA molecular size determination.
   (ii) Extraction & purification of DNA from gel.
   (iii) Extraction & isolation of genomic DNA from bacteria / Yeast / human cheek cells.
   (iv) Experiments using restriction enzymes & DNA ligase.
   (v) Isolation of RNA from bacteria.
7. Slides: Types of cells (squamous, cuboidal, columnar epithelial cells, nerve cells, muscles cell) connective tissue of various types, adipose tissue & slides related to experiments.

SUGGESTED BOOKS
M. Sc. ZOOLOGY II SEMESTER
CORE PAPER
ZOL 203: BIOSTATISTICS

Max. Marks: 100
Total Hours: 60

UNIT-I

Introduction to Biostatistics:
1. Definition of biostatistics
2. Scope and applications of biostatistics
3. Sampling methods
4. Probability (Binomial, normal and Poisson)
5. Collection, organization and representation of data (graphical & diagrammatic)

Measures of Central Tendency & Variability:
1. Mean, median & mode
2. Mean deviation
3. Standard deviation & standard error
4. Variance & coefficient of variation
5. Confidence interval and level of confidence

UNIT-II

Correlation and Regression:
1. Types of correlation
2. Methods of studying correlation
3. Regression analysis

Probability:
1. Basic concepts related to probability theory.
2. Classical, Posteriori, Personalitic & Axiomatic probability.
3. Theorems of probability & Probability distributions.

UNIT-III

Tests of significance:
1. Hypothesis testing & level of significance
2. Type I & II errors
3. Significance of difference in means
4. Z-test
5. Students t-test (Unpaired & Paired)
6. F-test (variance ratio)

Analysis of variance:
1. One way classification
2. Two way classification
UNIT-IV

Chi square test:
1. Testing Goodness of fit
2. Chi Square distribution and characteristics
3. Applications of Chi-square test
4. Yate’s correction

Computational statistics using MS Excel

PRACTICALS
1. Preparation of frequency tables, bar diagrams, histograms, frequency, ogives and pi-diagrams.
2. Calculation of mean, median, mode, standard deviation and coefficient of variation.
4. Estimation of significance between samples using Student’s t-test, F-test and Chi-square test.
5. Plotting of scatter diagrams & regression lines, calculation of correlation and regression analysis.
6. Analysis of variance (One way & Two way classification).
7. Use of MS Excel spread sheet for data processing.
8. Preparation of graphs using computers

RECOMMENDED BOOKS
ZOL 211: PRACTICAL-III
(BASED ON ZOL 201, ZOL 202 and ZOL 203)

Scheme for Practical Examination

Max. Marks: 100

1. Major Exercise
2. (a) Minor Exercise
   (b) Minor Exercise
3. Spotting (8 x 3)
4. Seminar
5. Viva Voce
6. Record

Time: 4 hrs

- 26
- 10
- 10
- 24
- 10
- 10

Notes:

1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

M. Sc. ZOOLOGY II SEMESTER

ELECTIVE (GROUP A)

ZOL 2 A01: IMMUNOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

1. Historical perspective of Immunology, Early theories of Immunology, Innate, Adaptive (cell mediated and humoral)- Passive: Artificial and Natural Immunity, Active: Artificial and Natural Immunity.
2. Haematopoiesis, Cells of the immune system, Organs of the immune system: Primary and secondary lymphoid organs, Lymphatic system.

UNIT-II

1. Properties of antigens.
2. Adjuvants and Haptens.
3. Basic structure, classes and function, Polyclonal sera.

UNIT-III

1. Structure and functions of antibodies.
2. Mechanism of cell mediated and humoral immunity.
3. Endogenous pathway and exogenous pathway of antigen presentation.
UNIT-IV

1. Brief introduction to Vaccines.
2. Immunodeficiency and autoimmunity.
3. Hypersensitivity.
4. Diseases of immune reaction

PRACTICALS
1. Dissection and display of lymphoid organs.
2. Ouchterlony's double immunodiffusion method.
3. ABO blood group determination.
4. Viability and cell counting of peritoneal macrophages using trypan blue.
5. Study of various types of immune reactions in vitro.

SUGGESTED BOOKS

M. Sc. ZOOLOGY II SEMESTER

ELECTIVE (GROUP A)

ZOL 2B02: ENVIRONMENTAL POLLUTION AND MANAGEMENT

Max. Marks: 100
Total Hours: 60

UNIT-I

Introduction to Ecology, Community and Ecosystem:
1. Different types of pollution-air, water, soil, noise, thermal, oil, radiation and their local, regional and global aspects.
2. Effects of pollutants on human health, animals, vegetation, material and structures

UNIT-II

1. Setting environment goals, resource mobilization, use of natural recourses and environmental indicators, output budgeting, monitoring and evaluating environmental programs.

UNIT-III

Environmental laws
1. Environmental legislation status in India.
2. The water (Prevention and control of pollution) Act 1974

UNIT-IV

Environmental Impact Assessment (EIA)
1. Concept of EIA, scope and objects of EIA, Organization responsible for EIA, Site selection and area classification, Setting criteria for EIA projects.
2. Various steps of EIA, content of EIA, assessment methodology, cost benefit analysis, case studies.

PRACTICALS
1. Study of the biotic and abiotic components of any one ecosystem.
2. Study of population density by using different methods - natural and hypothetical community.
5. Ecological adaptations of two animals and two plants.
6. Collection of data on- water or air pollution.
7. Visit to any restored biodiversity.
8. Visit to a National Park or wild life sanctuary.
9. Visit to any ecosystem - Natural or Human modified.

SUGGESTED BOOKS
4. Environmental Biology, P.D. Sharma, Rastogi Publications (2014)

M. SC. ZOOLOGY II SEMESTER

ELECTIVE (GROUP A)

ZOL 2A03: WILD LIFE, ITS MANAGEMENT AND CONSERVATION

Max. Marks: 100

Total Hours: 60

UNIT-I

Wildlife:
1. Definition and significance.
2. National park and Sanctuaries, Reserves, Hot spots and Hope spots.
3. IUCN classification of species, red data book.

UNIT-II

Techniques of studying wild life, traditional and advanced both.
2. Endangered species of India and their present status.
3. Measures adopted by government to protect them.
4. Management of excess population and translocation, Bio-telemetry, care of injured animal and Quarantine

UNIT-III
1. Management of special habitats.
2. Problems in plantations and exploited forests.
3. Species conservation projects: tiger, lion, rhino and crocodile management plan for protected areas
4. Threats to survival of Slender Loris, Musk Deer, Great Indian Bustard and Olive Ridley turtle.

UNIT-IV
1. Wildlife and livelihood, wildlife and illegal trade, its control
2. Use of Biotechnology in Wildlife conservation.
3. Captive breeding *in-situ* and *ex-situ* gene pool conservation.
4. Indian biodiversity act, economics of Indian biodiversity.

PRACTICALS
1. Study of wildlife habitat.
2. Visit to Zoological Park, National park and sanctuaries, reserves, hot spots and hope spots.
3. Study of different type of animals in soil, pond and water.
4. Quantitative estimation of any two species in nature by traditional method. (Insect, amphibian, reptiles or mammals)

SUGGESTED BOOKS
1. Techniques for wildlife Census in India (A field manual); Rogers W.A. Wildlife Institute of India, Dehradun.
7. Techniques for wildlife census in India (a field manual) W.A. Rogers, wildlife institute of India.
M. Sc. ZOOLOGY II SEMESTER
ELECTIVE (GROUP B)
ZOL 2B01: APPLIED BIOLOGY

Max. Marks: 100
Total Hours: 60

UNIT-I
1. Introduction to the concept of Recombinant DNA Technology.
2. Cloning vectors.
3. Restriction and modifying enzymes.
4. Transfection techniques (microbial, plants and animals).
5. Isolation, Sequencing and synthesis of genes.
6. Construction and screening of cDNA libraries.

UNIT-II
1. Molecular analysis of DNA, RNA and proteins (i.e., Southern, Northern and Western blotting), DNA sequencing (Maxam-Gilbert and Sanger methods).
2. Polymerase chain reaction and DNA microarrays.
3. Molecular map of animal genomes.

UNIT-III
1. Molecular diagnosis of genetic diseases (Cystic fibrosis, Huntington’s disease and Sickle cell anemia).
2. Recombinant vaccines.
3. Recombinant DNA in Medicine (Recombinant insulin and Human growth hormone).
4. Gene therapy (ADA and Cystic fibrosis).
5. Stem Cells and their applications.

UNIT-IV
1. Production and applications of transgenic plants (biotic, abiotic and improvement of nutritional quality) and transgenic animals (generation of medicines and hormones).
2. Different types of Bioreactors and their uses.
3. Use of Biotechnology in conservation of Biodiversity.

PRACTICALS
1. Isolation of plasmid DNA from *E. coli*.
2. Transformation of *E. coli* (pUC 18119) and calculation of transformation efficiency.
3. Restriction Endonuclease Digestion of plasmid DNA.
4. Ligation of target DNA.
5. Gene amplification using PCR.
6. DNA sequencing: Interpretation of sequence from the data provided.
8. Separation of proteins by SDS-PAGE.

SUGGESTED BOOKS
3. Molecular Biotechnology - Principles and Applications of Recombinant DNA. Glick

M. Sc. ZOOLOGY II SEMESTER

ELECTIVE (GROUP B)

ZOL 2 B02: HISTOLOGY AND HISTOPATHOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

1. Definition and scope of histology and histopathology.
3. Techniques in histology: Sample preparation, obtaining tissue samples, handling reagents, fixatives, processing of fixed samples, dehydration, embedding, block making.
4. slide preparation
5. Staining principles and demonstration techniques. Stains, dyes and dyebinding reactive groups, mordants and mordanting.

UNIT-II

1. Cellular Pathology; necrosis, pycnosis, apoptosis, nuclear fragmentation, fatty degeneration etc.
2. Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.
3. Skin.

UNIT-III

1. Histology and histopathology- thyroid, parathyroid, pituitary and adrenal gland.
2. Reproductive system – male and female.

UNIT-IV

1. Histology and histopathology-esophagus, stomach, intestine, colon and rectum, liver, pancreas.

PRACTICALS

1. Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology
2. Microscopic measurements of histological samples using micrometers and planimeters
3. PAS reaction, Alcian blue reaction, and detection in situ
4. Alkaline phosphatase detection in situ
5. Feulgen reaction
6. Sudan black B staining for lipids
7. Ethyl green – Pyronin G method of detection of nucleic acids
8. Study of different types of pathology in the tissues with the help of permanent slides.

SUGGESTED BOOKS

M. Sc. ZOOLOGY II SEMESTER

ELECTIVE (GROUP B)

ZOL 2B03: POPULATION GENETICS

Max. Marks: 100
Total Hours: 60

UNIT-I
1. Introduction to population genetics.
2. Genetic variation, Ecological significance of molecular variations.
3. Hardy Weinberg's law of genetic equilibrium – Assumptions, predictions and derivation of Hardy Weinberg's law, testing & extensions of Hardy Weinberg's law and limitations.

UNIT-II
1. Molecular phylogenetics:
3. Phylogenetic inference- Distance methods, Parsimony methods, Maximum likelihood method.
4. Immunological techniques.
5. Amino acid sequence and phylogeny.
6. Nucleic acid phylogeny, DNA – RNA hybridizations, restriction enzyme sites, nucleotide sequence comparisons and homologies.

UNIT-III
1. Molecular evolution
2. Gene evolution.
3. Gene duplication and divergence.
5. Molecular drive.

UNIT-IV
1. Genetics and quantitative traits in population.
2. Estimation of heritability.
3. Molecular analysis of quantitative traits.
5. Inbreeding and Heterosis.
7. Migration including One Way migration.

PRACTICALS
1. Estimates of Heritability
   a) Broad sense
   b) Narrow sense
   c) Components in Phenotypic variations
   d) Genetic variance
   e) Genetic environmental interactions
2. Hardy Weinberg Principle
   a) Genotypic frequencies and hardy Weinberg law
   b) Allelic frequencies (from observed no of different genotypes at particular locus and from genotypic frequencies
   c) Calculation of allelic frequencies with multiple alleles and at X linked locus
3. Genetic Structure of populations
   a) Phenotypic Frequency
   b) Allelic frequency
   c) Recessive and dominant characters
4. Exercises based on blood groups
5. Demonstration of microbes increment (Population Growth) by inoculating culture medium with microorganisms from soil air and water

SUGGESTED BOOKS
2. Evolution, Strickberger, M.W. Jones and Barlantt Publishers, Boston London
4. Evolution Genetics Merrill, D.J. Holt, Rinchart and Winston, Inc.
7. Evolutionary Biology, Futuyamma, D.J. Suiuauer Associate, Inc. Publishers, Sunder land
ZOL 212A/ZOL 212B: PRACTICAL-IV
(BASED ON ZOL 2A01, ZOL 2A02, ZOL 2A03/ ZOL 2B01, ZOL 2B02, ZOL 2B03)

Scheme for Practical Examination

Max. Marks: 100

1. Major Exercise
2 (a) Minor Exercise  
   (b) Minor Exercise
3. Spotting (8 x 3)
4. Seminar
5. Viva Voce
6. Record

Time 4 hrs  
26  
10  
10  
24  
10  
10  
10

Notes:
1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.
M.Sc. ZOOLOGY III SEMESTER
CORE PAPER
ZOL 301: BIOLOGY OF CHORDATES
Max. Marks: 100
Total Hours: 60

UNIT-I
1. Outline classification of the chordates and characters
2. Evolutionary time scale; evolutionary significance of notochord and endostyle in protochordates
5. The early Gnathostomes (Placoderms).

UNIT-II
1. A general account of the Elasmobranchii, Holoccephali, Dipnoi and Crosspterygii.
4. Origin and evolution of Reptiles: Seymouria and Cotylosauria; Dinosaurs
5. Skull types in Reptiles.
6. Sense organs in reptiles including vomeronasal organs.

UNIT-III
1. Origin and evolution of birds.
3. Flightless Birds.
4. Modifications of beak, feet and palate in birds.

UNIT-IV
1. Origin of mammals: Primitive mammals (Prototheria and Metatheria); Evolution of viviparity
2. Evolution and significance of exothermy & endothermy.
3. General account on adaptive radiations in Eutherian mammals.
4. Stomach in ruminants; evolution of primates

PRACTICALS
1. Anatomy:
   Cranial Nerves of Wallago attu or any other locally edible fish.
   Accessory respiratory organs of Heteropneustus fossilis.
   Labyrinthine organs of Anabas.

2. Museum specimens:
   Lower Chordates: Salpa-Asexual and Sexual stage, Doliolum- oozoid, Botryllus, Herdmania and Amphioxus, Petromyzon, Myxine.
Clarias, Mestacembelus, Diodon, Tetradon, Ostracion, Lophis, Syngnathus, Hippocampus, Anguilla, Labeo, Ophiocephalus, Harpodon (Bombay Duck).


Reptilia: Testudo, Chelone, Sphenodon, Calotes, Hemidactylus, Phrynosoma, Draco, Vranus, Chameleon, Cobra, Hydrophis, Rattle Snake, Viper, Pit Viper, Kratt, Eryx, Gavialis.

Aves: Archaeopteryx, Taylor Bird, Indian Koel, Jungle fowl, Pavo, Columba, Psittacula, Wood Pecker, Bubo (Horned), Flamingo.

Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat, Mongoose, Hystrix, Otter.

3. Microscopic Slides:
Lower Chordates: Herdmania - tadpole larva, Amphioxus - T. S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoete larva whole mount.

Pisces: Placoid scale, Cycloid scale, Ctenoid scale.

Amphibia: V S skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testes, ovary, spinal cord, bone.

Reptilia: V S skin of lizard.

Aves: V S skin of bird, contour feather, down feather.
Mammalian tissues: Blood smear, Simple cuboidal epithelium, Simple columnar epithelium, Simple squamous epithelium, Adipose tissue, Reticular tissue.

Mammals: V S skin of mammals, T S passing through stomach, intestine, liver, pancreas, kidney, testes, ovary, thyroid gland, adrenal gland, pituitary gland, lung, bone, spinal cord.

4. Comparative Osteology:

Comparative account of axial and appendicular skeletons of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).

Skull of Reptiles (Anapsida and Diapsida).

Palate in Birds.

Skull and lower jaw of carnivore mammal & herbivore mammal.

5. Collection of various types of feather.
Note:
1. With reference of whole mounts and museum specimens the animal types may be substituted with diagrams/photosographs/models etc.
2. It should be ensured that animals used in the practical exercise are not covered under the wildlife act 1972 and amendments made subsequently.

SUGGESTED BOOKS
2. Structure and Habit in vertebrate evolution - carter, G.S.Sedgwick and Jackson, London.

M.Sc. ZOOLOGY III SEMESTER

CORE PAPER

ZOL 302: GENES AND DIFFERENTIATION

Max. Marks: 100  Total Hours: 60

UNIT-I

Principles of developmental biology:
1. Potency, commitment, specification, induction and competence.
2. Determination and differentiation; morphogenetic gradients; cell fate and cell lineages.
3. Development in unicellular eukaryotes and metazoans.

Early vertebrate development:
1. Cleavage types
2. Gastrulation, Cell movement and formation of germ layer (fruit fly, frog, chick and mouse)
Cell-cell interaction and cell signalling:
1. Cell-cell interaction and cell signalling during morphogenesis in early embryo gastrulation, neurulation and primordial organ rudiments

UNIT-II

Body Axes:
1. Genetics of axis specifications in Drosophila
2. Establishment of body axes in mammals and birds
3. Tetrapod limb development
4. Homeobox concept in different phylogenetic groups

Hormones as mediators of development:
1. Insect metamorphosis
2. Amphibian metamorphosis

UNIT-III

Environmental regulation and animal development:
1. Environmental cues and effects
2. Malformations and disruptions
3. Changing evolution through development modularity
4. Developmental constraints
5. Creating new cell types—basic evolutionary mystery.

Biology of sex determination:
1. Chromosomal sex determination in Drosophila and Mammals
2. Testis determination genes
3. Ovarian development
5. Environmental sex determination

UNIT-IV

Embryonic stem cells:
1. Totipotency and Pluripotency
2. Embryonic stem cells, stem cells niches.
3. Genomic equivalence and the cytoplasmic determinants
4. Renewal by stem cells-epidermis, connective tissue & skeletal muscle

Hemopoietic Stem cells:
1. Blood cell formation
2. Bone marrow transplants
3. Stem cell disorders
4. Gene therapy

Genetic errors of human development:

PRACTICALS
1. To Study life cycle of Drosophila
2. Identification of male and female Drosophila
3. Identification of wild and mutant forms of Drosophila
4. To prepare permanent slide of 'Sex comb' of Drosophila
5. To prepare permanent slide of W.M. of Drosophila
6. To make a squash preparation of salivary gland chromosome from 3rd Instar larva of *Drosophila*
7. Monohybrid and dihybrid inheritance in *Drosophila*
8. Simple problems based on Mendelism
9. Identifications of blood groups
10. Demonstration of sex chromatin
11. Embryology of Frog
12. Embryology of Chick
13. Blastoderm mounting of chick embryo
14. To study development of chick embryo through window preparation.

**SUGGESTED BOOKS**
1. Development Biology S.F. Gilbert, Sinauer Associates Inc., Massachusetts
3. An Introduction to embryology, Balinsky, B.I.: W.B. Saunders Comp., ?
6. Chicago

M.Sc. ZOLOGY III SEMESTER

CORE PAPER

**ZOL 303: EVOLUTION**

Max. Marks: 100  Total Hours: 60

**UNIT I**

1. Concept of evolution (Lamarkism, Darwanism & Neo Darwínism).
2. Evidences of evolution (macro and micro) – From comparative anatomy, embryology and physiology.
3. Rate of evolution (Horotely, Bradytely and Tachytely).
4. Time line for major events in the history of life on earth.

**UNIT II**

1. Variations –including transgressive variation.
2. Mutations.
3. Genetic drift.
5. Migration.
UNIT III

1. Isolation and isolating mechanisms.
2. Species and Speciation – Phylogenetic and biological and other concepts of species, modes of speciation (Allopatric, sympatric, parapatric and peripatric)
4. Phenotypic plasticity.
5. Polymorphism

UNIT IV

1. Punctuated equilibrium and phyletic gradualism.
2. Human evolution.
3. Altruism, selfish gene, coevolution and kin selection.
4. Extinctions and mass extinctions.

PRACTICALS

1. Exercises based on natural selection
   a) Darwinian fitness
   a) Selection coefficient
   b) Effects of natural Selection on gene frequencies
2. Construction of phylogenetic trees
3. Study of examples of different types of Speciation.
4. Study of examples of Adaptations in various habitats.
5. Study of selected stages in human evolution.
6. Study of Altruism, co-evolution and kin selection with the help of examples.

SUGGESTED BOOKS

Evolution and Population genetics, Rashmi Sisodia, Paragon international Publishers.
Evolution Strickberger, M.W. Jones and Barlantt Publishers, Boston London
Evolution and Genetics Merrall, D.J. Holt, Rinchart and Winston, Inc.
Evolutionary Biology , Futuyamma, D.J. Suinuaer Associate, Inc. Publishers, Sunderland
Genetics and Origin of Species, Dohnzhansky, Th. F.J. Alaya G.L. Stebbines and J.M. Valentine, Surjeet Publication Delhi
Genes and Evolution , Jha A.P. John Publication New Delhi

ZOL 311: PRACTICAL-V

(Based on ZOL 301, ZOL 302 and ZOL 303)

Scheme for Practical Examination
Max Marks 100

1. Major Exercise 26
2. (a) Minor Exercise 10
   (b) Minor Exercise 10
3. Spotting (8 x 3) 24
4. Seminar 10
5. Viva Voce 10
6. Record 10

Notes:
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M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP A (SPECIAL PAPER)

ZOL 3A01: CANCER & RADIATION BIOLOGY

BASICS OF RADIATION BIOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

Fundamentals of radiation and its management:
1. Natural and artificial radioactivity.
2. X-rays production, characteristics and applications, hard and soft X-rays.
3. Ionizing and non-ionizing radiation (electromagnetic radiation).
4. Units of radiation and half-life of radioisotopes.

UNIT-II

Radioactive contamination and decontamination:
1. Sources of radioactive contamination.
2. Nuclear fallout.
3. Decontamination.
4. Types and management of radiation accidents.

UNIT-III

Detection monitoring and measurement of radiation:
1. Film badge.
2. Pocket dosimeter.
3. Thermo luminescence dosimeter.
4. G. M. counter.
5. Scintillation counter.
6. Proportional counter.
7. Gamma ray spectrophotometer.
UNIT-IV

Radiation safety and regulatory aspects:
1. Maximum permissible dose.
2. Source storage facilities.
3. Radiographic installations.
4. Personnel management.
5. Safe work practice.

M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP A (SPECIAL PAPER)

ZOL 3A02: CANCER & RADIATION BIOLOGY

RADIATION EFFECTS

Max. Marks: 100

Total Hours: 60

UNIT-I

Cellular radiobiology:
1. Effects of radiation on macromolecules.
2. In vivo cell survival curves.
3. Concept of LD50/30 and Dose reduction factor (DRF).
4. Radio-sensitivity of cell cycle phases, cell division delay and cell cycle check points.

UNIT-II

Interaction of radiation with matter:
1. Direct and indirect effects.
2. Photoelectric and Compton effects.
3. Ion pair production and Scattering.

UNIT-III

Radiation syndromes:
1. Prodromal Syndrome.
2. Gastro-intestinal syndrome.
3. Hematopoietic syndrome.
4. Central nervous system syndrome.

UNIT-IV

Delayed radiation effects:
1. Stochastic and deterministic effects.
2. Life shortening.
3. Radiation hormesis.
4. Radiologic aging.
5. Radiation carcinogenesis.
UNIT-I

Radiation induced DNA damage and repair:
1. Repair of DNA breaks.
2. Repair of base damage.
4. Postreplication recovery.
5. Base excision repair, nucleotide excision repair (NER).
6. Transcription coupled repair (TCR) and bulk DNA repair.

UNIT-II

Radiation Chemistry:
1. Radiolysis of water.
2. Formation of oxygen reactive species.
3. Oxygen effect.
4. Linear energy transfer and relative biological effectiveness.

UNIT-III

Cytogenetic effects of radiation:
1. Chromosomal aberrations.
3. Radiation mutations.

UNIT-IV

Application of radiation in Medicine:
1. Radiation therapy.
2. Therapeutic nuclear medicine.
5. Radioimmunoassay.

PRACTICALS
1. Symbol of Radiation: Trefoil.
2. Knowledge and use of the various instruments. Geiger-Muller counter.
5. Finding out the operating voltage of the G-M tube.
6. Calculation of Inverse Square Law.
8. Absorption of beta and gamma rays.
10. Histopathological, histochemical and biochemical studies of various tissues after external irradiation.
12. Decontamination of contaminated material.
13. Visits to the Radiotherapy Department, S.M.S. Medical College, Jaipur; Rajasthan Atomic Power Project, Kota and Bhabha Atomic Research Centre, Mumbai.

SUGGESTED BOOKS

ZOL 312: PRACTICAL-VI

Scheme for Practical Examination
(Based on ZOL 3A01, ZOL 3A02 and ZOL 3A03)

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<th>Max Marks: 100</th>
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M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP B (SPECIAL PAPER)

ZOL 3B01: CELL AND MOLECULAR BIOLOGY

CELLULAR STRUCTURE AND FUNCTION

Max. Marks: 100

UNIT-I

Biomembranes:
1. Molecular constituents of membranes: Lipids (glycerophospholipids, sphingophospholipids, glycolipids, sterols); proteins (extrinsic, intrinsic —glycoporin, porin & fusion proteins); prediction of integral membrane protein topology from its sequence, spatial relationship of proteins to lipid bilayer; carbohydrates-glycocalyx.
3. Fluidity and mobility of lipids and proteins.
5. Chemistry of fixatives: Common properties of fixatives, formalin, acetic acid, alcohol acetone, picric acid, gluteraldehyde, metallic ions and complexes.

UNIT-II
Transport across cell membrane:
1. Mechanism of diffusion; Facilitated diffusion.
2. Osmosis, permeability constant, factors influencing permeability & Gibb's – Donnan effect.
3. Uniporter-catalyzed transport, difference between uniport-catalyzed transport and passive diffusion, GLUT- 1-5 transport & its kinetics.
4. Ion channels and membrane electric potential (Nernst equation).
5. Active transport - P-class ion pumps, F-class and V-class ion pumps, ABC superfamily. Plasma membrane Ca⁺⁺ATPase pump, Muscle Ca⁺⁺ATPase pump & Na⁺/K⁺ ATPase pump, Ionophores.
6. Cotransport by sympporters and antiporters.
7. Transport across epithelia; Endocytosis: pinocytosis, phagocytosis & receptor mediated; Transcytosis.
8. Diseases: Cystic fibrosis & Type I diabetes mellitus.

UNIT-III
Cytoskeleton:
1. Intermediate filament: Proteins, assembly, organization (desmosomes, hemidesmosomes, desmin & neurofilaments).
2. Microfilaments:
   (i) Actin: G-actin, F-actin, structural and functional polarity.
   (ii) Assembly, disassembly and organisation of actin filaments: Polymerization, actin – binding proteins (Formin, Arp2/3 complex, ADF/ COFlin, Proflin, CapZ etc.), actin bundling proteins, toxins affecting polymerization.
5. Microtubules: Structure, assembly of microtubules from organizing centre, dynamic organization, microtubule associated proteins (MAPS), microtubules associated structures (Centrosome duplication, kinetochore and force for poleward chromosome movement, Organization of spindle pole and orientation of assembly, astral microtubule and cytokinesis & microtubules and plant cell formation) and drugs disrupting microtubules.
6. Microtubules motor proteins:
   (i) Intracellular transport: Role of kinesin and dynein, microtubule tracks and intracellular membrane vesicles.
   (ii) Amoeboid movements.

Cilia and flagella:
1. Structure and movements
   (i) Sliding of outer doublet.
   (ii) Dynein sliding forces in axonemes.
1. Dynemin and axonemal bending.
2. Dynemin regulatory complex.

UNIT-IV

Cell-cell adhesion and communication:
1. Cadherin mediated Ca$^{2+}$ dependent homophilic cell-cell adhesion.
2. N-CAM’s mediate Ca$^{2+}$ independent homophilic cell-cell adhesion.
3. Cell junctions: Occluding junctions, anchoring junctions (adhesion belts, focal contacts, desmosomes & hemidesmosomes) & communicating junctions (gap junctions, chemical synapses & plasmodesmata).
4. Cadherin containing junctions.
5. Cell adhesion molecules as diagnostic tools in cancer.

Cell matrix adhesion molecules:
1. Integrin-in cell matrix and cell-cell interaction.
2. Collagen-Basic structure and assembly.
4. Role of selectin, integrin & Ig in extravasation.

Cell wall:
1. Bacterial cell wall.
2. Plant cell wall.
3. Auxin & cell expansion.

M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP B (SPECIAL PAPER)

ZOL 3 B02: CELL AND MOLECULAR BIOLOGY

CELLULAR PHYSIOLOGY AND REGULATORY MECHANISM

Max. Marks: 100
Total Hours: 60

UNIT-I

Cell-Cell signalling:
1. Endocrine, paracrine and autocrine signaling.
2. Receptor Proteins: Cell surface receptors and intracellular receptors, toll receptors.
3. Second messenger System: cAMP & signal to transcription (CREB); IP$_3$ DAG and PIP$_3$ (PI-3 kinase, AKT & mTOR pathway).
4. Cell Surface receptors: G-protein coupled receptors (hormones etc.), ion channel receptors (voltage gated channel, ligand gated channel & signal gated channel), tyrosine kinase-linked receptors (general idea, EGF, erythropoietin & interferon) and receptors with intrinsic enzymatic activity.
5. MAP kinase, JAK/STAT and TGF-β / Smad signaling and NF-kB signaling.

Signal-mediated transport through nuclear pore:
1. Nuclear pore complex.
2. Nuclear exports signals and transport of cargo proteins from nucleus to cytosol.
3. Nuclear localization signal and transport of cargo proteins from cytoplasm to nucleus.

UNIT-II

Cell cycle:
1. Bacterial cell cycle (Helmstetter-Cooper or I+ C+ D model), partition and cytokinesis.
2. Eukaryotic cell cycle: GI, S, G2 and M phases.
3. Cell cycle and checkpoints.
4. Molecular basis of cell cycle regulation:
   (i) Cyclins and cyclin-dependent kinases.
   (ii) Regulation of CDK cyclin activity.

UNIT-III

Cell death (Apoptosis):
1. Apoptosis and necrosis.
4. Extrinsic death receptor pathway (TNF-1 & Fas); intrinsic mitochondrial pathway & mitophagy.
5. Inhibitors of apoptotic proteins.
6. Caspase independent cell death.
8. Role of apoptosis in immunity and cancer.

UNIT-IV

Aging: The biology of senescence
1. Genetic instability.
2. Cellular basis of aging.
3. Free radicals, oxidative damage and antioxidants.
4. Telomeres and aging.
5. Diseases: Alzheimer's, Dementia, Parkinson's, Type II diabetes, Osteoporosis, Atherosclerosis & Progeria.

M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP B (SPECIAL PAPER)

ZOL 3803: CELL AND MOLECULAR BIOLOGY

GENE EXPRESSION

Max. Marks: 100
Total Hours: 60

UNIT-I

Molecular structure of genes and chromosomes:
2. Chromosomal organization of genes and non-coding DNA.
3. Functional re-arrangements in chromosomal DNA.
5. Transposons: Retrotransposons – viral & non viral (LTR, reverse transcription of retroviral genomic RNA to DNA); Transposons; Miniature inverted Repeats transposable elements & transposons in bacteria.

Genes:
1. Mutable units: Seymour Benzer experiment-complementation test.
2. Mutation types and causes (radiation, chemical & environment).
3. Inheritance in bacteria (Luria and Delbrück experiment, Newcombe experiment, Lederberg’s experiment).
4. Mutation rates; reversion & suppression.
5. Isolation (Positive & negative selection) and analysis of mutants.
6. Genetic mapping of mutations.
7. Molecular cloning of genes defined by mutations.

UNIT-II

Regulation of gene expression:
1. Operon concept.
2. Inducers and corepressors.
3. Positive and Negative regulation – lac operon.
4. Regulation by attenuation: his and trp operons.
5. Ara operon.

Lytic and lysogeny:
1. Lambda lytic cascade
2. Lysogenic repression

UNIT-III

DNA binding proteins and gene regulation:
1. Homeodomain proteins.
2. Zinc finger proteins.
3. Winged-helix (Forked head) proteins.
4. Leucine-Zipper proteins.
5. Basic Helix - Loop - helix proteins.

UNIT-IV

Cancer:
1. Tumor types: Benign & malignant; sarcoma & carcinoma and leukaemia & lymphoma.
2. Onset of cancer; Metastasis
3. Properties of cancer cells
4. Proto-oncogene; retroviral oncogenes; oncogenes; tumor suppressor genes (RB, p53 & p16) and caretaker genes (BRCA1 & BRCA2).
6. Knudson two hit hypothesis
7. Mutation causing loss of cell cycle.
8. Mutations affecting genomic stability.

PRATICALS
1. Operation of microscopes:
   (i) Experiments on phase contrast.
   (ii) Use of fluorescence microscope: Detection of nucleic acid by acridine orange / ethidium bromide.
2. Preparation of biological tissues and sectioning:
   (i) Paraffin wax histology by microtome.
   (ii) Fresh- frozen by cryostat.
3. Micrometry:
   (i) Use of occulometer-standardization and measurements of cell height, nuclear diameter and tubular diameter.
   (ii) Use of ocular grid- standardization and counting of cells or nuclei in cross section of epithelium.
4. Cytochemistry / Histochemistry:
   (i) Carbohydrate (a) PAS method (b) Alcian blue method (c) Carmin method
   (ii) Proteins (a) Mercury bromophenol blue method (b) Ninhydrin method.
   (iii) Phosphomolybic acid method (b) Copper phthalocynanin method (c) Acetone-Sudan black method.
   (iv) Nucleic acid (a) Feulgen method (b) Methyl green- Pyronin method.
   (v) Detection of enzymes (a) Alkaline phosphatase (b) Acid phosphatase (c) Adenosine tri- phosphatase.
5. Biochemical methods:
   (i) Determination of pK value.
   (ii) How to prepare a buffer at particular pH and pK value for acid?
   (iii) Quantitation of enzymes:
      (a) By end point techniques as exemplified by alkaline and acid phosphatase.
      (b) By substrate - left over technique as exemplified by LDH.
6. Fractionation:
   (i) Tissue homogenization and fractionation by differential centrifugation for isolation of mitochondria, nuclei and cytosol and use of marker enzymes for assessment of purity of the components.
   (ii) Fractionation of protein, RNA and DNA and their quantification.
7. Techniques:
   (i) Separation of proteins and DNA by agarose electrophoresis.
   (ii) Separation of proteins and isoenzymes on SDS-PAGE and PAGE.
   (iii) Electrophiluting of proteins, DNA/RNA from electrophoretic gels.
   (iv) Comet assay.
   (v) DNA ladder assay.
   (vi) Western blotting.
   (v) Experiments on PCR.
8. Chromosomal Techniques:
   (i) Preparation of salivary gland chromosomes from Drosophila / Chironomous larva and stain with acetocarmine/aceto-orcein/ Feulgen.
   (i) Preparation of mammalian chromosomes from bone marrow or testis and stain with Giemsa stain.
9. Permanent slides:
Histopathological changes in organs, Mitosis, Meiosis, various cancer cells & slides from all the above experiments.

Slides and tissue blocks to be submitted at the time of practical examination

SUGGESTED BOOKS

ZOL 312B: PRACTICAL-VI

Scheme for Practical Examination
(Based on ZOL 3B01, ZOL 3B02 and ZOL 3B03)

Max Marks: 100

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Time: 4 hrs
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**M.Sc. ZOOLOGY III SEMESTER**

**ELECTIVE GROUP C (SPECIAL PAPER)**

**ZOL 3C01: ENTOMOLOGY**

**PHYLOGENY, TAXONOMY AND EVOLUTION OF INSECTS**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

1. Collection, preservation and methods of study of insects.

**UNIT-II**

1. Introduction to primitive insects.
2. Endognathous hexapods: Protura, Collembola and Dipleura.
3. Apterygota: Microcoryphia and Thysaneura.

**UNIT-III**

3. Theories on the evolution of insects.

**UNIT-IV**

1. Detailed classification of important and selected super families and families of insects of the following orders: Orthoptera, Isoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera.
2. Characteristics of Trilobita chelicera and Mandibulata.
3. Elementary idea of DNA base reading and its application in entomology.

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**M. Sc. ZOOLOGY III SEMESTER**

**ELECTIVE GROUP C (SPECIAL PAPER)**

**ZOL 3C02: ENTOMOLOGY**

**MORPHOLOGY AND PHYSIOLOGY OF INSECTS**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

General organization of insect body:

1. Integument.
2. Head: sutures and area of cranium, Dyanin law, tentorium, gnathal appendages, antennae.
3. Thorax: Legs and their modifications, wings and wing coupling, wing bearing segment.
UNIT-II
1. Digestive system: Alimentary canal and its modifications (including filter chamber).
   Physiology of digestion.
2. Physiology of circulatory system.
3. Excretory system and its modifications (Cryptonephridial system).
4. Respiratory system and its modifications, adaptations for aquatic respiration.

UNIT-III
1. Nervous system and its modifications.
2. Sense organs: Mechanoreceptors, Chemoreceptors.
3. Auditory organs (typanum), light producing organs, sound producing organs, visual organs (Compound eye and ocelli).

UNIT-IV
1. Muscular system and distribution of muscles.
2. Reproductive system. Morphology and physiology of male and female reproductive system, its associated ducts and glands and external genitalia, pheromones.
3. Morphology and physiology of neuro-endocrine system.
4. Endocrine control of development and metamorphosis.

M.Sc. ZOOLOGY III SEMESTER
ELECTIVE GROUP C (SPECIAL PAPER)
ZOL 3C03: ENTOMOLOGY
DEVELOPMENT AND ECOLOGY OF INSECTS

Max. Marks: 100  
Total Hours: 60

UNIT-I
1. Embryology: Structure of egg, types, embryonic and post embryonic development.
2. Types of larvae, pupae and metamorphosis (Amambolous, hemimetabolous and holometabolous).

UNIT-II
1. Social life in Isoptera and Hymenoptera.
2. Life cycle of locusts (phase theory).
3. Life cycle of aphids (polymorphism).

UNIT-III
Ecology of insects:
1. Effect of physical factors, viz., temperature, light, relative humidity, wind, etc. on insects.
2. Intra and inter specific relations (Biotic factors)
3. Insect plant interaction.
UNIT-IV
2. Biochemical adaptations to environmental stress (various types of metamorphoses, diapauses, polymorphisms, swarms, out breaks and migration).

PRACTICAL
1. Anatomy:
   a) Cockroach: Endocrine complex, Nervous system, Alimentary canal
   b) Grass hopper: Nervous system, Reproductive system, Alimentary canal
   c) White grub: Nervous system

2. Permanent Mounting:
   a) Biting and chewing mouth parts (cockroach)
   b) Piercing and sucking mouth parts (mosquito)
   c) Siphoning mouth parts (Butterfly)
   d) Tymanum and spiracle of Grasshopper (*Poecilocerus pictus*)
   e) Antennae, wings and legs of mosquito, butterfly, grasshopper, cockroach
   f) Whole mounts of (lice, ants, termite, bedbug, mosquito)

3. Insect rearing:
   a) *Tribolium*
   b) *Rhizopertha*
   c) *Heliothis armigera*
   d) *Corcyra*
   e) *Callosobruchus sps*
   f) *Lesioderma serricornae*

4. Study of prepared slides:
   a) Whole mounts of insects
   b) Legs
   c) Mouth Parts
   d) Wings
   e) Antennae
   f) Histology of Insects

5. Study of selected insects:
   a) Study of selected insects as museum specimens.
   b) Identification of selected insects and their identification with the help of taxonomic key.

6. Microscopy
7. Field trips for insect collection; Preservation of insects (eggs, larvae, pupae & adults)
8. Spotting:
   a) Insect specimens with morphological adaptation
   b) Whole mounts of insects
   c) Their specialized body parts
   d) Histology slides

SUGGESTED BOOKS
1. Agricultural pests of India & South east Asia, Arwal; Kalyani Publishers 1986
6. "The Principles of Insect Physiology & Wigglesworth-" 
7. Borror and DeLong's introduction to the study of insects – Charles A., Triplehorn and 
   Norman F., Johnson, Thomson Books/Cole
11. "A manual of Practical Entomology" (Field Laboratory Guide), M.H. Trigunayat: 
    Scientific publications, India

ZOL 312C: PRACTICAL-VI

Scheme for Practical Examination
(Based on ZOL 3CO1, ZOL 3C02 and ZOL 3C03)

Max Marks: 100  Time: 4 hrs

1. Major Exercise 26
2. (a) Minor Exercise 10
   (b) Minor Exercise 10
3. Spotting (8 × 3) 24
4. Seminar 10
5. Viva Voce 10
6. Record 10

Notes:

1. With reference to anatomy and study of museum specimens, candidates must be well 
   versed in the study of various systems with the help of charts/models/CD-ROMs, 
   multimedia computer based simulations including computer assisted learning (CAL) and 
   other softwares.
2. It should be ensured that animals used in the practical exercises are not covered under the 

M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP D (SPECIAL PAPER)

ZOL 3 D01: ENVIRONMENTAL BIOLOGY

ENVIRONMENTAL BIOLOGY: CONCEPT AND APPROACHES

Max. Marks: 100  Total Hours: 60

UNIT-I

60
Introduction to environmental biology and earth systems:
1. Definition, principle and scope of environmental biology, its relation to other Sciences.
2. Basic concept of ecosystem, abiotic and biotic factors, structure and function of ecosystem, productivity, trophic levels, ecological pyramids and energy flow in an ecosystem.
3. The origin and structure of earth, primary differentiation and formation of core, mantle, crust.
5. Major biomes of the world, Ecozones of India, Anthropogenic biomes.

UNIT-II

The physical environment:
1. Lithosphere - Weathering and soil formation, - soil colloids, adsorption and exchange of anions and cations, role of microbes in soil, types of soil, soil profile, classification of rocks, folds, faults and dykes and other geological formations and their environmental significance.
3. Hydrosphere -Visible and invisible hydrosphere, Range of aquatic habitats, water cycles between earth and the atmosphere, Global water balance, ice sheets, origin and composition of sea water, sea level changes, River basins and watershed.

UNIT-III

Weather and climate:
1. Definitions and scope of climatology, weather and climate, components of climate system, Climatic regions of India.
2. Earth’s thermal environment, earth intercepts solar radiation, seasonal variation in intercepted solar radiation, air temperature in relation to altitude.
3. Global circulation of air masses, wind and earth’s rotation on ocean currents, influence of temperature on moisture content of air, global pattern of precipitation, influence of topography on regional pattern of precipitation.
4. Classification of climate-Koeppen’s classification and Thorn Thwaite’s scheme, Climatic zones, Clouds and their types.

UNIT-IV
Landscape ecology:
1. Land and Landscape processes, Hierarchy: ecosystems to land units; ecological principles at work with Landscapes.
2. Human dimensions and Land use in agro-ecosystems, urban ecosystems, rangelands, riparian and wetland systems (Keoladeo, Sambhar Lake and Sunderbans), coastal and estuarine systems (Chilka Lake, Kerala Backwaters and Ennore Creek).
3. Ecological land degradation, desertification, water logging, salinization and soil erosion.
5. Use of soil survey, aerial photos, topographic maps and other resource data in landscape management; case studies on corridor selection problems.

M.Sc. ZOOLOGY III SEMESTER
ELECTIVE GROUP D (SPECIAL PAPER)
ZOL 3 D02: ENVIRONMENTAL BIOLOGY
POPULATION ECOLOGY, ENVIRONMENTAL ADAPTATIONS AND ENVIRONMENTAL DISASTERS

Max. Marks: 100
Total Hours: 60

UNIT-I

Population ecology:
1. Population and its characteristics.
2. Demography- Life tables, generation time, reproductive value, Census and sampling, Population indices
5. Methods of population estimation- Point and line survey methods, Belt and Quadrate transect.

UNIT-II

Environmental adaptations:
2. Terrestrial adaptations- Desert adaptations, Cave adaptations, Cursorial adaptations, Fossorial and subterranean adaptations, Arboreal adaptations, flight adaptations.
3. Eco-physiological adaptations to terrestrial environments.
4. Parasitic adaptations, adaptations for defense and mimicry.
UNIT-III

Environmental limiting factors:
2. Physical environment as limiting factor- Light, humidity, fire, atmospheric gases, current and pressure, Microenvironment and Ecological optima.
3. Inter and intra-specific relationships: Predator- prey relationship, predator dynamics, optimal foraging theory (patch choice, diet choice, prey selectivity, foraging time). Parasitism, Mutualism, Phoresis, Antibiosis, Insect-plant interactions.

UNIT-IV

Environmental phenomena and disasters:
1. Definition, Earthquake, flood, Tsunami, draught.
2. Windstorms, Cyclones and anticyclones.
3. Volcanoes, Avalanche, lightening, El Nino and La Nina
4. Environmental degradation by Anthropogenic activities: Ozone depletion and Green house effect. Nuclear disasters: Fukushima Daiichi nuclear disaster, Japan; Chernobyl disaster, Russia; Bhopal Gas Tragedy, The Exxon Valdez Oil Spill.
5. Disaster management.

M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP D (SPECIAL PAPER)

ZOL 3 D03: ENVIRONMENTAL BIOLOGY

NATURAL RESOURCES, BIODIVERSITY, WILDLIFE AND CONSERVATION BIOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

Natural resources:
1. Natural resources and their types- Water resources, Land resources and Biological resources, Mineral resources and their cycles.
2. Energy resources- Renewable sources of energy, energy from biomass
3. Non-renewable sources of energy, Nuclear energy, geothermal energy.
5. Water- A vital resource, India’s Water budget.
6. Human impact on natural resources.

UNIT-II

Biodiversity:
1. Concept of biological diversity, origin of biodiversity, Types of biodiversity, values of biodiversity, loss of biodiversity.
2. Biodiversity and ecosystem function, Bio-wealth, Bioprospecting and Biopiracy.
3. Critically endangered Indian animals, Biotic impoverishment
5. Biological diversity Act of India, National Biodiversity Authority, Indian Biodiversity Act 2002, National Board of Biodiversity, State Board of Biodiversity. Legal coverage of biodiversity conservation and use in India.

UNIT-III

Wildlife and its management:
2. Restoration of wild life population: Re-introduction or Rehabilitation (soft and hard release) and captive breeding, wild life corridor.

UNIT-IV

Biodiversity conservation:
2. National and international programmes for biodiversity conservation. CITES and TRAFFIC.
3. Traditional conservation strategies; People’s participation in Conservation-Participatory Forest Management (PFM), Community reserve and People’s Biodiversity Register (PBR). Biodiversity Management Committee (BMC).

PRACTICALS
1. Mark location of different biomes on world map and write their characteristics.
2. Mark important Sanctuaries and National Parks of Rajasthan on map and write details of any two.
3. Mark major Ecozones of India on map of India. Visit a desert/grass land/rain forest and submit write up.
4. Soil texture using micrometry from two different sites.
5. Determination of moisture content of soil.
6. Determination of soil pH from at least three different locations and correlate it with the soil type.
7. Analysis of soil composition: Chloride, Calcium, Magnesium, Potassium and Phosphorous.
10. Measurement of water quality based on Acidity, Alkalinity, Dissolved oxygen and Free CO₂ in water sample.
11. Study the abiotic components i.e. pH, turbidity, temperature and light intensity of water in a pond ecosystem.
12. To study the biotic components of pond ecosystem.
13. Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results.
14. Compare the results of Dark and Light bottle method and Chlorophyll method.
15. Identification of trophic levels from gut analysis (Fish or insect).
16. Study the ecology of Aravali Hill around the Arboretum in Jaipur.
17. Find out density of Gerbils/ Fish by Mark and recapture method (Lincoln index).
18. Find out density of Monkeys/any domestic animal in an area using Line transect method.
19. Study the local plant species around your residence/University campus.
20. Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, evenness and diversity indices. (This can be done as part of the three / four day field study compulsory for this elective).
21. Visit to Institutions engaged in environment /conservation research; a sanctuary/national park. Report the study conducted and submit a write up/ print out giving the dates, methodology, results and references. Include photographs of the activity.

SUGGESTED BOOKS

ZOL 312D: PRACTICAL-VI

Scheme for Practical Examination
(Based on ZOL 3D01, ZOL 3D02 and ZOL 3D03)

Max Marks: 100
Time: 4 hrs

1. Major Exercise 26
2. (a) Minor Exercise 10
   (b) Minor Exercise 10
3. Spotting (8 x 3) 24
4. Seminar 10
5. Viva Voce 10
6. Record 10

Notes:
1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

Dy. Registrar (Acad.)
University of Rajasthan
JAIPUR
M.Sc. ZOOLOGY III SEMESTER

ELECTIVE GROUP E (SPECIAL PAPER)

ZOL 3 E01: REPRODUCTIVE BIOLOGY

ENDOCRINE GLANDS AND HORMONES

Max. Marks: 100
Total Hours: 60

UNIT-I

Endocrine glands: An overview, basic concepts of endocrinology

Vertebrate endocrine glands: Study of the major endocrine glands of vertebrate. Structure, secretions and physiology (With the special emphasis on the role in reproduction):
1. The pituitary gland
2. Thyroid
3. Parathyroid
4. Adrenal
5. Pineal
6. Pancreas
7. Gastrointestinal tract

UNIT-II

Hormones:
1. Classification and characteristics of hormones
2. Chemical nature of hormones
3. Hormonal regulation
4. Feedback mechanism.
Steroid hormones:
1. Structure and nomenclature
2. Steroidogenesis.

UNIT-III

Hormone actions:
1. Transportation of hormones
2. Receptors and target cells

Prostaglandins: Chemistry, mechanism of action and their role in reproduction.

Pheromones:
1. Mammalian and insect pheromones
2. Applications of pheromones
3. Fertility control in insects
4. Induced spawning in fishes and amphibians.
UNIT-IV

Invertebrate endocrine glands:
Anatomy and physiology of the endocrine and neuroendocrine structures of
1. Annelids
2. Arthropods
3. Mollusca (with special reference to their role in reproduction):

M.Sc. ZOOLOGY III SEMESTER
ELECTIVE GROUP E (SPECIAL PAPER)
ZOL 3E02: REPRODUCTIVE BIOLOGY

MALE AND FEMALE REPRODUCTIVE SYSTEMS

Max. Marks: 100
Total Hours: 60

UNIT-I

The female reproductive system:
1. Comparative anatomy and physiology of the mammalian and sub mammalian ovary and ductal system.
2. Follicular growth, kinetics and atresia,
4. Autocrine, paracrine and endocrine regulation of ovarian functions.

UNIT-II

The male reproductive system:
1. Comparative anatomy and physiology of the mammalian and sub mammalian testis.
2. Functional organization of testis, spermatogenic cycle.
3. Testicular androgens, autocrine, paracrine, and endocrine regulation of testicular functions.
4. Epididymis and the sex accessory glands, semen and its biochemistry.

UNIT-III

Regulation of reproduction:
1. Hypothalamus and its neurosecretory centres: Structure of neurosecretory cells, the hypothalamic principles: synthesis, storage, release and chemistry
2. The phenomenon of neuroendocrine integration and the hypothalamo-hypophyseal gonadal axis.

UNIT-IV

Biology of Sex-determination and Sex differentiation:
1. Development of gonads
2. Development of genital ducts and accessory organs
4. Sex determination in mammals.
M.Sc. ZOOLOGY III SEMESTER
ELECTIVE GROUP E (SPECIAL PAPER)
ZOL 3E03: REPRODUCTIVE BIOLOGY

BIOLOGY OF GAMETES, REPRODUCTIVE CYCLES AND BEHAVIOUR

Max. Marks: 100 Total Hours: 60

UNIT -I

Biology of spermatozoa and ovum:
1. Structure, development and function of spermatozoa and ovum.
2. Hormonal regulation of reproductive behaviour.

UNIT -II

Breeding seasons and reproductive cycles and their hormonal regulation (Brief account):
1. Breeding seasons in vertebrates
2. Types of reproductive cycles
3. Estrous cycle

UNIT -III

Puberty, adolescence and menopause:
1. Onset of puberty
2. Hormonal control of onset of puberty
3. Precocious and delayed puberty
4. Menopause and climacteric

UNIT -IV

Impact of aging on male and female reproduction:
1. Andropause
2. Menopause
3. Hormone replacement therapy

PRACTICALS
1. Location and identification of various endocrine glands in rodents
2. Anatomy of male reproductive systems.
3. Anatomy of female reproductive systems
4. Microtomy: Histology of male and female genital organs and endocrine glands in normal and pathological conditions
5. Staining of permanent slides of endocrine glands
6. Morphometry of spermatozoa
7. Study of the permanent histological slides-mammalian and sub mammalian
8. Monitoring of vaginal smear
9. Permanent slide preparation of vaginal smear
10. Monitoring of sperm function tests.
15. Vertebrate Endocrinology, Norris D.O.
16. Comparative Vertebrate Endocrinology, Bentrey P.
17. Human Physiology (Vol. II), C.C. Chatterjee.

ZOL 312E: PRACTICAL-VI

Scheme for Practical Examination
(Based on ZOL 3E01, ZOL 3E02 and 3E03)
Max. Marks: 100

1. Major Exercise
   (a) Minor Exercise
   (b) Minor Exercise
2. Spotting (8 x 3)
3. Seminar
4. Viva Voce
5. Record

Time: 4 hrs

26
10
10
24
10
10
10

Notes:
1. With reference to anatomy and study of museum specimens, candidates must be well
   versed in the study of various systems with the help of charts/models/CD- ROMs,
   multimedia computer based simulations including computer assisted learning (CAL) and
   other softwares.
2. It should be ensured that animals used in the practical exercises are not covered under the
   Wildlife act 1972 and amendments made subsequently.

[Signature]
Registrar (Acad.)
University of Rajasthan
JAIPUR
M.Sc. ZOOLOGY IV SEMESTER (2017-18)

CORE PAPER

ZOL: 401: ECOLOGY

Max. Marks: 100
Total Hours: 60

UNIT-I

Ecosystem: Structure and function:
1. Types of ecosystem
2. Basic structure of ecosystem
3. Physical, chemical & genetic structure of ecosystem
4. Function of ecosystem
5. Energy flow within the ecosystem & Y-shaped mode of energy flow.
6. Productivity.
7. Food chain and trophic levels.
8. Ecological efficiencies.
10. Ecological niche
11. Homeostasis and stability of ecosystem

UNIT-II

Fragile Ecosystems
1. Coral reef ecosystem
2. Mangroves
3. Wetlands
4. Antarctic ecosystem
5. Arctic ecosystem
6. Mountain environment

Population Ecology:
1. Population density, natality, mortality and age distribution
2. Biotic potential of population
3. Growth forms and concept of carrying capacity of population
4. Population dispersal
5. Regulation of population

Unit III

Environmental factors
1. Law of minimum (Leibig’s Law)
2. Law of tolerance (Shelford’s Law)
3. Combined concept of limiting factors
4. Physiological environment as limiting factor
5. Light, humidity, temperature, fire, atmosphere gases, current and pressure

Species interactions
1. Biotic environmental factors
2. Competitive Exclusion principle
3. Interspecific and intraspecific interactions.

UNIT-IV

Concept of community:
1. Characters and classification of community
2. Community periodism
3. Community stratification, succession & climax
4. Community boundary: Ecotone and edge effects.

Biogeochemical and nutrient cycles:
1. Nitrogen cycle
2. Carbon cycle
3. Phosphorus cycle
4. Sulfur cycle

PRACTICALS
1. Estimation of alkalinity, acidity, dissolved oxygen, chloride in water samples.
2. Estimation of nitrogen and phosphorous estimation in soil.
3. Listing of animals around your home/department & comments upon them.
4. Microbial analysis in soil/air/water.
5. Limnological study of a local water body submission of written report.

SUGGESTED BOOKS
7. The Life of Mammals (Life of Mammals) by David Attenborough

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M.Sc. ZOOLOGY IV SEMESTER

CORE PAPER

ZOL 402: ETHOLOGY

Max. Marks: 100
Total Hours: 60

UNIT-I

Scientists and their works: Konrad Lorenz, Niko Tinbergen, Karl Von Frisch, Skinner BF and Harlow Harry, Richard Dawkins, EO Wilson, Desmond Morris.

Concepts of Ethology (SS, FAP, ASE, IRM), Flush Toilet model; genes and behaviour; evolution of behaviour.

UNIT-II

Neuroethology:
1. Methods of studying brain and behaviour: Neuroanatomical, neurophysiological and neurochemical.
2. Mammalian brain and behaviour, Limbic system and hypothalamus.

UNIT-III

Social behaviour:
1. Properties and advantages of social grouping, social group of monkeys.
2. Sociobiology-Darwinian fitness, individual fitness, kin selection, group selection.
   Co-operation, reciprocation, altruism, reciprocal altruism, proximate and ultimate causations
3. Territorial behaviours: home range, territory, core area

UNIT-IV

1. Feeding and sexual strategies in animals.
2. Courtship and mating behaviour in animals
3. Parental care in animals.
5. Learning introduction and definition, types of learning, Habituation, trial and error, conditioning, cognition and imprinting.

Yours, Registrar (Acad.)
University of Rajasthan
Jaipur
PRACTICALS
1. Learning by trial and error in animals using maze and jumping box.
2. Study of movement of fish in aquarium.
3. Food preference in Tribolium.
4. Pheromones in Earthworms.
5. Study of exploratory behaviour of rats/mice.
6. Study of grooming, rearing and locomotory behaviour of rats/mice.
7. Nest building behaviour in anyone species of animal (Insects, spiders, fishes, birds and mammals).
8. Reproductive behaviour in anyone species of animal.

SUGGESTED BOOKS
3. The Life of Mammals, Life of Mammals, by David Attenborough.
8. Introduction to Ethology. Immelman, C.
14. The Science of Ecology by Richard Brewer, Publisher: Brooks Cole

M.Sc. ZOOLOGY IV SEMESTER

CORE PAPER
ZOL 403: TOOLS AND TECHNIQUES

Max. Marks: 100
Total Hours: 60

UNIT-I
Principle, construction and applications of Microscopy
1. Light Microscopy.
1. Bright field and Dark field Microscopy.
2. Phase contrast Microscopy.
3. Fluorescence Microscopy.

UNIT-II

Separation Techniques

Centrifugation:
1. Basic principles of sedimentation
2. Types of centrifuges
3. Analytical and preparative centrifugation
4. Differential and density gradient centrifugation

Chromatography:
1. Paper chromatography
2. Thin layer chromatography
3. Ion exchange chromatography
4. Gel permeation chromatography
5. Affinity chromatography
6. Gas chromatography
7. High pressure liquid chromatography (HPLC)

Electrophoresis:
1. Paper electrophoresis
2. Polyacrylamide gel electrophoresis (PAGE) and SDS-PAGE
3. Agarose gel electrophoresis
4. Two Dimensional electrophoresis and Isoelectricfocusing
5. Pulse field electrophoresis, Capillary electrophoresis
6. Immunoelectrophoresis
7. Blotting techniques (Southern and Western)
8. DNA sequencing
9. Polymerase Chain Reaction (PCR)

UNIT-III

1. Principle and applications of colorimetry and spectrophotometry; UV-VIS Spectrophotometer.
3. Dosimetry, Ionization chamber, GM counter, Solid and liquid scintillation counters
4. Radioisotopes- types, characteristics and uses, Autoradiography.

UNIT-IV

Histological techniques:
1. Principles of tissue fixation, factors affecting tissue fixation.
2. Chemical basis of fixation by Formaldehyde, Glutaraldehyde, Chromium salts,
3. Mercury salts, Osmium salts, Alcohol and Acetone.
5. Staining of carbohydrates, proteins, lipids and nucleic acids.

Animal tissue culture techniques:
Sterilization of materials to be used for tissue culture.
2. Culture media, preparation and essential components.
3. Types of tissue culture, organ and organotypic cultures.
4. Primary culture and the establishment of cell lines.
5. Characterization of cell lines.
6. Cell proliferation measurements and cell viability tests.
7. Cryopreservation and retrieval of cells from frozen storage.

PRACTICALS
1. Experiments using Fluorescence microscope and Phase contrast Microscope.
3. Preparation of samples using different centrifuges.
4. Use of Spectrophotometer for measuring the optical density of different biological samples.
5. Separation of free sugars/amino acids from different samples by paper chromatography.
7. Separation of molecules by Ion exchange/ Gel permeation/ Affinity Chromatography (Demonstration).
8. Study the working of (a) Gas Liquid Chromatography (b) HPLC (Demonstration).
9. Separation of protein samples by PAGE/SDS-PAGE (Demonstration).
10. Isolation of Genomic DNA from blood or any other sample.
11. Study the working of PCR (Demonstration).
12. Agarose gel electrophoresis of DNA.
13. Study of DNA digestion using restriction enzymes and their separation.
14. Viable cell counting with hemocytometer (Dye exclusion method).
15. MTT and XTT Assay.
16. Fixing, dehydrating, embedding, section-cutting, staining and mounting of different tissues.

- Candidates are expected to prepare a record of practical works
- Twenty five (25) slides of serial sections and five (5) tissue blocks shall be submitted at the time of practical examination.

SUGGESTED BOOKS
4. Physical Biochemistry; David Freifelder. Freeman publications
(Based on ZOL 401, ZOL 402 and ZOL 403)

Scheme for Practical Examination

Max. Marks: 100

1. Major Exercise
   (a) Minor Exercise 26
   (b) Minor Exercise 10
2. Spotting (8 × 3) 10
3. Seminar 24
4. Viva Voce 10
5. Record 10

Notes:
1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP A (SPECIAL PAPER)

ZOL 4 A01: CANCER & RADIATION BIOLOGY

NATURE OF CANCER

Max. Marks: 100

Total Hours: 60

UNIT-I

Cancer epidemiology:
1. Definitions of cancer.
2. Global aspects of cancer.
3. Cancer problem in India.
4. Geographic and environmental risk factors (risk factors for cancer, tobacco, alcohol, physical factors, occupational exposure, and environmental carcinogens).
5. Cancer of different age groups and sex.

UNIT-II

Classification of tumors:
1. Benign and malignant.
2. Carcinoma and sarcoma.
3. Leukemia and lymphoma.
4. Epithelial and non-epithelial tumors.
5. Specialized tumors.
6.

UNIT-III

Characteristics of tumors:
UNIT-IV

Apoptosis and cancer:
2. Caspases.
3. BCl2 family proteins.
4. Extrinsic and Intrinsic mitochondrial pathway.
5. Inhibitors of apoptotic protein.
6. Role of apoptosis in cancer.

M.Sc. ZOOLOGY IV SEMESTER
ELECTIVE GROUP A (SPECIAL PAPER)
ZOL 4 A02: CANCER & RADIATION BIOLOGY
BIOCHEMISTRY AND GENETICS OF CANCER

Max. Marks: 100
Total Hours: 60

UNIT-I

Biochemistry of cancer:
1. Biochemical characteristics of cancer cells.
2. Biochemical mechanisms for activation of proto-oncogenes to oncogenes.

UNIT-II

Oncogenes and tumor suppressor genes:
1. Growth promoting oncogenes.
2. Growth suppressing anti-oncogenes.
3. Viral oncogenes.
4. Tumor suppressor genes (p53, p53 and p^{APC}).

UNIT-III

Cancer genetics:
1. Inherited cancer genes.
2. Heredity and cancer.
3. Mutator genes and cancer.
4. Genomic integrity and cancer.

UNIT-IV

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Causation of cancer:
1. Chemical carcinogenesis.
2. Radiation carcinogenesis.
3. Viral carcinogenesis.

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP A (SPECIAL PAPER)

ZOL 4A03: CANCER & RADIATION BIOLOGY

CANCER TYPES, TUMOR IMMUNOLOGY AND TREATMENT

Max. Marks: 100

Total Hours: 60

UNIT -I
Common types of cancer (signs, symptoms, prevention and treatment):
1. Oral cancer.
2. Stomach cancer.
3. Liver cancer.
4. Lung cancer.
5. Prostate cancer.
6. Skin cancer.
8. Gynecological cancers.

UNIT-II
Diagnosis of cancer:
1. Tumor markers.
2. Histological and cytological methods.
3. Histochemistry and cytochemistry methods.
4. Immunohistochemistry and biochemical assays.
5. Electron microscopy.

UNIT- III
Tumor immunology:
1. Immune suppression and role of immune surveillance in growth of tumors.
2. Tumor specific antigens and immune response.

UNIT- IV

Treatment of cancer:

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2. Radiation therapy.
3. Chemotherapy.
4. Hormone therapy.
5. Immune therapy.
6. Hyperthermia.
7. Gene therapy.
8. Other treatment methods (cryosurgery, laser therapy, photodynamic therapy, hyperthermia)

PRACTICALS
1. Tumor Pathology.
2. Pre-cancerous lesions.
4. Tumors of different tissues and organs in animals and humans.
5. Tumor induction.
6. Skin carcinogenesis in mice.
7. Cervical carcinogenesis in mice.
8. Short term carcinogenicity tests.
10. Micronucleus test.
11. Radiation therapy of transplantable tumors.
12. Tumor transplantation.
13. Chemoprevention of chemical carcinogenesis.
14. Morphological, histopathological, and biochemical studies of various cancerous tissues.
15. Study of Pre-cancerous and cancerous lesions of oral cancer, breast cancer, cervix cancer, prostrate cancer etc.
16. Visit to Radiotherapy Department, S. M. S. Medical College, Jaipur, Sri Bhagwan Mahaveer Cancer Hospital, Jaipur and Tata Memorial Cancer Hospital, Mumbai.

RECOMMENDED BOOKS
2. Targeted Therapies in Cancer, Craig A. Almeida , Publisher: Springer.
3. Cancer, Publisher: Craig A. Almeida, Oxford University Press, USA.
5. P Pathology of Diseases. S. Lotran, V. Kumar, T. Collins. Robbins.
11. Lauren Pecorino, Cellular and Molecular Biology of Cancer, Publisher: Oxford University Press, USA.
13. Biology of Cancer, Randall W. Phillis, Publisher: Benjamin Cummings.
14. Cancer of System Biology, Randall W. Phillis, Publisher: CRC Press

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17. Introduction to Cancer Biology, Robin Hesketh, University of Cambridge, January 2013.

ZOL 412A: PRACTICAL-VIII

Scheme for Practical Examination
(Based on ZOL 4AO1, ZOL 4AO2 and ZOL 4AO3)

Max Marks: 100 Time: 4 hrs

1. Major Exercise
   (a) Minor Exercise 26
   (b) Minor Exercise 10
   2. Spotting (8 × 3) 24
   3. Seminar 10
   4. Viva Voce 10
   5. Record 10

Notes:
1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP B (SPECIAL PAPER)

ZOL 4B01: CELL AND MOLECULAR BIOLOGY

BASIC IMMUNOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

Molecular immunology:
1. Innate (non-specific) immunity
   (i) Anatomic barriers.
   (ii) Physiological barriers.
   (iii) Chemical mediators
   (iv) Phagocytic / endocytic barriers
   (v) Inflammatory barriers
2. Adaptive (specific) immunity (brief idea).

Cells and organs of immune system:
1. Haematopoiesis
   (i) B-Lymphocytes, T-lymphocytes and Null cells.
   (ii) Mononuclear cells (antimicrobial and cytotoxic activities, secretion of factors).
   (iii) Granulocytic cells (Neutrophils, Eosinophils and Basophils).
   (iv) Mast cells.
   (v) Dendritic cells and Langerhans cells.
   (vi) Haematopoiesis growth factors, Genes involved in haematopoiesis.

2. Organs of immune system
   (i) Primary lymphoid organs (Thymus and bone marrow) & Thymic education.
   (ii) Secondary lymphoid organs (Lymph nodes, spleen, mucosal associated lymphoid tissue and cutaneous associated lymphoid tissue, tonsils and Peyer’s patches).
   (iii) Lymphatic system.

UNIT-II

Lymphocyte development:
1. T-cell lineage
2. B-cell lineage

Immune response:
1. Phases of Immune response
   (i) Cognitive.
   (ii) Activation.
   (iii) Effector.
   (iv) Clonal selection hypothesis.
2. Humoral and cell-mediated immune responses (CMI)
   (i) Recognition of antigen by B-and T-lymphocytes and antigen presenting cell.
   (ii) Clonal selection of lymphocytes
3. Cellular interactions required for generation of immune responses
   (i) Activation and proliferation of B and T cells.
   (ii) Generation of humoral immune responses.
   (iii) Generation of CMI and cell mediated cytotoxicity.

UNIT-III

Antigens:
1. Immunogenicity versus antigenicity
2. Factors that influence immunogenicity
   (i) Contribution of immunogens (foreignness, molecular size, chemical composition and heterogeneity, susceptibility to antigen processing and presentation).
   (ii) Haptens and epitopes.
   (iii) Immunogen dosage and route of administration and adjuvants.

Immunoglobulins Structure and Function:
1. Molecular structure of Ig
2. Immunoglobulin classes (IgG, IgM, IgE, IgA and IgD) and their biological activities.
3. Immunoglobulin - mediated effector functions (Opsonization, activation of complement, antibody dependent cell-mediated cytotoxicity, neutralization).
4. Antigenic determinants on immunoglobulin (isotype, allotype and idioype).
UNIT-IV

Organization and Expression of Ig Genes:
1. Genetic model compatible with Ig structure.
   (i) Germ line and somatic variation models.
   (ii) Two gene model of Dryer and Bennett.
   (iii) Verification of Dryer and Bennett hypothesis.
2. Multigene organization of Ig genes
   (i) I-chain multigene family.
   (ii) k-chain multigene family.
   (iii) Heavy chain multigene family.
3. Variable region gene rearrangement
   (i) V-J rearrangements in light chain DNA.
   (ii) V-D-J rearrangements in heavy chain DNA.
4. Mechanism of variable region DNA rearrangement
   (i) Recombination signal sequences.
   (ii) Enzymatic joining of gene segments.
   (iii) Identification of Raf-1 and Raf-2 genes.
   (iv) Defects in Ig gene rearrangements.
   (v) Productive and non-productive rearrangement.
   (vi) Allelic exclusions.
5. Generation and antibody diversity
   (i) Multiple germ line VD and J gene segments.
   (iii) Junctional flexibility.
   (iv) P-addition and N-addition.
   (v) Association of heavy and light chain.
6. Class switching among constant region genes, Expression of Ig genes.
   (i) Differential RNA processing of heavy chain primary transcripts.
   (ii) Expression of membrane of secreted Ig.
   (iii) Simultaneous, assembly and secretion of IgM and IgD.
   (iv) Synthesis, assembly and secretion of Ig.
7. Regulation of Ig gene transcription
   (i) Effect of DNA rearrangement of transcription.
   (ii) Inhibition of Ig-gene expression in T-cells.
8. Antibody genes and antibody engineering
   (i) Chimeric and hybrid monoclonal antibodies.
   (ii) Monoclonal antibodies constituted from Ig gene libraries.

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP B (SPECIAL PAPER)

ZOL 4B02: CELL AND MOLECULAR BIOLOGY

IMMUNOLOGY: MOLECULAR EXPRESSION AND FUNCTION

Max. Marks: 100

Total Hours: 60
UNIT-I

Monoclonal Antibodies:
1. Formation and selection of hybrid cells
2. Production of monoclonal antibodies
3. Clinical uses of monoclonal antibodies

Antigen-antibody Interaction:
1. Antibody affinity and avidity.
2. Cross reactivity.
3. Agglutination reactions.
4. Precipitation reactions.
5. Complement & its regulation, complement fixation test & complement deficiencies.

UNIT-II

Major Histocompatability Complex:
1. General organization and inheritance of MHC.
   (i) Location and function of MHC.
   (ii) MHC haplotypes.
2. MHC molecules and genes
   (i) Structure of class I molecules.
   (ii) Structure of class II molecules
   (iii) Organization of class I and II genes.
   (iv) Peptide binding by MHC molecules.
   (v) Class III molecules
3. Genomic maps of MHC genes
   (i) Maps of class I MHC
   (ii) Maps of class II MHC
   (iii) Maps of class III MHC
4. Regulation of MHC expression.
5. Human MHC loci.
6. MHC and immune responsiveness.
7. MHC and diseases susceptibility.

Antigen Processing and Presentation
1. Role of antigen presenting cell
   (i) Early evidence for the necessity of antigen processing.
   (ii) Cells that function in antigen presentation.
2. Evidence for two processing and presentation pathways.
   (i) Endogenous antigens. The cytosolic pathways, Peptide generation by proteosomes, Peptide transport from the cytosol to rER, Assembly of peptide with class I MHC molecules.
   (ii) Exogenous antigens. The endocytic pathway, Peptide generation in endocytic vesicles, Transport of class II MHC molecules to endocytic vesicles, Assembly of peptide with class II MHC molecules.

UNIT-III

Cytokines:
1. Properties of cytokines.
2. General structure of cytokines.
3. Types of cytokines.
4. Function of cytokines.
5. Cytokines related diseases
   (i) Bacterial septic shock.
   (ii) Bacterial toxic shock and similar diseases.
   (iii) Lymphoid and myeloid cancers.
   (iv) Chagas disease.

UNIT-IV

Immune System in Health and Disease:
1. Immune response to infectious diseases
   (i) Viral infections, Viral neutralization by humoral antibody, Cell-mediated antiviral mechanism, Viral evasion of host defense mechanisms.
   (ii) Bacterial infections, Immune responses to extracellular and intracellular bacteria, Bacterial evasion of host defence mechanism.
   (iii) Protozoa and diseases.
   (iv) Diseases caused by helminthes.
   (v) Immunity to protozoa and worms.

M.Sc. ZOOLOGY IV SEMESTER
SPECIAL PAPER
ZOL 4 B03: CELL AND MOLECULAR BIOLOGY
IMMUNOLOGY: APPLICATION AND CELLULAR MALFUNCTION

Max. Marks: 100
Total Hours: 60

UNIT-I

Vaccines:
1. Characteristics of vaccine.
   (i) Active and passive immunization.
   (ii) Immunization schedule (Recommended by Indian Academy of Pediatrics)
   (iii) Designing vaccines for active immunization
   (iv) Whole organism vaccine
2. Attenuated viral or bacterial vaccines.
3. Inactivated viral or bacterial vaccines.
4. Polysaccharide vaccines.
5. Recombinant vector vaccines.
6. DNA vaccines.
7. Synthetic peptide vaccines.
8. Multivalent peptide vaccines.

UNIT-II

Immuno deficiencies:
1. Primary immunodeficiencies:
(i) Lymphoid - Severe Combined Immunodeficiency, Defects in B-cell maturation, Defects in T-cell development & Combined B-cell and T-cell disorders.
(ii) Myeloid lineage – Chronic Granulomatous Disease, Leukocyte Adhesion Deficiency, Chediak–Higashi syndrome & Neutropenia or Granulocytopenia.

UNIT-III

Hypersensitivity:
1. Type I, II, III and IV
2. In vivo and in vitro

Tolerance and autoimmunity:
1. General features of immunologic tolerance.
2. T- and B- cell tolerance; Induction of tolerance.
3. Organ specific autoimmune disease.
4. Systemic autoimmune disease.

UNIT-IV

Tumor immunology:
1. Tumor antigen.
2. Immune response to tumors (T-cell mediated; NK cell and macrophage mediated)
3. Tumor evasion.
4. Therapies.

Transplantation immunology:
1. Acute, hyperacute and chronic rejection.
2. Tissue matching (HLA typing).
3. Graft Vs host (GVH) reaction.
4. Xenotransplantation.
5. Immunosuppressive drugs; role of monoclonal antibodies in transplantation.

PRACTICALS:
1. Immunization route:
   (i) Intradermal.
   (ii) Subcutaneous.
   (iii) Intramuscular.
   (iv) Intraperitoneal.
   (v) Intravenous.
   (vi) Foot pad.
2. Bleeding schedules and collection of blood:
   (i) Bleeding from ear.
   (ii) Retro-orbital.
   (iii) Cardiac puncture.
   (iv) Branchial vein.
   (v) From external jugular vein.
3. Immunization techniques:
   (i) Emulsification with Freund’s reagents.
(a) Preparation of emulsions with syringe method.
(b) Preparation of emulsion with hubbed needle method.
(ii) Testing type of emulsion.
(iii) Absorption of soluble proteins on insoluble colloidal carrier.
   (a) Alum precipitates.
   (b) Alum hydroxide adjuvants.
4. Antigens and antibodies:
   (i) Preparation of antigens.
   (ii) Raising of antibodies in animal model.
   (iii) Blood collection & serum preparation.
5. Separation and preservation of serum:
   (i) Liquid storage.
      (a) Using preservative.
      (b) Sterilization.
   (ii) By freezing.
   (iii) By lyophilization.
6. Purification of antibodies and antigens:
   (i) Insolubilization of antibodies an antigenic proteins using gluteraldehyde.
   (ii) Immuno-adsorption.
   (iii) Dissociation of absorbed material from immuno-adsorbents.
   (iv) Affinity chromatography (antibody purification).
7. Isolation and fractionation of mononuclear cell population (T and B cells):
   (i) From spleen.
   (ii) From lymph nodes.
   (iii) Rosette formation of T-cells from red blood cells.
8. Cell viability (Tryphan blue) and cell proliferation (MTT assay).
9. Quantitation of antibodies
   (i) Precipitation techniques
   (ii) Agglutination test – C-reactive protein (CRP), Antistreptolysis ‘O’ titres & Rheumatoid arthritis factor (RA Factor).
   (iii) Immunodiffusion methods - RID, Ouchterlony (DID).
   (iv) Immunoelectrophoresis method - RIE.
   (v) Widals test; Sypillus test.
10. Immunoassays RIA; ELISA
11. Permanent slides: Slides related to experiments.

SUGGESTED BOOKS

ZOL 412B: PRACTICAL-VIII

Scheme for Practical Examination
(Based on ZOL 4B01, ZOL 4B02 and 4B03)

Max. Marks: 100 Time: 4 hrs

1. Major Exercise 26
2 (a) Minor Exercise 10
   (b) Minor Exercise 10
3. Spotting (8 x 3) 24
4. Seminar 10
5. Viva Voce 10
6. Record 10

Notes:
1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP C (SPECIAL PAPER)

ZOL 4C01: ENTOMOLOGY

INSECT PESTS OF CROPS, PREVENTION AND MANAGEMENT

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Definition of pest. How and why insects have become pests?
2. Bionomics, distribution; mode of damage caused and management of major pests
UNIT-II
1. Pests of cash crops: sugar cane, tobacco and cotton.

UNIT-III
1. Pests of vegetables
2. Pests of fruits
3. Pests of oil seed crops

UNIT-IV
1. Pests of stored grains and milled products.
2. Methods of safe storage
3. Non insect pests of storage and their management
4. Factors affecting storage
5. Household pest management.

MSC. ZOOLOGY IV SEMESTER
ELECTIVE GROUP C (SPECIAL PAPER)
ZOL 4C02: ENTOMOLOGY
MEDICAL AND APPLIED ENTOMOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I
1. Pests of medical and veterinary importance; vectors of various diseases (protozoans, viral and bacterial). Their control and management.
2. Role of WHO and UNICEF in their management.

UNIT-II
1. Forensic entomology with special reference to man and wildlife.

UNIT-III
1. Beneficial insects.
2. Silk worm, honey bee and lac insect cultivation and industries related to them. Problems related to these industries.

UNIT-IV
Pesticides:
1. Their impact on wildlife
2. Their impact on human health; bio concentration, bio accumulation, bio magnification, biodegradation
3. Biological half-life
4. Dynamics of environmental pollution due to pesticides.

MSC. ZOOLOGY IV SEMESTER

ELECTIVE GROUP C (SPECIAL PAPER)

ZOL 4 C03: ENTOMOLOGY

INSECT PEST MANAGEMENT

Max. Marks: 100

Total Hours: 60

UNIT- I

Definition and history of various methods of insect pest control:
1. Physical
2. Mechanical
3. Chemical
4. Cultural
5. Quarantine regulations.

UNIT- II

1. Nomenclature and classification of insecticides.
   (i) Concept of lst, llnd and lllrd generation pesticides.
   (ii) Pesticides act of India.
   (iii) Selection of insecticides, their formulation and mode of action.
2. Preventive measures and antidotes.
3. Fumigants and appliances used for application of insecticides.

UNIT- III

1. Biological control:
   (i) Definition, biological control agents.
   (ii) Microbial pesticides
   (iii) Mass production and distribution
   (iv) Advantages and disadvantages of biological control.
   (v) Parasites, parasitoids and predators

UNIT- IV

1. Integrated pest management (IPM):
   Concepts and principles of IPM, its components, strategies for field crops, economic threshold levels, constraints and strategies of IPM implementation, impact of climatic change on insect pests.
1. Anatomy:
   a) Honey bee - Nervous System
   b) House fly - Nervous System
   c) Gryllus - Nervous System, Alimentary Canal
2. Permanent Preparation:
   a) Sting apparatus, pollen basket, mouth parts, antennae, leg and wings of Honey bee
   b) Sponging mouth parts, antennae, leg and wings of House fly
   c) Whole mounts of thrips and aphids
3. Testing of insecticide - Bio assay method (LC50 and LD50 of any one synthetic and one natural insecticide in stored grain pests)
4. Study of prepared slides:
   a) Whole mounts of insects
   b) Legs
   c) Mouth Parts
   d) Wings
   e) Antennae
   f) Histology of Insects
5. Appliances for application of insecticides:
   a) Knapsack sprayer
   b) Knapsack duster
   c) Hand sprayer
6. Study of selected insects-
   a) Study of selected insects as museum specimens.
   b) Study of selected insects and their identification with the help of taxonomic key.
7. Microtomy
8. Exercise in Physiology
   a) Analysis of honey and its quality control
   b) Analysis of Chitin presence in the insect integument
   c) Study of pH of the gut in larvae of insects
   d) Action of amylase enzyme in the cockroach
   e) Application of Dyar's Law
   f) Study of giant chromosomes.
   g) Detection of Allantoin in cockroach excreta by paper chromatography.

SUGGESTED BOOKS
5. Principles of Insect Morphology, Snodgrass.

ZOL 412C: PRACTICAL-VIII

Scheme for Practical Examination
(Based on ZOL 4C01, ZOL 4C02 and ZOL 4C03)

Max. Marks: 100

1. Major Exercise                  -26
2 (a) Minor Exercise              -10
    (b) Minor Exercise              -10
3. Spotting (8 × 3)                -24
4. Seminar                        -10
5. Viva Voce                      -10
6. Record                         -10

Time: 4 hrs

Notes:
1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of charts/models/CD-ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.
2. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP D (SPECIAL PAPER)
ZOL 4D01: ENVIRONMENTAL BIOLOGY

ENVIRONMENTAL TOXICOLOGY AND ENVIRONMENTAL HEALTH

Max. Marks: 100

Total Hours: 60

UNIT-I

Ecotoxicology:
1. Definition, scope and history of Toxicology, Fundamental of Ecotoxicology, Acute, Sub-acute and Chronic toxicity, Doses, Dose-Response relationships, LC50, LD50, Effective Concentration (EC), Maximum Acceptable Toxicant Concentration (MATC), Application Factor (AF), Cumulative toxicity.
5. Detoxification mechanisms: Phase I and Phase II reactions.

UNIT-II

Environmental pollution and management:

1. Sources and classification of pollutants, primary and secondary pollutants, Effects of pollutants on human health, animal, vegetation, materials and structures.
5. Solid Waste Management: Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing and resources recovery and recycling. Aerobic and anaerobic systems - composting, vermicomposting; Bio-digesters (Biogas plants); incineration, pyrolysis, pyrolysis; sanitary landfills and open dumping yards.

UNIT-III

Toxicants of public health and occupational health:
1. Toxicity of Pesticides: Organochlorines, Organophosphates, Carbamates and Pyrethroids.
2. Toxicity of heavy metals and metalloids: Arsenic, Mercury, Lead, Aluminum, Cadmium, Chromium and Copper.
5. Occupational hazards and diseases: Physical hazards (Heat and cold, light, noise, vibration, ultraviolet radiation, ionizing radiation), Chemical hazards (Mustard gas, Nerve agents, Lewisite, Phosgene oxide, Cyanide), Biological hazards (Anthrax, Leptospirosis, Psittacosis, Botulism, Brucellosis, Cholera, Gas Gangrene, Ebola
hemorrhage Fever, Melioidosis, Q fever, Rift Valley fever, Ricin, Saxitoxin, Mycotoxicosis, Tularemia). Psychosocial hazards and diseases.

UNIT-IV
Environmental impact and risk assessment: (10 hrs.)
1. Definition, Scope, Characteristics, Objectives and Components.
2. EIA process and methodology; Procedure for obtaining EIA clearance; Preparation of EIA document; Major limitations of EIA; EIA Case Studies.
3. Prediction and assessment of impacts on earth resources.

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP D (SPECIAL PAPER)
ZOL 4002: ENVIRONMENTAL BIOLOGY

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I
Microbial diversity and metagenomics:
1. Microbial diversity in air, water and soil.
2. Microbial diversity of extreme environments.
3. Introduction to metagenomics.

UNIT-II
Microbial interaction with xenobiotic inorganic pollutants:
1. Persistence and Biomagnifications of Xenobiotic molecules.
2. Polychlorinated Biphenyl and Dioxins.
4. Acid Mine Drainage.
5. Microbial Methylations.
6. Microbial accumulation of Heavy Metals and Radionuclides.

UNIT-III
Bioremediation of xenobiotic pollutants:
1. Bioremediation.
2. Environmental modification for Bioremediation.
3. Microbial seeding and Bio-Engineering approaches to the bioremediation of pollutants.
4. Bioremediation of Marine Oil pollutants and Air pollutants.

UNIT-IV
Use of microorganisms:
1. Recovery of Metals.
2. Recovery of Petroleum.
3. Production of Fuels.
4. Production of microbial biomass.
5. Microbial control of pests.

M.Sc. ZOOLOGY IV SEMESTER
ELECTIVE GROUP D (SPECIAL PAPER)
ZOL 4D03: ENVIRONMENTAL BIOLOGY
ENVIRONMENTAL EDUCATION, MANAGEMENT AND REGULATIONS

Max. Marks: 100
Total Hours: 60

UNIT-I

Environmental education:
1. Knowledge about the environment, knowledge about humanity-environment relationship.
2. Knowledge about Environment and population growth, knowledge about the solution and prevention of environmental problems, rational use of resources.
3. Environmental education- goals, objectives, guided principles.
4. Strategies for environmental education- Authorisation, Curriculum renewal, teacher’s training renewal, teaching methods, evaluation.
5. Models for future environmental education system.

UNIT-II

Environmental institutions and international cooperation:
2. Global Environmental Agreements, Institutions of climate change, Indian Environmental Institutions, Central Pollution Control Board (CPCB).

UNIT-III

Environmental laws:
1. Environmental Legislation status in India.
5. The Biological Diversity Act, 2002.
UNIT-IV

National and international regulatory organizations:
1. MoEF (Ministry of Environment And Forests), ZSI (Zoology Survey of India) WI (Wild life Institute of India), Bombay Natural History Society (BNHS).
2. Zoo Authority of India (ZAI), Salim Ali Centre for Ornithology & Natural History (SACONH), Indira Gandhi Conversation and Monitoring Centre (IGCMC), National Biodiversity Authority (NBA), Animal Welfare Board of India (AWBI), Centre for Environment Education (CEE).
5. Ramsar (Wetland) sites in India and Ramsar convention.

PRACTICALS:
1. Measurement of particulate air pollutants, dust fall and suspended particulate matter from different sites.
2. Measurement of Noise pollution of different areas.
4. Determination of total suspended and dissolved solids/salts (TSS &TDS).
5. Toxicity Analysis of Water: For Chlorine, H2S, Ammonia, Copper and Chromium.
6. Estimation of BOD and COD of polluted water.
7. Determination of LC50 for fish (pesticide) using Probit analysis (use of appropriate software is suggested).
8. Study of Histo-pathological changes in any two of the tissues (Liver/ Kidney/ Gonad) using pesticide/heavy metal/nanoparticle.
9. Isolation and Enumeration of microorganisms in soil, water and air.
10. Bacteriological quality testing of water and wastewater: (a) Presumptive coliform test (MPN Index), (b) Confirmatory coliform test, Completed test.
11. Boric acid test for turmeric in chilly and coriander powder.
12. Detection of Lead chromate in chilly, and turmeric powder.
15. Detection of starch and cellulose in milk.
16. Detection of added Glucose in milk and milk powder.
17. Foreign vegetable fats in milk.
20. Case studies on oil pollution and nuclear reactor disasters (At least one each).
21. Project work: To locate and describe water harvesting system like tanka/bawri in and around Jaipur and physicochemical and microbiological analysis of their water. (This can be done as part of the three / four day field study compulsory for this elective).
22. Visit to Institutions engaged in environmental management/Toxicology research and an industrial /polluted area. Report the study conducted and submit a write up/ print out
giving the dates, methodology, results and references. Include photographs of the activity.

SUGGESTED BOOKS:
1. Environmental Microbiology: Maier, R.M, Pepper, I. L., Gerba, C. P.
3. Biotechnology: Applying the Genetic Revolution, Clark, D. P. & Tazdernik, N. J.
4. Principle of Environmental Science, Cunningham, W.P & Cunningham, M...
5. Microbiology Fundamentals and Application, Purohit, S. S.
6. Microbial Biopesticides, Koul, O & Dhaliwal, G. S.
7. Bioremediation Technology, Fulekar, M. H.
18. Methods of Air sampling and Analysis (3rd Edn.). James, P. Lodge, J.R., JSc Lewis Pub., INC.
24. EIA for Developing Countries. Asit K. Biswas et al., 1987, United Nations University, Tokyo.
Scheme for Practical Examination  
(Based on ZOL 4D01, ZOL 4D02 and ZOL 4D03)

Max Marks: 100  
Time: 4 hrs

1. Major Exercise  
2 (a) Minor Exercise  
   (b) Minor Exercise  
3. Spotting (8 × 3)  
4. Seminar  
5. Viva Voce  
6. Record  

Notes:  
1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP E (SPECIAL PAPER)  
ZOL 4E01: REPRODUCTIVE BIOLOGY  
PHYSIOLOGY OF REPRODUCTION  
Max. Marks: 100  
Total Hours: 60

UNIT-I  
Fertilization:  
1. Prefertilization events,  
2. Biochemistry of fertilization  
3. Post-fertilization events  
4. Capacitation.

UNIT-II  
Implantation:  
1. Implantation, decidual changes  
2. Hormonal regulation,  
3. Delayed implantation  
Placenta as endocrine tissue: foeto-placental unit.

UNIT-III  
Gestation:  
1. Physiological changes  
2. Pregnancy tests  
3. Hormonal regulation.
**Parturition:**
1. Onset of parturition
2. Hormonal control of parturition.

**Lactation:**
1. The mammary gland
2. Hormonal control of lactation.

**UNIT-IV**

Miscellaneous factors affecting reproduction:
1. Nutrition and reproduction
2. Effect of light, temperature
3. Environmental disruptors

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP E (SPECIAL PAPER)

ZOL 4 E02: REPRODUCTIVE BIOLOGY

CONTRACEPTION AND REPRODUCTIVE HEALTH

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Fundamental aspects of control of fertility in males:**
1. Mechanical
2. Surgical
3. Chemical
4. Immunological methods.

**UNIT-II**

**Fundamental aspects of control of fertility in females:**
1. Natural.
2. Mechanical.
3. Surgical.
4. Chemical.
5. Immunological.

**UNIT-III**

**Sexually transmitted diseases:** Pathophysiology, diagnosis, prevention, treatment of
1. Bacterial diseases (Syphilis, Gonorrhea)
2. Viral (AIDS)
3. Fungal (Candidiasis)
4. Protozoan (Trichomoniasis)

Hormones and cancer:
1. Definition of cancer
2. Benign and malignant tumor
3. Types of cancer: Prostate, cervical, breast, testicular and ovarian cancers
4. Cancer problem in India
5. Hormones and cancer

UNIT-IV

Teratological effects of Xenobiotics.

Demography:
1. Population growth rate
2. National population policy
3. Pearl Index
4. Family welfare programmes

M.Sc. ZOOLOGY IV SEMESTER

ELECTIVE GROUP E (SPECIAL PAPER)

ZOL 4 E03: REPRODUCTIVE BIOLOGY

REPRODUCTIVE TECHNOLOGIES

Max. Marks: 100

Total Hours: 60

UNIT-I

Reproductive dysfunctions in males and females:
1. Endocrinological
2. Physiological
3. Anatomical
4. Congenital
5. Idiopathic factors

Diagnosis of male infertility:
1. Semen analysis: Physical examinations, microscopic examinations, biochemical analysis, Immunological tests.
3. Endocrinological diagnosis.
UNIT-II

Diagnosis of female infertility:
1. Monitoring of ovarian and reproductive cycles.
2. Endometrial biopsy.
3. Ductal blockage.
4. Endocrine diagnosis

Assisted reproductive technology (ART):
1. Artificial insemination
2. Super ovulation, oocyte collection.
3. Collection and preparation of sperm for assisted fertilization.
4. In vitro fertilization and related techniques (IVF, GIFT, ZIFT, TET, ICSI etc.).
5. Ethical issues and regulatory guidelines

Cryopreservation:
1. Semen,
2. Oocytes
3. Embryos

UNIT-III

1. Animal cloning.
2. Sperm and embryo sexing.

Animal husbandry:
1. Improvement of breeds of farm animals
2. Artificial insemination and embryo transfer technique
3. Transgenic animals.
4. Induction of early puberty in cattle

UNIT-IV

Pre-natal diagnosis of genetic diseases.

Hormonal bioassay: Principles, Procedure and applications of hours
1. ELISA
2. Radio immunoassay (RIA)
3. Radioreceptor binding assay
4. Immuno-cytochemistry.

PRACTICALS
1. Surgical procedure in reproduction:
   (i) Castration,
   (ii) Ovarectomy,
   (iii) Adrenalectomy
   (iv) Vasectomy
2. Biochemical investigation of marker parameters.
3. Induction of superovulation and collection of oocytes.
4. Hormonal bioassays estrogens & androgen.
5. Pregnancy test.
8. Demonstration of in vitro fertilization (GIFT, ZIFT, TET, ICSI, etc.).
9. Immunoassays: RIA, ELISA.
10. Visit to State and National laboratories / Institute

SUGGESTED BOOKS
12. Text Book on Sexually Transmitted Diseases and AIDS by IASSTD & AIDS, Vinod K Sharma, Rishi Bhargava and N. Usman VIVA BOOKS PVT. LTD, Jaipur
15. Reproductive Biotechnology of Farm Animals, Dugwekar Vg Agrotech Publishing Academy, 2006.

[Signature]
Dy. Registrar (Acad.)
University of Rajasthan
Jaipur
ZOL 412E: PRACTICAL-VIII

Scheme for Practical Examination
(Based on ZOL 4E01, ZOL 4E02 and 4E03)

Max. Marks: 100

1. Major Exercise
2 (a) Minor Exercise
   (b) Minor Exercise
3. Spotting (8 x 3)
4. Seminar
5. Viva Voce
6. Record

Time: 4 hrs

26
10
10
24
10
10
10

Notes:
1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.