

INSTITUTE OF SCIENCE, NAGPUR.

(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF ZOOLOGY



Syllabus

Bachelor of Science (B.Sc.) Semester Pattern

Zoology

(ZOO/UG /2021/01)

(To Be Implemented From 2021-22)

B.Sc. (Semester Pattern) Syllabus
Semester wise Name of Papers
Subject – Zoology

Semester	Paper	Name of the Paper	Paper Code
I	I	Life and Diversity of Animals-Nonchordates	BZFS11
	II	Environment Biology	BZFS12
	Laboratory Coursework Practical (if applicable)		BZFS13
II	I	Life and Diversity of Animals-Nonchordates (Arthropoda to Hemichordata)	BZFS21
	II	Cell Biology	BZFS22
	Laboratory Coursework Practical (if applicable)		BZFS23
III	I	Life and Diversity of Animals-Chordates(Protochordata to Amphibia)	BZSS31
	II	Genetics	BZSS32
	Laboratory Coursework Practical (if applicable)		BZSS33
IV	I	Life and Diversity of Animals-Chordates (Reptilia, Aves and Mammals)	BZSS41
	II	Molecular Biology and Immunology	BZSS42
	Laboratory Coursework Practical (if applicable)		BZSS43
V	I	General Mammalian Physiology I	BZTS51
	II	Applied Zoology I (Aquaculture and Economic Entomology)	BZTS52
	Laboratory Coursework Practical (if applicable)		BZTS53
VI	I	General Mammalian Physiology II	BZTS61
	II	Applied Zoology II (Biotechniques, Microtechnique, Biotechnology, Bioinformatics and Biostatistics)	BZTS62
	Laboratory Coursework Practical (if applicable)		BZTS63

Marking Scheme of Syllabus

Faculty of Science B.Sc. Semester-I to VI (Zoology)

Institute of Science

(An Autonomous Institute of Government Of Maharashtra)

SYLLABUS FOR B.Sc. ZOOLOGY (SEMESTER PATTERN)

(With effect from the academic year 2021-22)

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 two theory papers each of three hours duration and carries 50 marks each and a practical of 4 hours duration carries 30 marks. Internal assessment for each semester based on two theory papers of 10 marks each and shall be conducted by teachers. Internal assessment marks should be submitted to the examination committee one month prior to the final examination. Candidates are expected to pass separately in theory, internal assessment and practical examination.

The Structure of Syllabus for B.Sc. Zoology (Semester Pattern) along with distribution of marks is also displayed in the following Table

Semester	Semester wise Theory Papers and Practicals	Marks			Total Marks
		Theory	Internal Assessment	Practical	
Semester - I	Theory Paper – I : Life and Diversity of Animals-Nonchordates(Protozoa to Annelida) Paper -II : Environment Biology Practical - I (Based on Paper I & II)	50	10		150
		50	10		
				30	
Semester- II	Theory Paper - III : Life and Diversity of Animals-Nonchordates(Arthropoda to Hemichordata) Paper - IV : Cell Biology Practical - II (Based on Paper III & IV)	50	10		150
		50	10		
				30	
	Theory Paper - V : Life and Diversity of Animals-Chordates	50	10		150
		50	10		

Semester-III	(Protochordata to Amphibia) Paper - VI : Genetics Practical - III (Based on Paper V & VI)			30	
Semester IV	Theory Paper - VII : Life and Diversity of Animals- Chordates (Reptilia, Aves and Mammals)	50	10		150

Contd. on Pg. 2

	Paper - VIII : Molecular Biology and Immunology	50	10		
	Practical - IV (Based on Paper VII & VIII)			30	
Semester V	Theory Paper - IX : General Mammalian Physiology I	50	10		150
	Paper - X : Applied Zoology I (Aquaculture and Economic Entomology)	50	10		
	Practical - V (Based on Paper IX & X)			30	
Semester VI	Theory Paper - XI : General Mammalian Physiology II	50	10		150
	Paper - XII : Applied Zoology II (Biotechniques, Microtechnique, Biotechnology, Bioinformatics and Biostatistics)	50	10		
	Practical - VI (Based on Paper XI & XII)			30	
		Grand total			900

*Internal assessment –

- (For Semester I to IV) Based on students attendance and the performance during Unit test exam. and field work
- (For Semester V & VI) Based on students attendance and the performance during Unit test exam., field work and seminar

Semester - I
Paper – I : Life and Diversity of Animals -
Nonchordates(Protozoa to Annelida)
(BZFS11)

Objectives:

1. To gain a thorough understanding of non-chordate taxonomy and features.
2. To gain a better understanding of the morphological and anatomical characteristics of non-chordates.
3. To raise knowledge about the hazardous parasites that non chordates are susceptible to, as well as their economic value.

Course Outcome:

Paper – I : Life and Diversity of Animals - Nonchordates (Protozoa to Annelida)

By the end of this programme, the students will get knowledge and they will understand the:

- 1) General characters and classification of Protozoa, Porifera, Helminthes, Annelida.
 - 2) Structure and reproduction of Paramoecium, Plasmodium, Sycon, Obelia, Ascaris, Leech
 - 3) life cycle of Plasmodium, Obelia, Ascaris, Taenia solium.
 - 4) Parasitic Protozoans of Man- Mode of infection and its control, parasitic adaptations in helminthes.
 - 5) Trochophore larva- significance
 - 6) Canal system in sponges, corals and coral reef formation, Vermiculture and its importance.
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Unit – I

(9 Periods)

- 1.1 **Protozoa** : General characters and classification up to classes
- 1.2 **Paramoecium** : Structure and reproduction
- 1.3 **Plasmodium** : Structure and life cycle
- 1.4 **Parasitic Protozoans of Man** : *Entamoeba, Trypanosoma, Giardia and Leishmania* -Mode of infection and its control

Unit – II

(9 Periods)

- 2.1 **Porifera** : General characters and classification up to classes
- 2.2 **Sycon** : Structure, reproduction and development, Canal system in sponges
- 2.3 **Coelenterata** : General characters and classification up to classes
- 2.4 **Obelia**: structure and life cycle, Polymorphism in hydrozoa. Obelia: structure and life cycle, Polymorphism in hydrozoa.

Unit – III

(9 Periods)

- 3.1 **Helminthes** : General characters and classification up to classes
- 3.2 *Ascaris* : External morphology, reproductive system and life cycle
- 3.3 *Taenia solium* : Structure and life cycle
- 3.4 **Elementary idea of parasitic adaptations in helminthes**

Unit – IV

(9 Periods)

- 4.1 **Annelida** : General characters and classification up to classes
- 4.2 **Leech** : Morphology, digestive and urinogenital system
- 4.3 Copulation, fertilization and cocoon formation in leech.
- 4.4 Vermiculture and its importance

Semester – I
Paper – II : Environmental Biology
(BZFS12)

Objectives:

1. To instill knowledge of ecological and environmental concepts, issues, and solutions to environmental problems, as well as to raise awareness of them.
2. To mould students into good "ecocitizens" who can meet the world's environmental requirements.

Outcome:

By the end of this programme, the students will understand the:

- 1) Atmosphere (Hydrosphere, Lithosphere): Major zones and its importance, energy sources, Energy flow in an ecosystem
Ecosystem - Definition and types - pond ecosystem, Food chain, food web and ecological pyramids
 - 2) Biodiversity and its conservation , causes of reduction , Hot spots in India, Wildlife conservation acts (1972 and 1984), national parks and sanctuaries .
 - 3) Sources, effect and control measures - air pollution, water pollution, noise pollution
 - 4) Toxic effects of heavy metals- Bioaccumulation and biomagnifications .
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Unit – I

(9 Periods)

- 1.1 Atmosphere: Major zones and its importance, composition of air
- 1.2 Hydrosphere: Global distribution of water, Physico-chemical characteristics of water
- 1.3 Lithosphere: Types of rocks, formation of soil
- 1.4 Renewable and non- renewable energy sources

Unit – II

(9 Periods)

- 2.1 Ecosystem - Definition and types
- 2.2 Detailed study of pond ecosystem
- 2.3 Food chain, food web and ecological pyramids
- 2.4 Energy flow in an ecosystem, Single channel, Y – shape and Universal model

Unit – III

(9 Periods)

- 3.1 Biodiversity and its conservation
- 3.2 Causes of reduction of biodiversity
- 3.3 Wildlife conservation act 1972, Zoological survey of India: formation and role in animal conservation.
- 3.4 Hot spots of biodiversity in India. Study of national parks and sanctuaries- Tadoba, Melghat and Nagzira.

Unit – IV

(9 Periods)

- 4.1 Sources, effect and control measures of air pollution, Acid rain, green house effect, ozone depletion and global warming
- 4.2 Sources, effect and control measures of water pollution
- 4.3 Sources effect and control measures of noise pollution
- 4.4 Causes and effects of space pollution Causes and effects of space pollution.

Semester – I

PRACTICAL – I (Based on Paper – I and II)

Section A : Life and Diversity of Animals – Nonchordates (Protozoa to Annelida) & Section B : Environmental Biology (BZFS13)

Section A : Life and Diversity of Animals – Nonchordates (Protozoa to Annelida)

Outcome: B.Sc.I

Semester – I PRACTICAL – I

By the end of this programme, the students will be able to

- 1) Study and Classify Life and Diversity of Animals – Nonchordates with the help of museum specimens, permanent slides, diagrams.
- 2) Prepare temporary and permanent slides.
- 3) Estimate DO, free CO₂, pH, total hardness of water sample.
- 4) Study of pond ecosystem – analyze plankton quantitatively.
- 5) Observe animals in natural habitat of National park and Sanctuary.

1. Study of museum specimens by specimen /Charts /Model (Classification of animals up to orders).

- I. Protozoa (Slides) : *Paramoecium*, *Euglena*, *Amoeba*, *Plasmodium vivax*
- II. Porifera: *Sycon*, *Leucosolenia*, *Hyalonema*, *Euplectella*, *Spongilla*
- III. Coelenterata : *Obelia*, *Aurelia*, *Tubipora*, *Fungia*, *Adamsia*
- IV. Platyhelminthes : *Planaria*, *Fasciola*, *Taenia*
- V. Aschelminthes : *Ascaris*, *Drancunculus*, *Ancylostoma*, *Wuchereria*
- VI. Annelida : *Aphrodite*, *Nereis*, *Chaetopteurs*, *Tubifix*, *Hirudinaria*

2. Study of permanent slides: by specimen/Charts.

Enatmoeba, *Giardia*, Sponge gemmules, Sponge spicules, V.S. *Sycon*, T.S. *Sycon*, *Obelia* medusa, *Miracidium*, *Redia* and *Cercaria* larvae of *Fasciola*, T.S. male and female *Ascaris*, Scolex of *Taenia*, Mature and gravid proglottids of *Taenia solium*, T.S. of Leech through crop pockets, Trochophore larva

3. Study of anatomical features with the help of specimen/charts/models/videos.

Digestive, nervous and reproductive system of Earthworm.

4. Mounting

Mounting: Zooplanktons, Spicules and gemmules of sponge.

Section B: Environmental Biology

1. Estimation of dissolved oxygen of water
2. Estimation of free CO₂ of water
3. Estimation of pH of water sample
4. Estimation of total hardness of water

5. Study of pond ecosystem - Producers, consumers and decomposers
6. Quantitative analysis of plankton

Visit to a National park and Sanctuary

Distribution of Marks –	Total Marks 30
i. Identification and Comment on Spots (6 Museum specimens + 1 Env. bio. spot + 3 slides)	10
ii. Study of anatomical features-	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

Semester – II
Paper – III : Life and Diversity of Animals –
Nonchordates(Arthropoda to Hemichordata)
(BZFS21)

Objectives:

1. To gain a thorough understanding of non-chordate taxonomy and features.
2. To gain a better understanding of the morphological and anatomical characteristics of non-chordates.
3. To raise knowledge about the hazardous parasites that non chordates are susceptible to, as well as their economic value.

Outcome:

By the end of this programme, the students will be able to understand

- 1) General characters and classification up to classes: **Arthropoda** , **Mollusca**, **Echinodermata**, **Hemichordata**
- 2) study the Morphology and anatomy of **Cockroach** , **Pila**, **Asterias**, **Balanoglossus**.
- 3) **Insects as Vectors** , Social behavior in honey bees & **Pearl formation in Mollusca**
- 4) **Study the larval forms -crustacea, Mollusca, Echinoderms.**
- 5) Affinities of **Balanoglossus**.

Unit – I

(9 Periods)

- 1.1. **Arthropoda** : General characters and classification up to classes.
- 1.2 **Cockroach**: Mouth parts, digestive system and internal male and female reproductive systems.
- 1.3 **Insects as Vectors** : Mosquito, Housefly, Sandfly, Tse-Tse fly.
- 1.4 **Study of crustacean larvae** : Nauplius, Zoea and Megalopa.

Unit – II

(9 Periods)

- 2.1 **Mollusca** : General characters and classification up to classes.
- 2.2 **Pila** : Morphology and digestive system.
- 2.3 **Pila**: Respiratory and reproductive system.
- 2.4 **Molluscan larvae** : Glochidium and Veliger.

Unit – III

(9 Periods)

- 3.1 **Echinodermata** : General characters and classification up to classes
- 3.2 **Asterias** : External features and digestive system
- 3.3 Water vascular system in starfish.
- 3.4 **Echinoderm larvae** : Bipinnaria and Auricularia

Unit – IV

(9 Periods)

- 4.1 **Hemichordata** : General characters and phylogeny
- 4.2 ***Balanoglossus*** : External features and digestive system
- 4.3 Reproduction in *Balanoglossus* , Tornaria larva
- 4.4 Affinities of *Balanoglossus*

Semester – II
Paper – IV: Cell
Biology
(BZFS22)

Objectives:

1. To provide a foundational understanding of cell types and characteristics.
2. To gain a better understanding of cell organelles and their role in metabolic processes.
3. To comprehend cell division and genetic makeup, as well as their relevance.

Outcome:

By the end of this programme, the students will get knowledge and they will understand the:

- 1) Ultra structure of prokaryotic and eukaryotic cell ,
- 2) structure and function of Cell organelles.
- 3) Oxidative phosphorylation, Glycolysis and Krebs's cycle & Electron Transport Chain and terminal oxidation.
- 4) Giant chromosomes: Lamp-brush and polytene chromosome
- 5) Cell cycle and Mitosis ,Meiosis (different phases and significance),
- 6)Cellular ageing and cell death, Elementary idea of cancer and its causative agents.

Unit – I

(9 Periods)

- 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 –

(9 Periods)

II Ultrastructure of mitochondria

- 2.1
- 2.2 Oxidative phosphorylation – Glycolysis and Krebs's cycle
- 2.3 Electron Transport Chain and terminal oxidation
- 2.4 Lysosome: Structure, polymorphism and functions

Unit – III**(9 Periods)**

- 3.1 Nucleus: Ultrastructure of nuclear membrane. -Nuclear pore complex. Functions of nuclear membrane.
- 3.2 Structure and functions of nucleolus.
- 3.3 Chromosome: Structure and types, structure of nucleosome.
- 3.4 Giant chromosomes: Lamp-brush and polytene chromosome.

Unit - IV**(9 Periods)**

- 4.1 Ribosome: Structure, types, Lake's model and functions.
- 4.2 Somatic cell division: Cell cycle and Mitosis.
- 4.3 Meiosis (different phases and significance), synaptonemal complex.
- 4.4 Cellular ageing- Concept. Heyflick limit. HeLa cells. Telomere theory & free radical theory.

Semester – II

PRACTICAL – II (Based on Paper – III and IV)

Section A : Life and Diversity of Animals – Nonchordates (Arthropoda to Hemichordata) & Section B: Cell Biology

(BZFS23)

Outcome:

By the end of this programme, the students will be able to

- 1) Study and classify Life and Diversity of Nonchordates .
- 2) Prepare temporary and permanent slides.
- 3) **Section B: Cell Biology**
 1. Study the ultra structure of prokaryotic cell & eukaryotic cell .
 2. observe osmosis in human RBCs , Barr body in blood smear.
 3. prepare and observe the mitotic cell division in onion root tips , meiosis in Tradescantia bud/ Grasshopper testis by squash method .
 4. study the salivary gland chromosome in Chironomous larva.
 5. prepare and observe the mitochondria in buccal epithelium/ lip mucosa .
 6. Use ocular micrometer to measure micro objects.

Section – A : Life and Diversity of Animals – Nonchordates (Arthropoda to Hemichordata)

Objectives:

1. To learn everything there is to know about chordates, including their taxonomy and traits.
2. To gain a better understanding of chordates' morphological and anatomical characteristics.

1. Study of museum specimens with the help of specimen/ charts/ models(Classification of animals up to orders).

- I. Arthropoda : *Peripatus*, *Cyclops*, *Daphnia*, *Lepas*, *Sacculina*, *Limulus*, Crab, *Scolopendra*, *Julus*, Dragonfly, Grasshopper, Moth
- II. Mollusca : *Chiton*, *Dentalium*, *Aplysia*, *Pila*, *Mytilus*, *Loligo*, *Sepia*, *Octopus*
- III. Echinodermata : *Asterias*, *Ophiothrix*, *Holothuria*, *Antedon*, *Echinus*
- IV. Hemichordata : *Balanoglossus*, *Saccoglossus*

2. Study of permanent slides with the help of charts/ models-

Nauplius, Zoea and Megalopa larva of Arthropoda, Veliger and Glochidium larva of Mollusca, T.S. of arm of star fish, Bipinnaria and Auricularia larva, T.S.

Balanoglossus through collar and proboscis, Tornaria larva

3. Study of anatomical features with the help of charts/ models/ videos -

- I. Digestive system of Cockroach
- II. Reproductive system of Cockroach
- III. Nervous system of *Pila*

4. Mounting-

Crustacean larvae and plankton; Mouth parts, trachea and salivary gland of Cockroach; Gill lamella, osphradium and radulla of *Pila*

Section B: Cell Biology

1. Study of pictures of ultra structure of prokaryotic cell & eukaryotic cell.
2. Study of osmosis in human RBCs (hypotonic, hypertonic and isotonic medium).
3. Demonstration of mitotic cell division in onion root tips by squash method/ charts/ models/ videos.
4. Demonstration of meiosis in *Tradescantia* bud/ charts/ models/ videos.
5. Demonstration of salivary gland chromosome in Chironomous larva by using charts/ models/ videos.
6. Demonstration of mitochondria in buccal epithelium/ lip mucosa by Janus Green-B method.
7. Use of ocular micrometer and measurement of micro objects.
8. Demonstration of Barr body in blood smear.

Distribution of Marks –

Total Marks 30

i. Identification and Comment on Spots (6 Museum specimens + 4 slides)	10
ii. Study of anatomical features -	08
iii. Cell biology experiment	04
iv. Permanent stained preparation	03
v. Submission of certified practical record	03
vi. Submission of Slides	02

List of Recommended Books : (For Semester – I &

II) 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**
4. Kotpal, Agrawal & Khetrapal – **Modern Text Book of Zoology - Invertebrates**, Rastogi Publication, Meerut
5. Puranik P.G. & Thakur R.S. – **Invertebrate Zoology**
6. Majupuria T.C. – **Invertebrate Zoology**
7. Dhami & Dhami – **Invertebrate Zoology**
8. Parker & Hashwell, **Textbook of Zoology Vol. I (Invertebrates)** A.Z.T.B.S. Publishers & Distributors, New Delhi
9. Dr. S.S. Lal **Practical Zoology Invertebrates 9th edition**, Rastogi Publication Meerut
10. EJW Barrington– **Invertebrate Structure and Function** ELBS III Edition
1. R.L. Kotpal – **Phylum Protozoa to Echinodermata (series)**, Rastogi and Publication, Meerut
2. Parker J. and Haswell W. – **Text Book of Zoology**, ELBS Edition
3. Vidyarthi – **Text Book of Zoology**, Agrasia Publishers, Agra
4. Jordan E.L. and Verma P.S. – **Chordate Zoology**, S. Chand and Co., New Delhi
5. Ayer E. – **Manual of Zoology**
6. M.D. Bhatia – **The Indian Zoological Memories – Leech**
7. Beni Prasad – **The Indian Zoological Memories – Pila**
8. P. K. Gupta – **Vermicomposting for Sustainable Agriculture**, Agrobios India Ltd
9. A manual of Practical Zoology Invertebrates – P. S. Verma

Environmental Biology

1. Ashthana D.K. – **Environmental Problem & Solution**
2. Agrawal K.C. – **Environmental Biology**
3. Agrawal K.C. - **Biodiversity**
4. Mukharjee – **Environmental Biology**
5. S. Arora – **Fundamentals of Environmental Biology**
6. Sharma – **Ecology & Environmental Biology**

7. Verma P.S. & Agrawal V.K. – **Environmental Biology**, S. Chand.
 8. Trivedi & Rao – **Air Pollution**
 9. Chapman & Reiss – **Ecology-Principles and Applications**, Cambridge
 10. Chatterjee B – **Environmental Laws-Implementation and Problems**
 11. Sharma P.D. – **Environmental Biology**, Rastogi Publication, Meerut
 12. Trivedi R.K. – **Hand Book of Environmental Laws, Rules, Guidelines, Compliances and Standards, Enviromedia**
 13. Odum E.P. and Barret – **Fundamentals of Ecology**, Thomson
 14. Smith R.L. – **Ecology and Field Biology**, Harper Collins
 15. D.N. Saxena – **Environmental Biology**, Studium Press (India)
 16. Davis – **Behavioral Ecology**
 17. Kumar and Asija – **Biodiversity – Principle of Conservation**
 18. Rao and Rao – **Air Pollution**
 19. S. Satyanarayan, S. B. Zade, S.R. Sitre and P.U. Meshram – **A Text Book of Environmental Studies**, Allied publisher (India)
 20. Smitz – **Introduction to Water Pollution**
 21. N.S. Subrahmanyam A V.S.S. Sambamurthy –
- Ecology 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 Bala Rastogi – **Introduction to Cell Biology**, Rastogi Publication, Meerut
 5. Gerald Karp – **Cell and Molecular Biology-Concepts and Experiments**, John Wiley, 2007
 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**

Semester – III
Paper – V : Life and Diversity of Animals - Chordates
(Protochordata to Amphibia)
(BZSS31)

Objectives:

1. To learn everything there is to know about chordates, including their taxonomy and traits.
2. To gain a better understanding of chordates' morphological and anatomical characteristics.
3. To investigate the general characteristics, distribution, and economic significance of chordates.

Outcome:

By the end of this programme, the students will be able to understand

- 1) General characters and classification up to classes: Protochordata, Pisces, Amphibia, & Agnatha
- 2) the Morphology and anatomy of *Herdmania*, *Amphioxus*.
- 3) retrogressive metamorphosis of ascidian tadpole of *Herdmania*.
- 4) scales of fishes ,origin of paired fins ,migration and accessory respiratory organs and Embryology.
- 5) Parental care and Neotony in Amphibia .
- 6) Frog Embryology & Development of respiratory organs & Aortic arches in frog .

Unit – I

(9 Periods)

- 1.1 **Protochordata** : General characters and classification up to order
- 1.2 ***Herdmania*** : Structure, digestive system, ascidian tadpole and retrogressive metamorphosis
- 1.3 ***Amphioxus*** : Structure, digestive system, circulatory system, sense organs (Ocelli, Infundibular organ and Kollicker's pit) and protonephridia
- 1.4 **Agnatha** : General characters of Cyclostomata (*Petromyzon* and *Myxine*)

Unit – II

(9 Periods)

- 2.1 **Pisces** : Salient features of Chondrichthyes and Osteichthyes, Origin of paired fins in fishes
- 2.2 Migration and Accessory respiratory organs in fishes
- 2.3 **Amphibia** : General characters and classification up to order
- 2.4 Parental care and Neotony in Amphibia

Unit – III

(9 Periods)

- 3.1 Gametogenesis and type of eggs
- 3.2 Fertilization of egg
- 3.3 Post fertilization development of fish
- 3.4 Types of scales of fishes, Development of placoid scales

Unit – IV

(9 Periods)

- 4.1 Frog embryology- Cleavage, Blastulation and fate map.
- 4.2 Gastrulation: Morphogenetic movements in gastrula of frog.
- 4.3 Development of respiratory organs in frog
- 4.4 Development of Aortic arches of frog

Semester – III
Paper – VI :
Genetics
(BZSS32)

Objectives:

- 1) Students will be able to distinguish between classical, and population genetics.
- 2) Students will work on genetics issues.
- 3) Students will draw parallels between genetics, their personal life, and other fields.

Outcome:

By the end of this programme, the students will be able to understand

- 1) Mendelian Principles & laws.
- 2) Interaction of genes, quantitative genetics & extra nuclear genome .
- 3) Cytoplasmic inheritance, Linkage and crossing over.
- 4) Concepts of genes & Genetic disorders in human.
- 5) Sex determination.
- 6) Gene mutations & Lethal genes.
- 7) Population genetics, Genetic counseling & Applied genetics

Unit – I

(9 Periods)

- 1.1 Brief introduction to gene, Mendelism and Laws of heredity.
- 1.2 Interaction of genes- Epistasis: dominant epistasis (12:3:1) e.g. coat colour in dog, and recessive epistasis (9:3:4) e.g. coat colour in mice. Codominance e.g. Roan cattle, Incomplete dominance e.g. Andalusian fowl and *Mirabilis jalapa*.
- 1.3 Polygenic inheritance: e.g. Skin colour in human, eye colour in human, sickle-cell anaemia. Inbreeding and outbreeding, hybrid vigor.
- 1.4 Extracellular genome – Presence and functions of mitochondrial DNA. Plasmids- Types & significance.

Unit – II

(9 Periods)

- 2.1 Cytoplasmic inheritance- *Kappa* particles in *Paramecium*, CO₂ sensitivity in *Drosophila*, milk factor in mice
- 2.2 Linkage and crossing over – Basic concepts of linkage, types and theories
- 2.3 Concepts of genes – Cistron, muton and recon
- 2.4 Genetic disorders in human beings – Haemoglobin disorders – Thalassemia and Sickle cell anemia. Metabolic disorder: Phenylketonuria

Unit – III

(9 Periods)

- 3.1 Sex determination – ZZ, XY, XO, ZW pattern, Sex determination in *Drosophila*

–Genic balance theory, Environmental sex determination in *Bonellia*

3.2 Chromosomal aberrations: addition, deletion, duplication and inversion

3.3 Gene mutations- Spontaneous and induced mutations. Types of point mutation- deletion, insertion, substitution, transversion, transition, frameshift mutation. Mutagenic agents, baseanologs, alkylating agents.

3.3 Disorders related to chromosomal number- Turner syndrome, Klinefelter syndrome and Down syndrome

Unit – IV

(9 Periods)

4.1 Lethal genes – Concepts and consequences

4.2 Basic concepts in population genetics: populations, genepool, gene frequency, genetic drift. HardyWeinberg equilibrium and its significance.

4.3 Genetic counseling – Introduction , purpose, hereditary diseases and disorders

4.4 Applied genetics - DNA fingerprinting , amniocentesis, sperm banks, karyotyping

Semester – III

PRACTICAL – III (Based on Paper – V and VI)

Section A : Life and Diversity of Animals – Chordates (Protochordata to Amphibia) (BZSS33)

& Section B : Genetics

Outcome:

Section A : Life and Diversity of Animals – Chordates (Protochordata to Amphibia)

By the end of this programme, the students will be able to

- 1) Identify, classify and distinguish the characters and adaptive features of animals from Urochordata , Cephalochordata ,Cyclostomata , Pisces & Amphibia .
- 2) describe Digestive system ,Reproductive system &Brain of locally available culturable Fish.
- 3) explain the histology of Amphioxus and embryology of Frog from the permanent slides .
- 4) prepare the permanent stained slide .

Section B : Genetics

1. understand monohybrid and dihybrid ratio
2. Study of normal human karyotype (Normal male and female)
3. Study characters and karyotypes of Syndromes.
4. Study the genetic traits .

Section A : Life and Diversity of Animals – Chordates (Protochordata to Amphibia) studywith the help of specimen/ charts/ models.

1. Identification, classification , distinguishing characters and adaptive features of

- I. **Urochordata** : *Herdmania, Salpa, Doliolum*
- II. **Cephalochordata** : *Amphioxus*
- III. **Cyclostomata** : *Petromyzon, Myxine*
- IV. **Pisces** : *Pristis, Torpedo, Notopterus, Exocoetus, Clarius, Ophiocephalus, Catla, Rohu, Mrigal*
- V. **Amphibia** : *Ichthyophis ,Bufo, Salamander*

2. Study of anatomical features of fish with thehelp of charts/ models/ videos-

- i. Digestive system
- ii. Reproductive system
- iii. Brain

2. Developmental Biology –

Study of permanent slides of Frog embryology by using slides/ charts/ models- T.S. Blastula, T.S. Gastrula, T.S.Neurula, T.S. tadpole passing through internal and external gill stage

3. Study of permanent slides/ charts/ models-

Amphioxus through Pharynx, Intestine, Gonad and Caudal region; V.S. skin, T.S. Testis, T.S. Ovary of Frog; T.S. Stomach, T.S. Intestine, T.S. Liver of fish

4. Permanent stained preparation:

Fish scales – Placoid, cycloid, ctenoid; Hyaline cartilage and striated muscle

Section B : 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).

Distribution of Marks –

Total Marks 30

i.	Study of anatomical features-	06
ii.	Identification and comment on spots (6 Museum specimens, 4 slides – 2 from frog embryology and 2 from histology)	10
iii.	Genetics experiment	03
iv.	Genetics study – Karyotypes , syndromes, genetic traits in man	03
v.	Permanent stained preparation	03
vi.	Submission of certified practical record	03
vii.	Submission of	slides

Semester – IV
Paper - VII : Life and Diversity of Animals –
Chordates(Reptilia, Aves and Mammals)
(BZSS41)

Objectives:

1. To learn everything there is to know about chordates, including their taxonomy and traits.
2. To gain a better understanding of chordates' morphological and anatomical characteristics.
3. To investigate the general characteristics, distribution, and economic significance of chordates.

Outcome:

By the end of this programme, the students will be able to

- 1) Identify, classify and distinguish the characters and adaptive features of animals from Reptilia, Aves & Mammals.
- 2) understand Poison apparatus, biting mechanism, snake venom and its importance.
- 3) understand Comparison of Ratitae and Caranitae, Flight adaptations and migration .
- 4) understand theories of evolution & genetic basis of evolution.
- 5) understand Adaptations in animals.
- 6) understand Races in Man
- 7) understand Comparative account of aortic arches and heart in Reptiles, Birds and Mammals
- 8) understand embryology of Mammals & chick
- 9) understand Stem cells .
- 10) understand Biological clock : Diurnal and rhythmic behavior in birds and mammals
- 11) understand the Role of pheromones in reproductive behavior

Unit – I

(9 Periods)

- 1.1 **Reptilia**- Classification based on temporal vacuities
- 1.2 Poison apparatus, biting mechanism , snake venom and its importance
- 1.3 **Aves** – Comparison of Ratitae and Caranitae, Flight adaptations and migration
- 1.4 **Mammals** – General characters of Prototheria, Metatheria and Eutheria

Unit –II

(9 Periods)

- 2.1 Modern theories of evolution : Darwinism and Neo-Darwinism
- 2.2 Adaptations – Cursorial, Aquatic, Terrestrial, Fossorial and Volant
- 2.3 Origin and evolution of man-Ardipithecus, Australopithecus and Ramapithecus.
- 2.4 Races in Man (Caucasoid, Negroid, Mongoloid and Australoid)

Unit –III

(9 Periods)

- 3.1 Comparative account of aortic arches and heart in Reptiles, Birds and Mammals
- 3.2 Structure of hen's egg
- 3.3 Development of chick up to primitive streak stage
- 3.4 Development of extra embryonic membranes in chick and functions

Unit –IV**(9 Periods)**

- 4.1 Blastocyst and implantation in Mammals; Types of placenta on the basis of morphological and histological structure; functions of placenta
- 4.2 Stem cells : Sources, types and their use in human welfare
- 4.3 Biological clock : Diurnal and rhythmic behavior in birds and mammals
- 4.4 Role of pheromones in reproductive behavior

Semester – IV
Paper - VIII : Molecular Biology and Immunology
(BZSS42)

Objectives:

- 1) To learn the central dogma of molecular biology.
- 2) To have an understanding of the composition, types and structure of DNA and RNA.
- 3) To have an idea about the organization of DNA in the chromosome and the role of histone proteins.
- 4) To learn how the gene expression is regulated.
- 5) The purpose of this course is to teach students about the structural and functional characteristics of immune system components.
- 6) The students will be taught about immune processes, how to predict the nature of immune responses that occur in response to bacterial, viral, or parasite diseases, and how to conduct experiments to prove the mechanisms and produce vaccines against them.

Outcome:

By the end of this programme, the students will be able to understand

- 1) Structure & properties of DNA, RNA as genetic material ; DNA replication.
- 2) Recombination in Bacteria.
- 3) Genetic code & Protein synthesis.
- 4) Gene regulation .
- 5) Concepts of immunity, Structure, types and functions of Antigen & Antibody.
- 6) Antigen-antibody interaction .Types of immune response.
- 7) Complement system,Cytokines.
- 8) Autoimmunity and immunodeficiency.

Unit - I

(9 Periods)

- 1.1 DNA: Structure of DNA, forms of DNA, properties of DNA, DNA as a genetic material
- 1.2 RNA: Structure of RNA, types of RNA, RNA as genetic material.
- 1.3 Prokaryotic and eukaryotic gene structure
- 1.4 **Recombination in Bacteria:** Bacterial transformation – Griffith's experiment, Conjugation in bacteria, transduction

Unit - II

(9 Periods)

- 2.1 **DNA replication:** Semiconservative model, Meselson Stahl experiments. Process of replication – origin of replication, concept of replication, directionality of replication
- 2.2 **Genetic code:** Characteristics of genetic code, Wobble hypothesis

2.3 Protein synthesis: Transcription mechanism – Initiation, elongation and termination of transcription. Translation – activation of amino acids, transfer of activated amino acids to tRNA, Initiation, elongation and termination of polypeptide chain; inhibitors of protein synthesis

2.4 Gene regulation models - Lac operon and tryptophan operon

Unit - III

(9 Periods)

3.1 Concepts of immunity – Innate and acquired immunity, organs of the immune system

3.2 Antigen - Structure, diversity, functions and types of antigen

3.3 Antibody- Structure, types and functions

3.4 Antigen-antibody interaction – Precipitation and agglutination

Unit - IV

(9 Periods)

4.1 Types of immune response: B cell response (antibody mediated), T cell response (cell mediated)

4.2 Complement system: Basic concepts of complement cascades, classical, alternative and MBL pathways, MAC formation.

4.3 Cytokines- General account on cytokines, Cytokine related diseases

4.4 Autoimmune diseases and their treatment- Grave's disease, Rheumatoid, Arthritis, Insulin- dependent diabetes. Other immunodeficiencies (Wiskott- Aldrich Syndrome, Interferon-Gamma-Receptor Defect).

Semester – IV

PRACTICAL – IV (Based on Paper – VII and VIII)

Section A : Life and Diversity of Animals – Chordates (Reptilia, Aves, Mammals, Embryology) & Section B: Molecular Biology & Immunology (BZSS43)

Outcome:

By the end of this programme, the students will be able to understand

- 1) Identify, classify and distinguish the characters and adaptive features of animals from Chordates (Reptilia, Aves and Mammals)
- 2) skeleton of Rabbit and Fowl .
- 3) chick embryology from W.M.
- 4) Filoplume & skin of Bird, Skin of Mammal.
- 5) perform staining of DNA and RNA from blood smear of various animals.
- 6) understand basic laboratory instruments and equipments.
- 7) perform calculations of Molarity and normality of solutions .
- 8) Isolate Genomic DNA from any available source.
- 9) Determine blood groups in humans.
- 10) perform Antigen – Antibody interaction by double diffusion method (Ouchterlony).
- 11) Understand histological aspects of organs of immune system.

Section A : Life and Diversity of Animals – Chordates (Reptilia, Aves, Mammals, Embryology)

1. Identification, classification , distinguishing characters and adaptive features of (Study by using charts/ models/ specimen) –

- i. **Reptilia** : *Chameleon, Varanus, Pharynosoma, Draco, Tortoise, Cobra, Krait, Russel's viper, Sea snake*
- ii. **Birds** : Owl, Woodpecker, Kingfisher, Kite, Duck, Parrot
- iii. **Mammals** : Squirrel, Mongoose, Bat, Loris, Rabbit

2. Study of skeleton of Rabbit and Fowl by using specimen/ charts/ models-

3. Developmental Biology (Study by using slides/ charts/ models)–

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

4. Study of permanent slides by using slides/ charts/ models- V.S. skin of Bird, Filoplume of bird, V.S. Skin of Mammal

Section B: Molecular Biology and Immunology

Molecular Biology :

1. Staining of DNA and RNA in blood smear of fish/human by methyl green pyronin technique
2. Introduction to basic laboratory instruments and equipments- Autoclave, Centrifuge, pH meter, Micropipettes, Digital balance, Homogenizer, Electrophoresis apparatus; Molar and normal solutions calculations
3. Isolation of DNA (Genomic DNA from any available source like onion/ banana).

Immunology :

1. *Determination of blood groups (ABO and Rh) in humans*
2. Antigen – Antibody interaction by double diffusion method (Ouchterlony)
3. Study of histological slides of organs of immune system – Thymus, Lymph nodes and Spleen

Distribution of Marks –**Total Marks 30**

i.	Identification and comment on spots- (5 Museum specimens, 5 slides – 2 from chick embryology; from histology and 1 from immunology, 2 bones)	12
ii.	Molecular biology experiment	08
iii.	Immunology experiment	07
iv.	Submission of certified practical record	03

List of Recommended Books: (For Semester - III and IV)Life and Diversity of Animals -Chordates

1. T. B. of Zoology vol II – Parker & Haswell
2. T. B. of Vertebrate Zoology -S. N. Prasad
3. Chordate Zoology –E. L. Jorden and P. S. Verma
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
6. Phylum: Chordata – Newman H.H.
7. Biology of Vertebrates –Walter & Sayles
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.
14. Introduction to Chordates – Majupuria T.C.
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.
21. The Chordates – Alexander.
22. T. B. of Animal Embryology – Puranik
23. T. B. of Chordate Embryology – Dalella & Verma
24. T. B. of Embryology – Sandhu
25. T. B. of Embryology – Armugam
26. Early Embryology of Chick – Pattern
27. Chordate Embryology – Verma & Agrawal
28. Chordate Embryology – Tomar
29. The Frog – Rugh
30. An Introduction to Embryology – Balinsky
31. Comparative Vertebrate Embryology – Mcwen
32. Developmental Biology – S. C. Goel
33. Introduction to Embryology – Berry
34. Organic Evolution – N. Armugam
35. Evolution – M. P. Arora

36. Animal Behavior – Smith and Hill
37. Animal Behavior – Arora
38. Animal Behavior – Gundevia and Singh
39. Practical Zoology Vertebrates – Dr. S. S. Lal, Rastogi Publication, Meerut
40. A manual of Practical Zoology Vertebrates – P. S. Verma

Genetics

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, Dobzansky
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 - Stickberger
14. T. B. of Genetics- Veerbala Rastogi
15. Gene VI by Benjamin Lewis, Oxford press
16. Gene VIII 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
2. Molecular Biology by Turner P. C. and Mc Lennan , Viva Books Pvt. Ltd
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
9. Molecular Cell Biology by Laodish H., Berk A., Zipursky S. L., Matsudaira P. Baltimore D. and Darnell J., W. H. Freeman and Co.

10. The Cell: Molecular Approach by Cooper G. M.
11. Molecular Biology by Upadhyay A and Upadhyay K. Himalaya publication
12. Molecular cell Biology by Bamrath
13. Cell and Molecular Biology by P.K. Gupta

Immunology

1. Immunology – R. C. Kubly et al.
2. Immunology - Tizard
3. Immunology -. Roitt, Brostoff and D. Male
4. Immunology - Abbas

Semester – V
Paper - IX : General Mammalian Physiology –I
(BZTS51)

Objectives:

1. To offer a course on mammalian systems physiology, drawing on knowledge of basic physiological principles.
2. To elaborate on some of the topics in Physiology of Organisms, as well as to introduce new and more complex physiological functions.

Outcome:

By the end of this programme, the students will understand the:

- 1) Importance of vitamins & Enzymes-biocatalyst,
- 2) Glands and hormones associated with digestion and explain the
 - physiology of digestion , respiration, circulation
 - blood pressure, E.C.G. & working of Heart.
 - composition of blood, respiratory pigments in mammals.

Unit – I : Enzymes

(9 Periods)

- 1.1 Nomenclature and Classification of enzymes: IUPAC system.
- 1.2 Basics of enzymology: Definition, examples of Holoenzyme, apoenzyme, Co-factors. Definition, examples of metal ions, coenzymes, prosthetic group.
- 1.3 Enzyme Kinetics: concept of enzyme catalysis- active site, activation energy and Arrhenius concepts, specificity of enzymes-geometric and stereo specificity with example, lock and key hypothesis, induced fit hypothesis, Derivation of Michaelis- Menten equation, Concept of K_m and V_{max} . Lineweaver-Burk plot; Multi-substrate reactions
- 1.4 Factors affecting enzyme activity: (Temperature, pH, Inhibitors, Enzyme concentration, Substrate concentration)

Unit-II : Nutrition and Digestion

(9 Periods)

- 2.1 Structure and functions of digestive glands - (Salivary, Gastric, Intestinal, Liver and Pancreas)
- 2.2 Gastrointestinal hormones
- 2.3 Digestion and absorption of proteins, carbohydrates and lipids.
- 2.4 Vitamins- Fat soluble and water soluble vitamins; Sources, deficiency and diseases

Unit-III :Respiration

(9 Periods)

- 3.1 Respiratory pigments - Types , distribution and properties
- 3.2 Mechanism of Respiration
- 3.3 Transport of O_2 and CO_2
- 3.4 Respiratory disorders: COPD, Asthma, Bronchitis, SARS with reference to coronavirus infection. Effects of smoking.

Unit-IV : Circulation**(9 Periods)**

- 4.1 Composition and functions of blood
- 4.2 Blood clotting – Intrinsic and extrinsic factors, blood groups and *Rh* factor
- 4.3 Structure of heart and Cardiac cycle.
- 4.4 E.C.G. and Blood pressure

Semester – V
Paper –X : Applied Zoology-I
(Aquaculture and Economic
Entomology)
(BZTS52)

Objectives:

- 1) To seek to equip students with the knowledge and confidence to work on various types of aquaculture techniques by educating them on new trends and difficulties in farming society.
- 2) To make students familiar with both fundamental and practical aspects of aquaculture.
- 3) To learn the life cycles of crop pests & animal pests.
- 4) To enable the learners to understand the a methods of chemical & biological control of insect population.
- 5) To & learn & understand about importance & management of beneficial insects.

Outcome:

- 1) Students will get knowledge and will be able to
 - establish their own aquaculture unit, aquarium .
 - culture prawn and oyster (for pearl).
 - identify insects pest (agriculture and veterinary).apply ways to control them
 - understand the types of Silkworm, their Life cycle and economic importance.
 - establish their own sericulture , apiculture, lac culture units.

Unit –I : Aquaculture

(9 Periods)

- 1.1 Site selection and construction ,Pre stocking and post stocking manangement of nursery, rearing and stocking ponds
- 1.2 Breeding of fishes by bund and Chinese hatcheries. Induced breeding by hypophysetion. New generation drugs in induced breeding
- 1.3 Brief study of freshwater aquaculture system – Polyculture, cage culture, sewage fed fish culture, integrated fish farming
- 1.4 Fish products and byproducts, Fish preservation

Unit-II

(9 Periods)

- 2.1 Prawn culture and Pearl culture
- 2.2 Fabrication and setting up of aquarium and its maintenance
- 2.3 Breeding of aquarium fishes – Live bearers and egg layers
- 2.4 Diseases caused by fungi, bacteria, protozoa and helminthes

Unit-III : Economic Entomology (Methods of pest control)**(9 Periods)**

- 3.1 Chemical control : Insecticides - Pyrethroids, carbomate and HCN – mode of action, merits and demerits
- 3.2 Biological control – Biological agents – predators, parasites and pathogens with examples; merits and demerits.
- 3.3 Crop pest: Life cycle, damage and control of
 - I. Cotton spotted boll worm - *Earias vitella*
 - II. Stored grain pest- Rice Weevil, *Sitophilus oryzae*
- 3.4 Animal pest: Life cycle, damage and control of –
 - I. House fly – *Musca nebulo*
 - II. Stable fly – *Stomoxys calcitrans*

Unit-IV : Economic Entomology (Industrial entomology)**(9 Periods)**

- 4.1 Sericulture- Types of Silkworm. Life cycle and rearing of mulberry silkworm, *Bombyx mori*, Important diseases of mulberry silkworm.
- 4.2 Life cycle and rearing of non mulberry silkworm (Tasar), *Antheraea mylitta* ; Brief idea of cocoon processing for silk fabric - cocoon boiling, reeling, reeling, winding, doubling, twisting and weaving
- 4.3 Apiculture – Types of honey bees. Life cycle, culture, movable frame hive, bee product and its economic importance
- 4.4 Lac culture – Lac insect, *Laccifer lacca* - Life cycle, Lac processing, Lac products and Economic Importance

Semester – V

PRACTICAL – V (Based on Paper IX and X)

**Section A: General Mammalian Physiology - I and Section B : Applied
Zoology –I(Aquaculture and Economic Entomology)
(BZTS53)**

Outcome:

By the end of this programme, the students will be able to:

1. Detect the action of salivary amylase on starch.
2. Detect the presence of carbohydrates, proteins, Lipids, Vitamin A and Vitamin C in given sample.
3. Measure lung capacity .
5. Prepare slide of Haemin crystal.
6. Total WBC and RBC count from blood.
7. Understand histology of digestive and lungs.
8. Collect and identify Freshwater edible fishes & Aquarium fishes .
9. explain the digestive, reproductive systems and brain with pituitary of culturable fishes & the Gonosomatic index
10. Fabricate and set up own aquarium
11. Mount the Scales of fishes, zooplankton

Section A: General Mammalian Physiology – I

1. Detection of action of salivary amylase on starch
2. Detection of carbohydrates, proteins and Lipids
3. Detection of Vitamin A and Vitamin C
4. Measurement of lung capacity
5. Preparation Haemin crystal
6. Total count of WBC and RBC
7. **Study of histological slides of Mammal by using slides/ charts/ models** – T.S. salivary gland, T.S. stomach, T.S.intestine, T.S. pancreas, T.S. liver and T.S. lung
8. Recording of blood pressure using sphygmomanometer.

Section B : Applied Zoology –I (Aquaculture and Economic Entomology)Aquaculture:

1. Collection and identification of fishes

- a. Freshwater edible fishes – catla, rohu, mrigal, grass carp, silver carp, *Cyprinus carpio* , *Ophiocephalous*, *Clariaus*, *Heteropneustes*, *Wallago*, *Mystus*,

b. Aquarium fishes – Gold fish, Molly, Sword tail, Kissing *Gourami*

2. Study of anatomical features by using charts/ models/ videos

a. Digestive, reproductive and brain with pituitary of culturable fishes.

b. Gonosomatic index.

3. Fabrication and setting up of aquarium

4. Study of beekeeping equipments-Wooden framehive/Study of mulberry sericulture equipments.

Economic Entomology:

1. Study of Insect Pest by using specimen/ charts/ models

a. Agriculture pest – Grasshopper , Red Cotton bug, Gram pod borer, Cotton pink bollworm, Cotton spotted bollworm

b. Medical pest – House fly, Mosquito , *Pediculus humanus*

c. Veterinary pest – Stable fly , Dog tick, Bird lice

d. Stored grain pest – Stored grain weevil, Flour moth

e. Useful Insects – Honeybee, Silk moth, Lac insect, Dragon fly, Ladybird beetle

2. **Mounting** : Mouth parts, Legs, wings of any insects and sting of Honeybee

3. **Visit** to – Fish farm, Apiculture, Sericulture, Agricultural educational centre, Sea shore and Lake

Distribution of Marks

Total Marks 30

i. Physiology experiment	05
ii. Identification and comment on spots (2 from Mammalian histology, 3 from Aquaculture and 3 from Economic Entomology)	08
iii. Dissection of fish / Gonosomatic index	05
iv. Permanent stained preparation	02
v. Submission ,collection and study tour report	02
vi. Submission of certified practical record	03
vii. Viva voce	05

Semester – VI
Paper -XI : General Mammalian Physiology – II
(BZTS61)

Objectives:

1) To introduce students about the physiology of vital system of mammals.

Outcome:

1) By the end of this programme, the students will get knowledge and they will be able to understand

- E.M. structure ,types of Neurons & conduction of nerve impulse .
- ultrastructure & properties of striated muscle .
- muscle contraction- sliding filament theory.
- structure & function of uriniferous tubule.
- normal and abnormal constituents of urine, dialysis.
- structure and functions of endocrine glands.
- oestrous and menstrual cycle ,male and female sex hormones , Contraceptives .
- Causes of infertility, In-vitro fertilization.

Unit –I : Nerve and Muscle Physiology

(9 Periods)

- 1.1 Types of neurons, E.M. structure of neuron
- 1.2 Conduction of nerve impulse
- 1.3 Ultrastructure of striated muscle, Sliding filament theory of muscle contraction
- 1.4 Properties of muscles (Twitch, Tetanus, Tonus, Summation, All or None Principle, Muscle fatigue)

Unit-II : Excretion

(9 Periods)

- 2.1 Structure of uriniferous tubule
- 2.2 Mechanism of urine formation
- 2.3 Counter – current mechanism
- 2.4 Normal and abnormal constituents of urine; Elementary idea of dialysis

Unit-III : Endocrinology

(9 Periods)

- 3.1 Structure and functions of pituitary gland
- 3.2 Structure and functions of thyroid and parathyroid gland
- 3.3 Structure and functions of adrenal gland
- 3.4 Structure and functions of pineal gland

Unit-IV : Reproduction

(9 Periods)

- 4.1 Oestrous and menstrual cycle: phases and hormonal regulation.
- 4.2 Male and female sex hormones
- 4.3 Causes of infertility in male and female
- 4.4 Contraceptives – Mechanical and hormonal ; *In-vitro* fertilization

Semester - VI
Paper - XII : Applied Zoology –II
(Biotechniques, Microtechnique, Biotechnology, Bioinformatics and
Biostatistics)
(BZTS62)

Objectives:

1) To introduce students to vast array of applied aspects of different interdisciplinary fields of biology like microtechnique, biotechnology, bioinformatics & biostatistics.

Outcome:

1) By the end of this programme students will able to understand

- Sterilization methods, Separation of biomolecules; Chromatography (Elementary idea) ,Electrophoresis.
- principles of colorimeter and spectrophotometers.
- the microtechnique procedure
- histochemical staining techniques for carbohydrates, proteins and lipids .
- recombinant DNA technology, application of biotechnology: Insulin and vaccine production.
- Bioinformatics: Definition, Basic concepts, importance and its role in life sciences & Bioinformatics databases.
- Biostatistics.

Unit –I : Biotechniques

(9 Periods)

1.1 **Concepts of sterilization:** Filtration, autoclaving, dry heat sterilization, wet sterilization and radiation

1.2 **Separation of biomolecules:** Centrifugation (Sedimentation, density gradient); Chromatography (Elementary idea of thin layer, gel filtration and ion exchange - Principles and applications)

1.3 **Electrophoresis:** Agarose gel electrophoresis, SDS-PAGE

1.4 Principles of colorimeter and spectrophotometers

Unit-II : Microtechnique

(9 Periods)

2.1 Fixation, dehydration, clearing, embedding & section cutting

2.2 Difficulties encountered during section cutting (causes and remedies)

2.3 Double staining with Haematoxylin and Eosin

2.4 Histochemical staining techniques for carbohydrates (Periodic acid schiff), proteins (Mercury-bromophenol blue) and lipids (Sudan black-B)

Unit-III : Biotechnology**(9 Periods)**

- 3.1 Basic concepts in recombinant DNA technology.
- 3.2 Isolation of gene-Shotgun cloning, DNA manipulation enzymes: nucleases, ligases, polymerases
- 3.3 Basic concepts of cloning vectors and splicing : Insertion of DNA and ligation using blunt ends, cohesive ends, Cloning vectors
- 3.4 Application of biotechnology: Insulin and vaccine production

Unit-IV : Bioinformatics and Biostatistics**(9 Periods)**

- 4.1 Bioinformatics: Definition, Basic concepts in bioinformatics, importance and role of bioinformatics in life sciences
- 4.2 Bioinformatics databases- introduction, types of databases
- 4.3 Nucleotide sequence databases, Elementary idea of protein databases
- 4.4 Probability-Addition and multiplication rules and their applications.

Semester – VI
PRACTICAL – VI (Based on Paper XI and XII)
(Section A: General Mammalian Physiology – II and Section B: Applied Zoology – II ,
Biotechniques, Microtechnique, Biotechnology, Bioinformatics and Biostatistics)
(BZTS63)

Outcome:

By the end of this programme, the students will be able to

- 1) prove the role of salivary amylase in digestion.
- 2) detect the carbohydrates, proteins , Lipids ,Vitamin A & C by performing laboratory tests.
- 3) demonstrate the Haemin crystal & different cells from blood.
- 4) identify and explain the tissue from different organs and glands of digestive system.
- 5) Measure lung capacity.
- 6) identify and collect fresh water edible fishes and aquarium fishes.
- 7) identify and describe the digestive system, brain and pituitary of locally available culturable fish.
- 8) Fabricate and set up aquarium.
- 9) Identify the zooplanktons from water.
- 10) Identify the types of scales in different fishes.
- 11) identify and manage insect pest -agriculture pest, medical pest ,veterinary pest & stored grain pest .
- 12) identify useful insects.
- 13) mount the mouth parts, legs, wings of any insects and sting of honeybee
- 14) to detect of urea, albumin, sugar and creatin from urine .
- 15) to count the sperms from given semen sample .
- 16) to identify and explain the histology of kidney, endocrine glands, uterus, placenta, nerve fibre, muscles of mammals.
- 17) to use different techniques.
- 18) to develop skill in microtechnique & histochemistry.
- 19) to determine mean, mode, median from a given biostatistical data & to represent statistical data graphically using computers.

Section A : General Mammalian Physiology – II

1. Detection of urea, albumin, sugar and creatin in urine
2. Sperm count in a given semen sample
3. **Dissection:** Endocrine glands of Culturable fishes
4. **Study of histological slides of Mammal by using slides/ charts/ models– T.S.**
kidney, pituitary, thyroid, adrenal, testis, ovary; uterus, placenta, medulated and non medulated nerve fibre, smoothand striated muscle

Section B : Applied Zoology – II (Biotechniques, Microtechnique, Biotechnology, Bioinformatics and Biostatistics)

1. Separation of amino acids by paper chromatography
2. Separation of proteins by electrophoresis technique

3. Block preparation and section cutting
4. Double staining method (H-E)
5. Demonstration of carbohydrates, proteins and lipids by histochemical methods
6. Determination of mean, mode, median from a given biostatistical data and/or graphical representation of the data using computers
7. Use of internet for survey of literature using protein and nucleotide databases(NCBI)
8. Use of softwares like Microsoft offices
9. **Visit to Biotechnology centre to study working principles of different instruments**

Distribution of Marks		Total	Marks
		30	
I.	Physiology experiment	05	
II.	Identification and comments on spots (Mammalian histology 3 spots)	03	
III.	Microtechnique - Section cutting, spreading and H-E staining of given slide	03	
IV.	Dissection of fish	05	
V.	Analysis of given biostatistical data	02	
VI.	Retrieval of specific literature from given information	02	
VII.	Submission of slides and study tour report	02	
VIII.	Submission of certified practical record	03	
IX.	Viva voce	05	

List of Recommended Books: (For Semester V and VI)Physiology

1. Human Physiology – Chatterjee A. G. vol. I & II
2. Medical Physiology – Gyton
3. T. B. of Animal Physiology – Berry
4. Introduction to Animal Physiology and Related Biotechnology – H. R. Singh
5. Animal Physiology – Arora M.P.
6. General and Comparative Physiology – Hoar W. S.
7. T. B. of Animal Physiology – Hurkat and Mathur
8. Animal Physiology – Nahbhushan and kodarkar
9. T. B. of Animal Physiology & General Biology – Thakur & Puranik
10. General Endocrinology – Turner Bagnaro
11. Reproduction and Human welfare – Greep and koblinsky
12. Animal Physiology – Shashtri & Goel
13. Animal Physiology – Verma & Tyagi
14. Human Physiology - Vander and sheman
15. Applied Physiology – Keels, Neils and Joels
16. Animal Physiology – Rastogi S. C.
17. Animal Physiology – Veerbala Rastogi
18. Comparative Vertebrate Endocrinology – Beutley

Aquaculture

1. Wealth of India, Raw Material, Vol. IV – ICAR
2. Fishes of India vol I & II- Day
3. Fish & Fisheries of India – Jhingran
4. Hatchery Manual for Common Indian & Chinese carps – Jhivgan & Pallin
5. Fish Pathology – Roberts
6. Introduction of Fishes – Khanna
7. Fishery Science & Indian Fishes – Khanna
8. Fishery Science & Indian Fisheries – Shrivastava
9. A Manual of F. W. Aquaculture – Santhanam
10. An Aid to Identification of Commercial Fishes of India & Pakistan- Mishra
11. Standard Methods for Examination of Water & Waste Water - APHA
12. Hand Book of Breeding of Major Carps by Pituitary Hormones – S. L. Chonder
13. Principles of Aquaculture – Zade S. B., Khune C. J., Sitre S.R. and Tijare R.V.

Entomology

1. T. B. of Applied Entomology – K. P. Shrivastava
2. T. B. of Agricultural Entomology - II S Pruthi
3. Modern Entomology – D. B. Tembhare (2nd Edition)

4. A Hand Book of Practical Sericulture – Ullar S. R. & Narsimhanna M.N.
5. Destructive and Useful Insects – Metcalf C.L. & Flint W.P.
6. General Text Book of Entomology – Richards O. W. & Davis R. G.
7. Agricultural Pests of India & South East Asia – Atawal A.S.
8. Hand Book of Economic Entomology for South Asia – Ayyar & Ram Krishna.
9. Medical Entomology – Hati A. K.
10. Bee-Keeping in India – Singh S

Biotechnology and Microtechnique

1. Animal Tissue Technique – Humason
2. Histological Technique – Devaenport
3. Microtechnique – Jiwaji & Patki
4. Microtechnique – Wankhede
5. Biophysical Chemistry – Upadhyay, Upadhyay and Nath
6. Techniques in Life Sciences – D. B. Tembhare

Biotechnology

1. Elements of Biotechnology – Gupta
2. T. B. of Biotechnology – Dubey
3. Modern Concept of Biotechnology – Kumar H. D
4. Advances in Biotechnology – Jogdand
5. T. B. of Biotechnology – Chatwal
6. Molecular Biotechnology – Primrose

Bioinformatics and Biostatistics

1. Mount W. 2004. Bioinformatics and Sequence Genome Analysis 2nd Editon CBSPub. New Delhi.
2. Bergman, N. H. Comparative Genomics. Humana Press Inc. Part of SpringerScience+Business Media, 2007.
3. Baxevanis, A. D. Ouellate, B. F. F. 2009. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John-Wiley and Sons Publications, New York.
4. Campbell A. M. and Heyer, L. J. 2007. Discovering Genomics, Proteomics andBioinformatics, 2nd Edition. Benjamin Cummings.
5. Des Higgins and Willie Taylor 2000. Bioinformatics: Sequence, Structure andDatabanks. Oxford University Press.
6. Rashidi H. H. and Buehler 2002. Bioinformatics Basics: Applications in BiologicalScience and Medicine, CRC Press, London.
7. Gibas Cynthia and Jambeck P. 2001. Developing Bioinformatics Computer Skills:Shroff Publishersand Distributors Pvt. Ltd. (O'Reilly), Mumbai.

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