H.P. University, Summerhill, Shimla

Structure and Syllabus

of

ZOOLEGY

for

B.Sc. Undergraduate Programme

Based on:

U.G.C. Choice Based Credit System

(CBCS) Annual Pattern UG Courses

Model Curriculum

(Effective from Academic Session July, 2018 onwards)
Details of Courses for B.Sc. (Pass Course) Zoology Undergraduate Program

Annual Pattern

<table>
<thead>
<tr>
<th>Course</th>
<th>*Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory+ Practical</td>
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<tr>
<td></td>
<td>12X4= 48</td>
</tr>
</tbody>
</table>

I. Discipline Specific Courses  
(12 Papers)  
04 Courses from each of the  
03 disciplines of choice  
Discipline Specific Courses Practical / Tutorial*  
(12 Practical/ Tutorials*)  
04 Courses from each of the  
03 Disciplines of choice  

II. Discipline Specific Elective Course  
(6 Papers)  
Two papers from each discipline of choice  
including paper of interdisciplinary nature.  
Discipline Specific Elective Course Practical / Tutorials*  
(6 Practical / Tutorials*)  
Two Papers from each discipline of choice  
including paper of interdisciplinary nature
III. Ability Enhancement Courses

1. Ability Enhancement Compulsory Courses
   (2 Papers of 4 credits each)
   i. Environmental Sciences
   ii. English/Hindi/SKT

2. Skill Enhancement Course
   (Skill Based)
   (4 Papers of 4 credits each)

Total credit= 132  Total credit= 132

Institute should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

*wherever there is practical there will be no tutorials and vice -versa
Proposed scheme for choice based credit system in B.Sc. with Zoology (Annual Pattern)

<table>
<thead>
<tr>
<th>DISCIPLINE SPECIFIC COURSES (DSC)</th>
<th>Credits</th>
<th>Ability enhancement compulsory course (AECC) Credits</th>
<th>Skill enhancement courses (SEC) Credits</th>
<th>Discipline specific elective DSE Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DSC IA</strong></td>
<td></td>
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</tr>
<tr>
<td>Animal Diversity</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ZOOL 101 TH</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>ZOOL 101 PR</td>
<td>2</td>
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<tr>
<td><strong>DSC IB</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Comparative Anatomy and</td>
<td></td>
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</tr>
<tr>
<td>Developmental Biology of</td>
<td></td>
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</tr>
<tr>
<td>Vertebrates</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ZOOL 102 TH</td>
<td>4</td>
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<tr>
<td>ZOOL 102 PR</td>
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<tr>
<td><strong>DSC IC</strong></td>
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<tr>
<td>Physiology and Biochemistry</td>
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<tr>
<td>ZOOL 201 TH</td>
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<tr>
<td>ZOOL 201 PR</td>
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<tr>
<td><strong>DSC ID</strong></td>
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<tr>
<td>Genetics and Evolutionary</td>
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</tr>
<tr>
<td>Biology</td>
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<tr>
<td>ZOOL 202 TH</td>
<td>4</td>
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<tr>
<td>ZOOL 202 PR</td>
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<tr>
<td><strong>SEC-I</strong></td>
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<tr>
<td>Medical Diagnostics</td>
<td></td>
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<tr>
<td>ZOOL 203 TH</td>
<td>4</td>
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<tr>
<td><strong>SEC-II</strong></td>
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<tr>
<td>Apiculture</td>
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<tr>
<td>ZOOL 204 TH</td>
<td>4</td>
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<tr>
<td><strong>IIIrd Year</strong></td>
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</tbody>
</table>

| SEC-III                           |         |                                                      |                                        |                                        |
| Sericulture                       |         |                                                      |                                        |                                        |
| ZOOL 303 TH                       | 4       |                                                      |                                        |                                        |
| **SEC- IV**                       |         |                                                      |                                        |                                        |
| Aquarium Fish Keeping             |         |                                                      |                                        |                                        |
| ZOOL 304 (A) (TH)                 | 4       |                                                      |                                        |                                        |
| OR                                |         |                                                      |                                        |                                        |
| Research Methodology              |         |                                                      |                                        |                                        |
| ZOOL 304 (B) TH                   | 4       |                                                      |                                        |                                        |

<p>| DSE IA                            |         |                                                      |                                        |                                        |
| Applied Zoology                   |         |                                                      |                                        |                                        |
| ZOOL 301 (A) TH                   | 4       |                                                      |                                        |                                        |
| ZOOL 301 (A) PR                   | 2       |                                                      |                                        |                                        |
| OR                                |         |                                                      |                                        |                                        |
| Animal Biotechnology              |         |                                                      |                                        |                                        |
| ZOOL 302 (B) TH                   | 4       |                                                      |                                        |                                        |
| ZOOL 302 (B) PR                   | 2       |                                                      |                                        |                                        |
| OR                                |         |                                                      |                                        |                                        |
| Aquatic Biology                   |         |                                                      |                                        |                                        |
| ZOOL 303 (C) TH                   | 4       |                                                      |                                        |                                        |
| ZOOL 303 (C) PR                   | 2       |                                                      |                                        |                                        |</p>
<table>
<thead>
<tr>
<th>DSE IB</th>
<th>Insect, Vector and Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZOOL 302 (A)</td>
<td>TH 4</td>
</tr>
<tr>
<td>ZOOL 302 (A)</td>
<td>PR 2</td>
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<tr>
<td><strong>OR</strong></td>
<td>Immunology</td>
</tr>
<tr>
<td>ZOOL 302 (B)</td>
<td>TH 4</td>
</tr>
<tr>
<td>ZOOL 302 (B)</td>
<td>PR 2</td>
</tr>
<tr>
<td><strong>OR</strong></td>
<td>Reproductive Biology</td>
</tr>
<tr>
<td>ZOOL 302 (C)</td>
<td>TH 4</td>
</tr>
<tr>
<td>ZOOL 302 (C)</td>
<td>PR 2</td>
</tr>
</tbody>
</table>
Detail of Courses

DISCIPLINE SPECIFIC COURSES (DSC)

B.Sc. Ist Year

1. **DSC IA**: Animal Diversity
   
   ZOOL 101 TH; ZOOL 101 PR

2. **DSC IB**: Comparative Anatomy and Development Biology of Vertebrates
   
   ZOOL 102 TH; ZOOL 102 PR

B.Sc. IInd Year

3. **DSC IC**: Physiology and Biochemistry
   
   ZOOL 201 TH; ZOOL 201 PR

4. **DSC ID**: Genetics and Evolutionary Biology
   
   ZOOL 202 TH; ZOOL 202 PR

Discipline specific elective (DSE)

B.Sc. IIIrd year

DSE IA

1. Applied Zoology
   
   ZOOL 301 (A) TH; ZOOL 301 (A) PR

   OR

2. Animal Biotechnology
   
   ZOOL 301 (B) TH; ZOOL 301 (B) PR

   OR

3. Aquatic Biology
   
   ZOOL 301 (C) TH; ZOOL 301 (C) PR

DSE IB

4. Insect, Vector and Diseases
   
   ZOOL 302 (A) TH; ZOOL 302 (A) PR

   OR

5. Immunology
   
   ZOOL 302 (B) TH; ZOOL 302 (B) PR

   OR

6. Reproductive Biology
   
   ZOOL 302 (C) TH; ZOOL 302 (C) PR

Ability Enhancement Compulsory Courses

B.Sc Ist Year

1. Environmental Sciences

2. English/Hindi/SKT

Skill Enhancement Courses in Zoology

B.Sc IInd Year

1. Medical Diagnosis
   
   ZOOL 203 TH

2. Apiculture
   
   ZOOL 204 TH

B.Sc. IIIrd year

3. Sericulture
   
   ZOOL 303 TH

4. Aquarium Fish Keeping
   
   ZOOL 304 (A) TH

   OR

   Research Methodology
   
   ZOOL 304 (B) TH
# ANIMAL DIVERSITY

**Code: ZOOL 101 TH**  
**(CREDITS 4)**

## THEOREY

<table>
<thead>
<tr>
<th>Section A</th>
<th>Unit</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1: Kingdom Protista</strong></td>
<td>4</td>
<td>General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa</td>
<td></td>
</tr>
<tr>
<td><strong>Unit 2: Phylum Porifera</strong></td>
<td>3</td>
<td>General characters and classification up to classes; Canal System in <em>Sycon</em></td>
<td></td>
</tr>
<tr>
<td><strong>Unit 3: Phylum Cnidaria</strong></td>
<td>3</td>
<td>General characters and classification up to classes; Polymorphism in Hydrozoa</td>
<td></td>
</tr>
<tr>
<td><strong>Unit 4: Phylum Platyhelminthes</strong></td>
<td>3</td>
<td>General characters and classification up to classes; Life history of <em>Taenia solium</em></td>
<td></td>
</tr>
<tr>
<td><strong>Unit 5: Phylum Nemathelminthes</strong></td>
<td>5</td>
<td>General characters and classification up to classes; Life history of <em>Ascaris lumbricoides</em> and its parasitic adaptations</td>
<td></td>
</tr>
</tbody>
</table>

## Section B

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 6: Phylum Annelida</strong></td>
<td>3</td>
<td>General characters and classification up to classes; Metamerism in Annelida</td>
</tr>
<tr>
<td><strong>Unit 7: Phylum Arthropoda</strong></td>
<td>5</td>
<td>General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects</td>
</tr>
<tr>
<td><strong>Unit 8: Phylum Mollusca</strong></td>
<td>4</td>
<td>General characters and classification up to classes; Torsion in gastropods</td>
</tr>
<tr>
<td><strong>Unit 9: Phylum Echinodermata</strong></td>
<td>4</td>
<td>General characters and classification up to classes; Water-vascular system in Asteroidea</td>
</tr>
</tbody>
</table>

## Section C

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 10: Protochordates</strong></td>
<td>2</td>
<td>General features and Phylogeny of Protochordata</td>
</tr>
<tr>
<td><strong>Unit 11: Agnatha</strong></td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

7
General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces  4
General features and Classification up to orders; Osmoregulation in Fishes

Unit 13: Amphibia  4
General features and Classification up to orders; Parental care

Section D

Unit 14: Reptiles  4
General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

Unit 15: Aves  5
General features and Classification up to orders; Flight adaptations in birds

Unit 17: Mammals  5
Classification up to orders; Origin of mammals
ANIMAL DIVERSITY
Code: ZOOL 101 PR

PRACTICAL (CREDITS 2)

1. Study of the following specimens:
   Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, and Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pherepina, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and
   Antedon, Balanoglossus, Herdmania, Branchioesta, Petromyson, Sphynna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, Sorex, Bat, Funambulus, Loris

2. Study of the following permanent slides:
   T.S. and L.S. of Sycon, Study of life history stages of Taenia, T.S. of Male and female Ascaris

3. Key for Identification of poisonous and non-poisonous snakes

4. Project on any topic from theory.

SUGGESTED READINGS

**DSC IB**
**COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES**

**Code: ZOOL 102 TH**

<table>
<thead>
<tr>
<th>THEORY</th>
<th>Section A</th>
<th>(CREDITS 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1: Integumentary System</strong></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Derivatives of integument w.r.t. glands and digital tips</td>
<td></td>
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<tr>
<td><strong>Unit 2: Skeletal System</strong></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Evolution of visceral arches</td>
<td></td>
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</tr>
<tr>
<td><strong>Unit 3: Digestive System</strong></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Brief account of alimentary canal and digestive glands</td>
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<td></td>
</tr>
<tr>
<td><strong>Unit 4: Respiratory System</strong></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Brief account of Gills, lungs, air sacs and swim bladder</td>
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</tbody>
</table>

**Section B**

| **Unit 5: Circulatory System** | | 4 |
| Evolution of heart and aortic arches | |
| **Unit 6: Urinogenital System** | | 4 |
| Succession of kidney, Evolution of urinogenital ducts | |
| **Unit 7: Nervous System** | | 3 |
| Comparative account of brain | |
| **Unit 8: Sense Organs** | | 3 |
| Types of receptors | |

**Section C**

| **Unit 9: Early Embryonic Development** | | 14 |
| Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; | |

**Section D**

| **Unit 10: Late Embryonic Development** | | 12 |
| | 10 |
Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

**Unit 11: Control of Development**

Intercellular communication, cell movements and cell death.
1. Osteology:
   a) Disarticulated skeleton of frog and rabbit
   b) Carapace and plastron of Frog /tortoise
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
4. Study of placental development in humans by ultrasound scans as project.
5. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

B.Sc. IInd Year
DSC IC
PHYSIOLOGY AND BIOCHEMISTRY
Code: ZOOL 201 TH

THEORY (CREDITS 4)

Section A

Unit 1: Nerve and muscle 8
Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultrastructure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 2: Digestion 5
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit 3: Respiration 5
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Section B

Unit 4: Excretion 5
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system 6
Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction and Endocrine Glands 7
Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle
Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Section C

Unit 7: Carbohydrate Metabolism 8
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 8: Lipid Metabolism 5
β oxidation of palmitic acid

Section D

Unit 9: Protein metabolism 5
Transamination, Deamination and Urea Cycle

Unit 10: Enzymes
Introduction, Mechanism of action, Inhibition and Regulation

B.Sc. II nd Year
PHYSIOLOGY AND BIOCHEMISTRY
Code: ZOOL 201 PR
PRACTICAL(CREDITS 2)

1. Preparation of hemin and hemochromogen crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose).
5. Estimation of total protein in given solutions by Lowry’s method.
6. Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS
### Section A
#### Unit 1: Introduction to Genetics
Mendel’s work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

#### Unit 2: Mendelian Genetics and its Extension
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

### Section B
#### Unit 3: Linkage, Crossing Over and Chromosomal Mapping
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence.

#### Unit 4: Mutations
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

#### Unit 5: Sex Determination
Chromosomal mechanisms, dosage compensation

### Section C
#### Unit 6: History of Life
Major Events in History of Life

#### Unit 7: Introduction to Evolutionary Theories
Lamarckism, Darwinism, Neo-Darwinism

#### Unit 8: Direct Evidences of Evolution
Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

#### Unit 9: Processes of Evolutionary Change
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection
Unit 10: Species Concept
Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit 11: Macro-evolution
Macro-evolutionary Principles (example: Darwin’s Finches)

Unit 12: Extinction
Mass extinction (Causes, Names of five major extinctions),
Role of extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY
Code: ZOOL 202 PR

PRACTICAL (CREDITS 2)

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/pictures
6. Charts:
   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b) Darwin’s Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS


<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Host-parasite Relationship</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis</td>
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<tr>
<td>2</td>
<td>Epidemiology of Diseases</td>
<td>7</td>
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<tr>
<td></td>
<td>Transmission, Prevention and control of diseases: Tuberculosis, typhoid</td>
<td></td>
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<tr>
<td>3</td>
<td>Rickettsiae and Spirochaetes</td>
<td>6</td>
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<tr>
<td></td>
<td>Brief account of <em>Rickettsia prowazekii</em>, <em>Borrelia recurrentis</em> and <em>Treponema pallidum</em></td>
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<tr>
<td>4</td>
<td>Parasitic Protozoa</td>
<td>8</td>
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<tr>
<td></td>
<td>Life history and pathogenicity of <em>Entamoeba histolytica</em>, <em>Plasmodium vivax</em> and <em>Trypanosoma gambiense</em></td>
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<tr>
<td>5</td>
<td>Parasitic Helminthes</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Life history and pathogenicity of <em>Ancylostoma duodenale</em> and <em>Wuchereria bancrofti</em></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Insects of Economic Importance</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Biology, Control and damage caused by <em>Helicoverpa armigera</em>, <em>Pyrilla perpusilla</em> and <em>Papilio demoleus</em>, <em>Callosobruchus chinensis</em>, <em>Sitophilus oryzae</em> and <em>Tribolium castaneum</em></td>
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(CREDITS 4)
Unit 7: Insects of Medical Importance

Medical importance and control of *Pediculus humanus corporis*, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla cheopis*.

Unit 8: Animal Husbandry

Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle.

Unit 9: Poultry Farming


Unit 10: Fish Technology

Genetic improvements in aquaculture industry; Induced breeding and transportation of fish see.

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**APPLIED ZOOLOGY**

*Code: ZOOL 301 (A) PR*

**PRACTICAL**

*(CREDITS 2)*

1. Study of *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma gambiense*, *Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.

2. Study of arthropod vectors associated with human diseases: *Pediculus*, *Culex*, *Anopheles*, *Aedes* and *Xenopsylla*.

3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.

4. Identifying feature and economic importance of *Helicoverpa (Heliothis) armigera*, *Papilio demoleus*, *Pyrilla perpusilla*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*.

5. Visit to poultry farm or animal breeding centre. Submission of visit report.

SUGGESTED READINGS

- Kumar and Corton. *Pathological Basis of Diseases*.

ANIMAL BIOTECHNOLOGY

**Code: ZOOL 301(B) TH**

**THEORY**

(Credits 4)

**Unit 1: Introduction**

Concept and scope of biotechnology

8

**Unit 2: Molecular Techniques in Gene manipulation**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics)

Restriction enzymes: Nomenclature, detailed study of Type II

Transformation techniques: Calcium chloride method and electroporation.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

Southern, Northern and Western blotting; DNA sequencing: Sanger method

Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

24
Unit 3: Genetically Modified Organisms

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection
Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.
Production of transgenic plants: *Agrobacterium* mediated transformation.
Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4: Culture Techniques and Applications

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy
1. Genomic DNA isolation from *E. coli*

2. Plasmid DNA isolation (pUC 18/19) from *E. coli*

3. Restriction digestion of plasmid DNA.

4. Construction of circular and linear restriction map from the data provided.

5. Calculation of transformation efficiency from the data provided.

6. To study following techniques through photographs
   a) Southern Blotting
   b) Northern Blotting
   c) Western Blotting
   d) DNA Sequencing (Sanger's Method)
   e) PCR

   DNA fingerprinting

7. Project report on animal cell culture

**SUGGESTED READINGS**


THEORY

UNIT 1: Aquatic Biomes

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology


Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

PRACTICAL

1. Determine the area of a lake using graphimetric and gravimetric method.

2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

5. A Project Report on a visit to a Sewage treatment plant/Marine bioreserve/Fisheries Institutes.

SUGGESTED READINGS

- **Anathakrishnan**: Bioresources Ecology 3rd Edition
- **Goldman**: Limnology, 2nd Edition
- **Odum and Barrett**: Fundamentals of Ecology, 5th Edition
- **Pawlowski**: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
- **Wetzel**: Limnology, 3rd edition
- **Trivedi and Goyal**: Chemical and biological methods for water pollution studies
- **Welch**: Limnology Vols. I-II

DSE IB
INSECT, VECTORS AND DISEASES ZOOL 302(A) TH

THEORY

(Credits 4)

**Unit I: Introduction to Insects**
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

**Unit III: Insects as Vectors**
Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

24
Unit IV: Dipteran as Disease Vectors
Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies;
Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis;
Control of mosquitoes Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit IV: Siphonaptera as Disease Vectors
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

Unit V: Siphunculata as Disease Vectors
Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases – Typhus fever, Relapsing fever, Trench fever, Vagabond’s disease, Phthiriasis; Control of human louse

Unit VI: Hempitera as Disease Vectors
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

INSECT VECTORS AND DISEASES
Code: ZOOL 302 (A) PR

RACTICAL
(CREDITS 2)

1. Study of different kinds of mouth parts of insects

2. Study of following insect vectors through permanent slides/photographs:
   Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phthirius pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica, through permanent slides/photographs

3. Study of different diseases transmitted by above insect vectors

Submission of a project report on any one of the insect vectors and disease transmitted
SUGGESTED READINGS


DSE IB

IMMUNOLOGY ZOOL 302(B) TH

THEORY  (CREDITS 4)

Unit 1: Overview of the Immune System  10
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system

Unit 2: Cells and Organs of the Immune System  8
Haematopoeisis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system

Unit 3: Antigens  8
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants

Unit 4: Antibodies  8
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis

Unit 5: Working of the immune system  12
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.

Unit 6: Immune system in health and disease  10
Gell and Coombs’ classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency,

Unit 7: Vaccines  4
General introduction to vaccines, Various types of vaccines
PRACTICAL

1*. Demonstration of lymphoid organs
2. Histological study of spleen, thymus and lymph nodes through slides/photographs
3. Preparation of stained blood film to study various types of blood cells.
5. ABO blood group determination.
6*. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of  a) ELISA  b) Immunoelectrophoresis

(*Subject to UGC guidelines)

SUGGESTED READINGS


DSE IB
REPRODUCTIVE BIOLOGY
Code: ZOOL 302(C) TH

THEORY

Unit 1: Reproductive Endocrinology

Unit 2: Functional anatomy of male reproduction

Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

Unit 3: Functional anatomy of female reproduction

Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 4: Reproductive Health

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

REPRODUCTIVE BIOLOGY
Code: ZOOL 302(C) PR

PRACTICAL

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology.
6. Sperm count and sperm motility in rat
7. Study of modern contraceptive devices
SUGGESTED READINGS

- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.

SKILL ENHANCEMENT COURSES

SEC 1
MEDICAL DIAGNOSTICS
Code: ZOOL 203 TH

THEORY (Credits 4)

Unit 1: Introduction to Medical Diagnostics and its Importance 2

Unit 2: Diagnostics Methods Used for Analysis of Blood 15

Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

Unit 3: Diagnostic Methods Used for Urine Analysis 6
Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4: Non-infectious Diseases 10
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

Unit 5: Infectious Diseases 6
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: Tumours 6
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).
SUGGESTED READINGS


- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*

- Guyton A.C. and Hall J.E. *Textbook of Medical Physiology*, Saunders


Tutorial – 01 Credit

SEC-II
APICULTURE
ZOOL 204 TH
(CREDIT 4)

Unit 1: Biology of Bees
History, Classification and Biology of Honey Bees
Social Organization of Bee Colony
(10)

Unit 2: Rearing of Bees
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth
Bee Pasturage
Selection of Bee Species for Apiculture
Bee Keeping Equipment
Methods of Extraction of Honey (Indigenous and Modern)
(15)

Unit 3: Diseases and Enemies
Bee Diseases and Enemies
Control and Preventive measures
(8)

Unit 4: Bee Economy
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen Etc
(6)

Unit 5: Entrepreneurship in Apiculture
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens
(6)
SUGGESTED READINGS


SEC - III

SERICULTURE
Code: ZOOL 303 TH (CREDITS 4)

Unit 1: Introduction (8)
Sericulture: Definition, history and present status; Silk route
Types of silkworms, Distribution and Races
Exotic and indigenous races
Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm (6)
Life cycle of *Bombyx mori*
Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms (15)
Selection of mulberry variety and establishment of mulberry garden
Rearing house and rearing appliances
Disinfectants: Formalin, bleaching powder, RKO
Silkworm rearing technology: Early age and Late age rearing
Types of mountages
Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases (10)
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture (6)
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.
SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

Tutorial – 01 Credit

SEC – IV
AQUARIUM FISH KEEPING
Code: ZOOL 304 (A) TH (CREDITS 4)

Unit1: Introduction to Aquarium Fish Keeping 10
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes 15
Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes 6
Use of live fish feed organisms. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation 8
Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium 6
General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

SUGGESTED READINGS
Mary Bailey, Gina Sandford; The Complete Guide to Aquarium Fish Keeping (Practical Handbook) Publishers: Lorenz Books
- Mills, Dick; Keeping Aquarium Fish (Teach Yourself General) Publisher : Teach Yourself

OR
Unit 1: Foundations of Research
Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

Unit 2: Research Design
Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit 3: Data Collection, Analysis and Report Writing
Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

Unit 4: Ethical Issues
Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

SUGGESTED READINGS

- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009
END SEMESTER EXAMINATION (ESE) OF ZOOLOGY IN B.Sc. PROGRAMME

THEORY EXAMINATION SCHEME OF EXAMINATION

1. English shall be the medium of instruction and examination.
2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by Himachal Pradesh University.
3. Each course will carry **100 marks** and will have following components

   1. **Theory Paper End-Semester examination** 50 marks
   2. **Practicals** 20 marks
   3. **Internal Assessment** 30 Marks

Theory Paper + Practicals + Internal Assessment (50+20+30) =100 marks

Scheme of Examination for every course (Core Course, Discipline Specific Elective Course, Generic Elective Course):

- **End Semester Examination** 50 Marks Time 3 hrs
- **Practical for every course** 20 Marks Time 3 hrs
- **Internal Assessment** 30 Marks

Distribution of Internal Assessment /CCA:

(i) Class Attendance = 5 Marks
(ii) Class test to be taken on completion of 40% syllabus by the class teacher = 5 Marks
(iii) House test to be taken on completion of 75% of Syllabus = 10 Marks
(iv) Assignments, tutorials, general behavior of student. = 10 Marks

**Marks for Class attendance**

- □ 75% but < 80% 1 marks
- □ 80% but <85% 2 marks
- □ 85 but <90% 3 marks
- □ 90% but < 95% 4 marks
- □ 95% To 100% 5 marks

**Skill Enhancement Course & Ability Enhancement Compulsory Course:**

**Skill Enhancement Course** = **100 Marks** (Theory 70 + CCA 30)

**Ability Enhancement Compulsory Courses:** 1. Environment Science = 100 Marks

2. English/Hindi/SKT = 100 Marks (Theory 70 + CCA 30)
Instructions for Setting of Question Papers

I. Discipline Specific Courses and Discipline Specific Electives (Theory Papers) Max Marks: 50

1. Each question paper will contain 9 questions (divided into five parts A, B, C, D and E) of 10 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part. Each question may be divided into 2 parts.
4. Questions should be taken from the whole syllabus.

II. Skill Enhancement Courses (SEC) Max Marks: 70

1. Each question paper will contain 9 questions (divided into five Parts- A, B, C, D and E) of 14 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part.
4. Questions should be taken from the whole syllabus.