SYLLABUS FOR B.Sc. ZOOLOGY (SEMESTER PATTERN)  
(With effect from the academic year 2018-19)

The semester pattern syllabus for B.Sc. Three Year Degree Course in the Subject - Zoology comprises of six semesters. Each semester is based on six theory periods and six practical periods per week. The examination of each semester shall comprise of one theory papers each of three hours duration and carries 80 marks and a practical of 4 hours duration carries 30 marks. Internal assessment for each semester based on one theory papers of 20 marks and one practical of 20 marks shall be conducted by departmental teaching staff. Candidates are expected to pass separately in theory and practical examination.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Theory Paper</th>
<th>Internal Assessment</th>
<th>Practical Marks</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sem - I</td>
<td>Theory Paper – I :- Life and Diversity of Animals-Nonchordates</td>
<td>100</td>
<td>20</td>
<td>30</td>
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<tr>
<td></td>
<td>Practical - I (Based on Paper I)</td>
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<tr>
<td>Sem - II</td>
<td>Theory Paper - II :- Life and Diversity of Animals- chordates</td>
<td>100</td>
<td>20</td>
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<td></td>
<td>Practical - II (Based on Paper II )</td>
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<tr>
<td>Sem - III</td>
<td>Theory Paper - III :- Cell Biology and environmental Biology</td>
<td>100</td>
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<tr>
<td>Sem - IV</td>
<td>Theory Paper - IV :- Genetics and Molecular Cell Biology</td>
<td>100</td>
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<tr>
<td>Sem - V</td>
<td>Theory Paper - V :- Developmental Biology</td>
<td>100</td>
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<td>Practical - V (Based on Paper V)</td>
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<tr>
<td>Sem - VI</td>
<td>Theory Paper - VI :- Animal Physiology, Biotechniques, Bioinformatics &amp; Biostatistics.</td>
<td>100</td>
<td>20</td>
<td>30</td>
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<tr>
<td></td>
<td>Practical - VI (Based on Paper VI)</td>
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<tr>
<td>UNIT - I</td>
<td>(12 Periods)</td>
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<tr>
<td>1.1 Animal Kingdom</td>
<td>Classification</td>
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<tr>
<td>1.2 Invertebrate</td>
<td>History and concept &amp; Classification</td>
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<tr>
<td>1.3 Protozoa</td>
<td>General Characters &amp; Locomotion</td>
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<tr>
<td>1.4 Malaria</td>
<td>Causative organism &amp; its Life cycle</td>
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<table>
<thead>
<tr>
<th>UNIT - II</th>
<th>(12 Periods)</th>
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<tbody>
<tr>
<td>2.1 Porifera</td>
<td>General Characters</td>
</tr>
<tr>
<td>2.2 Canal system in Sponges</td>
<td>Brief account</td>
</tr>
<tr>
<td>2.3 Coelenterata</td>
<td>General characters, polymorphism in Coelenterata</td>
</tr>
<tr>
<td>2.4 Corals &amp; Coral reef formation, Economic importance of corals</td>
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<tr>
<th>UNIT - III</th>
<th>(12 Periods )</th>
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<tbody>
<tr>
<td>3.1 Helminthes</td>
<td>General characters, Platyhelminthes &amp; Aschelminthes</td>
</tr>
<tr>
<td>3.2 Ascaris</td>
<td>Morphology, Life Cycle; Taenia - Morphology, Life cycle</td>
</tr>
<tr>
<td>3.3 Annelida</td>
<td>General characters &amp; Metamerism</td>
</tr>
<tr>
<td>3.4 Leech</td>
<td>Morphology, Genital system</td>
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<tr>
<th>UNIT - IV</th>
<th>(12 Periods )</th>
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</thead>
<tbody>
<tr>
<td>4.1 Arthropoda</td>
<td>General characters and vision in Arthropoda</td>
</tr>
<tr>
<td>4.2 Crustacean Larvae</td>
<td>Nauplius, Zoaea, Megalopa</td>
</tr>
<tr>
<td>4.3 Mollusca</td>
<td>General characters &amp; Torsion in Gastropoda</td>
</tr>
<tr>
<td>4.4 Pearl formation in Mollusc, Molluscan Larvae</td>
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<thead>
<tr>
<th>UNIT - V</th>
<th>(12 Periods )</th>
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<tbody>
<tr>
<td>5.1 Echinodermata</td>
<td>General characters,</td>
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<tr>
<td>5.2 Echinoderm Larvae</td>
<td>Introduction</td>
</tr>
<tr>
<td>5.3 Asterias</td>
<td>External features, Water vascular system &amp; Locomotion</td>
</tr>
<tr>
<td>5.4 Hemichordata</td>
<td>General characters, Phylogeny</td>
</tr>
<tr>
<td>5.5 Balanoglossus</td>
<td>External features, Affinities of Balanoglossus</td>
</tr>
</tbody>
</table>
Unit VI  (12 Periods)

6.1 Parasitism - Concept, parasite protozoa – Entamoeba, Leshmania
6.2 Parasitic Helminthes - Adaptation, Ascarasis, Taasis
6.3 Vector - Biological & Mechanical, Insect vector, Housefly
6.4 Ascaris - Life cycle, Taenia – Life cycle

PRACTICAL – I Based on Life and Diversity of Animals – Nonchordates

1. Study of museum specimens (Classification of animals up to orders)
   I. Protozoa (Slides) :- Paramecium, Euglena, Amoeba, Plasmodium vivax
   II. Porifera :- Sycon, Leucosolenia, Hyalonema, Euplectella,
   III. Coelenterata :- Obelia, Aurelia, Tubipora, Adamsia
   IV. Platyhelminthes :- Planaria, Fasciola, Taenia
   V. Aschelminthes :- Ascaris, Wuchereria
   VI. Annelida :- Aphrodite, Nereis, Hirudinaria
   VII. Arthropoda :- Peripatus, Daphnia, Limulus, Scolopendra, Moth
   VIII. Mollusca :- Chiton, Pila, Mytilus, Octopus
   IX. Echinodermata :- Asterias, Holothuria, Echinus
   X. Hemichordata :- Balanoglossus,

2. Study of permanent slides

   Sponge spicules, T.S. Sycon, Redia and Cercaria larvae of Fasciola, T.S. male and female Ascaris, Scolex of Taenia,

   Nauplius, Zoea of Arthropoda, Glochidium larva of Mollusca, T.S. of arm of star fish, Bipinnaria larva, T.S. Balanoglossus through proboscis

3. Anatomical observation / demonstration & detail explanation of Digestive and reproductive system of Cockroach through ICT tools / Models / Charts / Photography

4. Whole mount preparation of or Study of permanent preparation of Pila Gill lamella Obelia colony, Nereis parapodia, with the help of already available permanent slides / ICT tools / Charts / Photographs

5. Local Biodiversity in J.B. Campus – field visit and diary or visit to National park & sanctuary & submission of tour report.
Distribution of Marks – Total Marks 30

I. Identification and Comment on Spots 08
   (4 Museum specimens + 4 slides)

II. Anatomical observation through ICT tools (Dissection) 04

III. Permanent stained preparation (through ICT tools) 06

IV. Submission of certified practical record 03

V. Submission of Slides & tour diary 06

VI. Viva voce 03

B.Sc. Semester I (List of Recommended Books)

Life and Diversity of Animals – Non Chordates

1. Barnes – Invertebrate Zoology (Halt-Saunders international) Philadelphia, USA
2. Barradaile L.A. & Potts F.A. – The Invertebrate
3. Nigam – Biology of Nonchordates
5. Puranik P.G. & Thakur R.S. – Invertebrate Zoology
7. Dhami & Dhami – Invertebrate Zoology
9. Dr. S.S. Lal Practical Zoology Invertebrates 9th edition, Rastogi Publication Meerut
10. EJW Barrington – Invertebrate Structure and Function ELBS III Edition
11. R.L. Kotpal – Phylum Protozoa to Echinodermata (series), Rastogi and Publication, Meerut
<table>
<thead>
<tr>
<th>No.</th>
<th>Author(s)</th>
<th>Title anthropology</th>
<th>Publisher/Publication Details</th>
</tr>
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<tbody>
<tr>
<td>14</td>
<td>Jordan E.L. and Verma P.S.</td>
<td>Chordate Zoology</td>
<td>S. Chand and Co., New Delhi</td>
</tr>
<tr>
<td>15</td>
<td>Ayer E.</td>
<td>- Manual of Zoology</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>M.D. Bhatia</td>
<td>The Indian Zoological Memories - Leech</td>
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<tr>
<td>17</td>
<td>Beni Prasad</td>
<td>The Indian Zoological Memories - Pila</td>
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<tr>
<td>18</td>
<td>P.K. Gupta</td>
<td>- Vermicomposting for Sustainable Agriculture, Agrobios India Ltd</td>
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<tr>
<td>19</td>
<td>-</td>
<td>Practical Zoology Invertebrates - P.S. Verma</td>
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<td>20</td>
<td>Barnes</td>
<td>- Invertebrate Zoology (Halt-Saunders international) Philadelphia, USA</td>
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<tr>
<td>21</td>
<td>Barradaile L.A. &amp; Potts F.A.</td>
<td>- The Invertebrate</td>
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<td>22</td>
<td>Nigam</td>
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<tr>
<td>23</td>
<td>Kotpal, Agrawal &amp; Khetrapal</td>
<td>Modern Text Book of Zoology - Invertebrates, Rastogi Publication, Meerut</td>
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<tr>
<td>24</td>
<td>Puranik P.G. &amp; Thakur R.S.</td>
<td>- Invertebrate Zoology</td>
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<tr>
<td>25</td>
<td>Majupuria T.C.</td>
<td>- Invertebrate Zoology</td>
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<tr>
<td>26</td>
<td>Dhami &amp; Dhami</td>
<td>- Invertebrate Zoology</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Dr. S.S. Lal</td>
<td>Practical Zoology Invertebrates 9th edition, Rastogi Publication Meerut</td>
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<tr>
<td>29</td>
<td>EJW Barrington</td>
<td>- Invertebrate Structure and Function ELBS III Edition</td>
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<tr>
<td>30</td>
<td>R.L. Kotpal</td>
<td>- Phylum Protozoa to Echinodermata (series), Rastogi and Publication, Meerut</td>
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</tr>
<tr>
<td>31</td>
<td>Parker J. and Haswell W.</td>
<td>- Text Book of Zoology, ELBS Edition</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Vidyarthi</td>
<td>- Text Book of Zoology, Agrasia Publishers, Agra</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Jordan E.L. and Verma P.S.</td>
<td>- Chordate Zoology, S. Chand and Co., New Delhi</td>
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<td>P.K. Gupta</td>
<td>- Vermicomposting for Sustainable Agriculture, Agrobios India Ltd</td>
<td></td>
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<tr>
<td>38</td>
<td>A manual of Practical Zoology</td>
<td>Invertebrates - P.S. Verma</td>
<td></td>
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</tbody>
</table>
B.Sc. Semester II

Paper II: Life and Diversity of Animals – Chordates

UNIT - I (12 Periods)
1.1 Chordata – Origin, Concept, Phylogenetic Tree of Evolution - animals
1.2 Protochordata: General Characters and Classification, Types Herdmania and Branchiostoma
1.3 Herdmania : Structure, Ascidian tadpole and retrogressive metamorphosis
1.4 Branchiostoma : External Characters and Sense organs

UNIT – II (12 Periods)
2.1 Agnatha:- Agnatha concept and Affinities
2.2 General Characters of Cyclostomata: Petromyzon and Myxine
2.3 Class Pisces: Origin, General features of Chondrichthyes and Osteichthyes,
2.4 Origin of paired fins in fishes; Migration in fishes - Types, causes, and significance.

UNIT – III (12 Periods)
3.1 Accessory respiratory organs in fishes
3.2 Osmoregulation in Fishes, Lateral line receptors.
3.3 Class Amphibia: Origin, General features and Classification up to orders
3.4 Parental care and Neotony in Amphibia.

UNIT – IV (12 Periods)
4.1 Class Reptilia- Origin, General features
4.2 Classification based on temporal vacuities
4.3 Snakes : General Characters, Poisonous and non-poisonous snakes,
4.4 Biting mechanism in snakes, Poison apparatus, snake venom properties

UNIT - V (12 Periods)
5.1 Class Aves– Origin, General features and Classification
5.2 Comparison of Ratitae and Caranitae
5.3 Flight adaptations; Flightless Birds: Origin and general characters example
5.4 Migration in birds
Unit VI (12 Periods)

6.1 Class Mammals – Origin, Concept, General Features
6.2 General characters of Prototheria, Metatheria and Eutheria with types
6.3 Adaptive radiations in mammals
6.4 Comparative account of Heart in Reptiles, Birds and Mammals
6.5 Urinogenital systems in Mammals

PRACTICAL - II Based on Life and Diversity of Animals –Chordates

Identification, classification, distinguishing characters and adaptive features of

Urochordata :- Herdmania, Salpa, Doliolum
Cephalochordata :- Amphioxus
Cyclostomata :- Petromyzon, Myxine
Pisces :- Pristis, Torpedo, Exocoetus, Clarius,
Amphibia :- Ichthyophis, Bufo, Salamander
Reptilia :- Chameleon, Draco, Tortoise, Cobra, Russel’s Viper, Rat Snake
Birds :- Owl, Kingfisher, Duck, Parrot
Mammals :- Squirrel, Bat, Loris, Rabbit

2. Study of skeleton of Rabbit

3. Dissection of the locally available culturable fish -
   i. Digestive system
   ii. Brain

4. Study of permanent slides
   Amphioxus through Gonad, V.S. of Skin of fish, V.S. of Skin of frog, V.S. of skin reptiles, V.S. skin of Bird, V.S. of mammals with the help available permanent slides/ ICT tools / Charts / Photographs

5. Permanent stained preparation:
   Fish scales – Placoid, cycloid, ctenoid and striated muscle with the help available permanent slides/ ICT tools / Charts / Photographs
### Distribution of Marks –

<table>
<thead>
<tr>
<th>Marks</th>
<th>Description</th>
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<tbody>
<tr>
<td>06</td>
<td>i. Dissection (through ICT tools)</td>
</tr>
<tr>
<td>10</td>
<td>ii. Identification and comment on spots (Museum specimens/slides)</td>
</tr>
<tr>
<td>04</td>
<td>iii. Permanent stained Preparation</td>
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<tr>
<td>04</td>
<td>iv. Submission of certified practical record</td>
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<tr>
<td>03</td>
<td>v. Submission of slides</td>
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<tr>
<td>03</td>
<td>viii. Viva voce</td>
</tr>
</tbody>
</table>

### Total Marks 30

### List of Recommended Books:

**Life and Diversity of Animals -Chordates**

1. T. B. of Zoology vol II – Parker & Haswell
2. T. B. of Vertebrate Zoology - S. N. Prasad
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
8. The Vertebrate Body – Romer A. S.
9. Comparative Anatomy of the Vertebrates - Kingslay J. D.
10. The Biology of Amphibia – Noble G. K.
11. Snakes of India – Gharpura K. G.
12. Life of Mammals – Young J.Z.
13. Vertebrates – Kotpal R. L.
15. Vertebrate Zoology – Dhami & Dhami
16. T. B. Vertebrate Zoology – Agrawal
17. Protochordates – Chatterjee & Pandey
18. Protochordates – Bhatia
19. T. B. of Chordates – Bhamrah and Juneja
20. Chordate Anatomy - Arora M.P.
22. Practical Zoology Vertebrates – Dr. S. S. Lal, Rastogi Publication, Meerut
# B.Sc. Semester – III

**Paper – III (Cell Biology & Environmental Biology)**

## UNIT – I

| 1.1 | Ultrastructure of Prokaryotic and Eukaryotic Cell |
| 1.2 | Plasma Membrane: Structure- Fluid Mosaic Model and Functions |
| 1.3 | Endoplasmic Reticulum: Types, Ultrastructure and Functions |
| 1.4 | Golgi Complex: Ultrastructure and Functions |

## UNIT – II

| 2.1 | Ultrastructure Of Mitochondria & functions |
| 2.2 | Ribosome: Structure, Types, Lake’s Model and Functions. |
| 2.3 | Lysosome: Structure, Polymorphism and Functions |
| 2.4 | Nucleus: Ultrastructure of Nuclear Membrane, Heterochromatin. Euchromatin |

## UNIT – III

| 3.1 | Structure and Functions of Nucleolus. |
| 3.2 | Chromosome: Structure and Types. |
| 3.3 | Giant Chromosomes: Lamp-Brush and Polytene Chromosome. |
| 3.4 | Structure of Nucleosome. |

## UNIT – IV

| 4.1 | Peroxisomes : Structure and Function. |
| 4.2 | Microtubules. |
| 4.3 | Microfilaments. |
| 4.4 | Mitosis , Meiosis (Different Phases and Significance) |

## UNIT – V

| 5.1 | Somatic Cell Division: Cell Cycle, Check points of Cell Cycle |
| 5.2 | Elementary Idea of Cancer. |
| 5.3 | Types of Stem Cell |
| 5.4 | Introduction to Animal Cell Culture. |

## UNIT – VI

| 6.1 | Concept & types of Ecosystem |
| 6.2 | Structure of ecosystem: Abiotic factors and Biotic factors; producer, consumer, decomposer. |
| 6.3 | Food chain, food web; ecological pyramids. |
| 6.4 | Concept of biodiversity; hot spots of biodiversity. |
Practical based on cell biology:

1. Principle and working of microscope.
2. Use of ocular micrometer and measurement of micro objects.
3. Study of slide of prokaryotic cell & eukaryotic cell.
4. Study of osmosis in any cell.
5. ATC Laboratory set up.
6. Primary cell culture.
7. Lymphocyte separation.

Practical based on Environmental Biology :-

2. Adaptations of aquatic and terrestrial animals based on a study of museum specimens.
3. Study of natural ecosystem and field report.
4. Identification of common animals - Soil invertebrate diversity, diversity of birds and mammals in parks / botanical gardens.
5. Mounting of plankton.
6. Qualitative analysis of fresh water plankton.

Reference Books on :-

Cell Biology

1. C.B. Powar, Cell Biology – Himalaya Publication, New Delhi
2. Dr. S.P. Singh, Dr. B.S. Tomar – Cell Biology 9th revised edition, Rastogi Publication, Meerut
3. Gupta P.K. – Cell and Molecular Biology, Rastogi Publication, Meerut
4. Veer BalaRastogi – Introduction to Cell Biology, Rastogi Publication, Meerut
6. De-Robertis – Cell Biology
7. Verma and Agrawal– Concepts of Cell Biology
8. Dowben– Cell Biology
9. Witt – Biology of Cell
10. Ambrose and Eastyr – Cell Biology
12. Ecology – odum
Practical: Two practical per week of 3 periods duration. Examination shall be of 5 Hrs. duration and of 50 marks. 30 marks examination and 20 marks internal.

Distribution of Marks – Total Marks 30
I. Identification and Comment on Spots 08
   (4 Museum specimens + 1 Env. bio. spot + 3 slides)
II. Dissection - 08
III. Environmental biology experiment 04
IV. Permanent stained preparation 03
V. Submission of certified practical record 03
VI. Submission of Slides & tour diary 02
VII. Viva voce 02
B.Sc. Semester IV

Paper IV - Genetics and Molecular Cell Biology

UNIT – I (12 Periods)


1.2 Interaction of genes - Chromosome theory of inheritance, Epistasis - dominant and recessive, codominance, incomplete dominance.

1.3 Linkage and crossing over - Chromosome theory of Linkage, kinds of linkage, mechanism of Meiotic Crossing over, significance of Crossing over.

1.4 Cytoplasmic inheritance - Kappa particles in Paramecium, CO₂ sensitivity in Drosophila, Extra nuclear inheritance: (mitochondria).

UNIT – II (12 Periods)

2.1 Chromosomal variation in Number: (Euploidy, Aneuploidy - Monosomes, Nullisomes and Trisomes) Disorders related to chromosomal number - Turner syndrome, Klinefelter syndrome and Down syndrome.

2.2 Chromosomal aberrations: Deletion, Duplication, Inversion, Translocation, Position Effect, Centromeric & Non-centromeric breaks in chromosomes. (Chronic Myeloid Leukemia (CML) and Burkitt’s Lymphoma).

2.3 Introduction and Types of Gene mutations (Spontaneous and induced mutations) - Base substitution, Frame shift mutation (insertion, deletion, missense, nonsense mutation).

2.4 Mutagens - Physical, chemical and biological.

UNIT – III (12 Periods)

3.1 Human karyotype and its applications.

3.2 Amniocentesis and its applications with examples.

3.3 Population genetics: Basic concepts in population genetics, Genetic Drift, Hardy Weinberg equilibrium and its significance.

3.4 Ames test.

UNIT – IV (12 Periods)

(Introduction to Molecular biology)

4.1 Chemical Basis of Heredity: DNA as genetic material, Experiments of Griffith.

4.2 DNA Composition & Structure

4.3 RNA types and structure.

4.4 Fine structure of the Gene: Cistron, muton and recon.
UNIT – V  
(12 Periods)
5.1 Meselson–Stahl experiment- DNA Replication in prokaryotes,
5.2 Transcription in prokaryotes.
5.3 Genetic code: Nirenberg and Matthaei experiment, Khurana Experiment, Wobbles Hypothesis.
5.4 Translation in Prokaryotes. (activation of amino acids, transfer of activated amino acids to tRNA, Initiation, elongation and termination of polypeptide chain.)

UNIT – VI  
(12 Periods)
6.1 Eukaryotic vs. Prokaryotic gene structure.
6.2 Regulation of Gene expression in prokaryote.
6.3 Operons – Lactose and Repressible operon – Tryptophan
6.4 Recombination in Bacteria: Bacterial transformation – Griffith’s experiment, Conjugation in bacteria, transduction.

Practical based on Genetics and Molecular Biology and Immunology

Section A : Genetics –
1. Study of monohybrid and dihybrid ratio
2. Study of normal human karyotype (Normal male and female)
3. Study of characters and karyotypes of Syndrome like Down, Klinefelter& Turner
4. Study of the genetic traits (Hardy Weinberg law) in human being (Tongue rolling, ear lobe, PTC taster/ non taster)
5. Drosophila culture: media preparation and handling of flies
7. Study of Drosophila mutants.

Section B: Molecular Biology and Immunology

Molecular Biology :
1. Introduction to basic laboratory instruments and equipments - Autoclave, Centrifuge, pH meter, Electrophoresis apparatus; Molar and normal solutions calculations
2. Isolation of DNA (Genomic DNA from any available source) by phenol extraction method or any other method.
3. Quantification of Isolated DNA using Spectrophotometer.
4. Demonstration of DNA amplification by PCR.
5. Thin Layer Chromatography.
(Note: PCR and TLC has to be introduced as its basic technique required in research)
Reference Books:

1. Genetics & Genetic Engineering – Joshi
2. Genetic Engineering & its applications – Joshi
3. Genetics – Gardener
4. Genetics – Winchester
5. Genetics – Gupta
6. Principles of Genetics – Sinnott Dunn, Dobzansy
7. Genetics – Ahluwalia
8. Genetics – Sarin
9. Elementary Genetics – Singleton
10. General Genetics – SRb, Owen & Edger
11. Genetics – Alenberg
12. Foundation of Genetics – Pai
13. Genetics - Strickberger
14. T. B. of Genetics- VeerbalaRastogi
15. Gene VI by Benjamin Lewis, Oxford press
17. Genetics Vol. I and II by Pawar C. B., Himalaya publication

Molecular Biology

1. Cell and Molecular Biology by De Robertis- E. D. P., I. S. E. publication
3. Advanced Molecular Biology by Twyman R. M., Viva Books Pvt. Ltd
4. Molecular Biology by Freifelder D., narosa publication House
5. Molecular Biology of Gene by Watson J. D. et. al., Benjamin publication
6. Molecular Cell Biology by Darnell J. Scientific American Books USA
7. Molecular Biology of the Cell by Alberts B., Bray D. Lewis J., garland publishing Inc
8. Essentials of Molecular Biology by Freifelder D., narosa publication House
10. The Cell: Molecular Approch by Cooper G. M.
11. Molecular Biology by Upadhay A and Upadhay K. Himalaya publication
12. Molecular cell Biology by Bamrach
13. Cell and Molecular Biology by P.K. Gupta
B.Sc. Semester V

Paper V: Developmental biology

UNIT I: (12 Periods)
Gametes to fertilization:
1.1 Spermatogenesis.
1.2 Oogenesis.
1.3 Sperm egg recognition and fusion in sea urchin.
1.4 Post fertilization events (prevention of polyspermy, rearrangement of egg cytoplasm)

UNIT II: (12 Periods)
Early embryonic development in frog:
2.1 Cleavage properties and types.
2.2 Blastula of frog.
2.3 Gastrulation of frog.
2.4 Germ layer formation.

UNIT III: (12 Periods)
Axis specification in embryo:
3.1 Embryonic organizer in frog.
3.2 Nieuwkoop Center.
3.3 Concept of morphogen gradient.
3.4 Basics of axis specification in Drosophila.

UNIT IV: (12 Periods)
Gene and development:
4.1 Sex determination in bird and human.
4.2 Dosage compensation.
4.3 Cloning by nuclear transfer in mammals.
4.4 Teratogens.

UNIT V: (12 Periods)
Techniques in developmental biology:
5.1 Multiple ovulation.
5.2 IVF, ICSI.
5.3 In situ hybridization.
5.4 Cryopreservation of gametes & embryos.

UNIT VI: (12 Periods)
Developmental biology in human welfare:
6.1 Model organisms with examples
6.2 Transgenic animals with examples
6.3 Stem cell isolation and collection of stem cells, culturing of stem cells with examples of application.
6.4 Induced pluripotency.
Practical based on Developmental Biology –

Study of permanent slides of Frog embryology: T.S. Blastula, T.S. Gastrula, T.S. Neurula, T.S. tadpole passing through internal and external gill stage.

Study of permanent slides of chick embryology W.M.: 18 hrs, 24 hrs, 30 hrs, 36 Hrs, 72hrs.

Semen analysis: physical viscosity, pH, liquefaction time, agglutination test, motility and sperm count (Source of semen: Government artificial insemination centre).

Sperm vitality study using suitable stains (Source of semen: Government artificial Insemination centre).

Hypo-osmotic swelling (HOS) for the assessment of normal semen.

Study of Egg Structure (Avian Egg)

Histology of male and female reproductive organs and accessory reproductive glands With the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

Study of developmental stages of insect life cycle.

Demonstration of Barr body.

<table>
<thead>
<tr>
<th>Distribution of Marks</th>
<th>Total Marks 30</th>
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<tbody>
<tr>
<td>I. Permanent stained preparation</td>
<td>2</td>
</tr>
<tr>
<td>II. Sperm count/vaginal smear/hypo-osmotic test for fertility</td>
<td>8</td>
</tr>
<tr>
<td>III. Spermatogenesis/oogenesis/sperm vitality</td>
<td>6</td>
</tr>
<tr>
<td>IV. Identification and comment on spots (1-5)</td>
<td>10</td>
</tr>
<tr>
<td>V. Class record</td>
<td>2</td>
</tr>
<tr>
<td>Vi. Viva</td>
<td>2</td>
</tr>
</tbody>
</table>
References Books :-

5. An Introduction to Developmental Biology: D. A. Ede.
B.Sc. Semester VI

Paper VI: Animal Physiology, Biotechniques, Bioinformatics and Biostatistics

UNIT I:

1.1 Respiration: Structure of respiratory organs: Gills and Lungs
1.2 Mechanism of respiration, Transport of gases: O2 and CO2 transport, Haemoglobin
1.3 Circulation: Blood: Definition and its constituents, functions of blood.
1.4 Heart: Structure of human heart, pacemaker, Cardiac cycle.

UNIT II:

2.1 Muscle Physiology: Types of Muscles: striated, non-striated and cardiac muscles
2.2 E.M. Structure and Chemical Composition of striated muscle. Mechanism of muscle contraction by Sliding filament theory.
2.4 Synapse and synaptic transmission (with acetyl choline as an example)

UNIT III:

3.1 Nutrition and Digestion: Structure and functions of digestive system and associated glands;
3.2 Digestion and absorption of proteins, carbohydrates and lipids.
3.3 Excretion: Structure of uriniferous tubule; Mechanism of urine formation;
3.4 Concept of ammonotelic, ureotelic, uricotelic animals.

UNIT IV:

4.1 Chemical co-ordination: Endocrine system: Hormones and their physiological roles of Pineal, Hypothalamus, Pituitary, Thyroid, Parathyroid, Adrenal, Islets of Langerhan's,
4.2 Reproductive Physiology: Estrous and menstrual cycle,
4.3 Hormonal control of reproduction in males and female,
4.4 Structure and physiology of human Placenta.

UNIT V: Biotechniques

5.1 Concepts of sterilization: autoclaving, dry heat sterilization, wet sterilization and radiation
5.2 Separation of biomolecules: Centrifugation (Sedimentation, density gradient); Chromatography (Elementary idea of thin layer, gel filtration and ion exchange - Principles and applications)
5.3 Electrophoresis: Agarose gel electrophoresis, SDS-PAGE (principle & application)
5.4 Principles and application of colorimeter and spectrophotometers

UNIT VI: Bioinformatics and Biostatistics

6.1 Bioinformatics: Definition, Basic concepts in bioinformatics, importance and role of bioinformatics in life sciences
6.2 Bioinformatics databases - introduction, types of databases
6.3 Nucleotide sequence databases
6.4 Biostatistics – Tabulation of data, presentation of data, sampling errors, mean, mode, median, probability, standard error and standard deviation
Practicals:

1. Estimation of hemoglobin percentage with the help of haemometer.
2. Preparation of haemin crystals.
4. Action of salivary amylase on starch.
5. Qualitative detection of nitrogenous waste products (Ammonia, urea, uric acid) in given sample.
7. Qualitative analysis of carbohydrate, lipid and protein.

Study of histological slides of Mammal – T.S. kidney, pituitary, thyroid, adrenal, testis, ovary; uterus, placenta, medulated and non medulated nerve fibre, smooth and striated muscle

Section B : (Biotechniques, Bioinformatics and Biostatistics)

1. Separation of amino acids by paper chromatography.
2. Separation of proteins by electrophoresis technique.
3. Determination of mean, mode, median, probability, SE, SD from a given biostatistical data.
4. Graphical representation of the data using computers.
5. Retrieval of gene sequences from gene Bank.

Distribution of marks for practical examination:

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<thead>
<tr>
<th>Time: 5 Hrs.</th>
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<tr>
<td>b) Minor ........................................</td>
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<td>02. Spotting (A-F)</td>
<td>12</td>
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<tr>
<td>03. Analysis of given biostatistical data</td>
<td>02</td>
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<tr>
<td>05. Retrieval of specific literature from given information</td>
<td>02</td>
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<tr>
<td>04. Class record duly signed by teacher in charge and certified by H.O.D.</td>
<td>02</td>
</tr>
<tr>
<td>06. Viva - voce</td>
<td>02</td>
</tr>
</tbody>
</table>
Reference Books

1. Prosser and Brown : Comparative Animal Physiology
2. Guyton : Physiology
3. Best and Taylor : Physiological basis of Medical practice
10. Stryer. L. Biochemistry Wiley International
13. Chatterjee, C.J; Human Physiology (Vol-I and II)

Biotechniques, Bioinformatics and Biostatistics

1. Biophysical Chemistry – Upadhyay, Upadhyay and Nath
2. Techniques in Life Sciences – D. B. Tembhare