

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College" Affiliated to
KBC North Maharashtra University, Jalgaon



SYLLABUS

ZOOLOGY

M. Sc. II

(Semester III and IV)

**Under Choice Based Credit System (CBCS)
[w. e. f. Academic Year: 2020-21]**

Program Specific Outcomes:

- Understand the nature and basic concepts of cell biology, genetics, taxonomy, physiology, ecology and applied Zoology
- Analyse the relationships of plants and microbes with animals
- Perform procedures as per laboratory standards in the areas of Taxonomy, Physiology, Ecology, Cell biology, Genetics, Applied Zoology, tools and techniques of Zoology, Toxicology, Entomology, Biochemistry, Fish biology, Animal biotechnology, Immunology and Research methodology
- Understand the applications of biological sciences in Apiculture, Aquaculture, Agriculture and Medicine
- Gains knowledge about research methodologies, effective communication and skills of problem-solving methods
- Contributes the knowledge for Nation building.

M. Sc. II Zoology Course Structure

Term / Semester	Course Module	Subject Code	Title of Paper	Credit	Hours per Week
III	DSC	ZOO-301	Animal physiology I / Fishery science I	4	4
	DSC	ZOO-302	Developmental biology	4	4
	DSC	ZOO-303	Practical based on ZOO-301	4	8
	DSC	ZOO-304	Practical Based on ZOO-302	4	8
	SEC	ZOO-305	Biostatistics	4	4
	DSE	ZOO-306	Toxicology	4	4
IV	DSC	ZOO-401	Animal physiology II / Fishery science II	4	4
	DSC	ZOO-402	Inheritance biology	4	4
	DSC	ZOO-403	Practical based on ZOO-401	4	8
	DSC	ZOO-404	Practical based on ZOO-402 and Dissertation	4	8
	GE	ZOO-405	Research methodology	4	4
	DSE	ZOO-406	Insect pest management	4	4

DSC: Discipline Specific Elective Core Course; **SEC:** Skill Enhancement Course;

DSE: Discipline Specific Elective (DSE) Course; **GE:** Generic Elective Course

ZOO-YSC : Zoology (Y-year; S-Semester; C-Course number)

Examination Pattern for the all Courses (60: 40)

Nature	Marks
External Marks	60
Internal Marks	40
Total Marks	100

M.Sc. (Zoology): Semester-III

ZOO-301: Animal Physiology I

Total Hours: 60

Credits: 4

Course objectives:

- The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.
- To understand how these principles are incorporated into the adaptations of different animal groups;
- To provide experience in researching, discussing, and answering questions about animal physiology;
- To provide practical experience in investigating physiological questions, and collecting, analyzing, interpreting, and reporting experimental data; and
- To provide experience in reading published primary physiology literature and incorporating it into your knowledge.

Course outcomes:

Student will be able to

- Students are taught the detailed concepts of digestion respiration excretion the functioning of nerves and muscles
- Students gain fundamental knowledge of animal physiology
- Students will gain skill to execute the roles of a biology teacher or medical lab technicians with training as they have basic fundamentals
- Understanding of stress physiology and endocrine mechanisms will allow them to control their stress and emotions there by diverting their energy towards the positive nation building activities
- Comparative animal physiology is a comprehensive subject that gives in depth knowledge of various physiological processes in the animal kingdom
- students gain knowledge about the comparative physiological concepts of nutrition digestion respiration excretion metabolism and osmoregulation.
- Course provides students comprehensive understanding about neurobiology, neurophysiology, molecular neurobiology
- Understanding of cognitive/behavior neurobiology, thus allowing then to correlate the human behaviour under given situation.
- It gives comprehensive understanding regarding inborn disorders and deranged metabolisms.
- Students feel confident in teaching physiology as well as executing research projects

Unit I: Introduction:

02 h

- Importance and scopes of physiology
- Branches of physiology

Unit II: Chemical foundation of physiology: **05 h**

- Diffusion and Osmosis,
- Body Buffer system: Buffer, Bicarbonate Buffer system
- Significance of buffers

Unit III: Thermoregulation: **05 h**

- Homeostasis;
- Classification of Animals Based on Thermoregulation;
- Vants Hoff law; Lethal temperature;
- Effect of cold Acclimation;
- Thermoregulatory Mechanisms;
- Thermoregulation in Camel

Unit IV: Nutrition **08 h**

- Unit IV: Nutrition 08 h
- Organization of Vertebrate Digestive System,
- Functional Adaptations of the Alimentary Canal,
- Physiology of digestion; Absorption; Assimilation; Egestion or defecation,
- Types of Digestion
- Types of nutrition; Ingestion; Feeding mechanism; Digestion; Enzymes;
- The evolution of digestive mechanism: Phagocytosis; A digestive cavity (Intracellular digestion)

Unit V: Excretion **08 h**

- Definition of Excretion; Types of excretory Products,
- Excretory organs in animals: In Invertebrates and Vertebrates,
- General Structure of Nephron,
- Metabolism of Nitrogen,
- Osmoregulation in Invertebrates,
- Osmoregulation in Vertebrates

Unit VI: Metabolism **14 h**

- **Carbohydrate Metabolism:** Intermediary Metabolism; Glycogenesis; Glycogenolysis; Glycolysis Krebs cycle, Electron transport system; Respiratory chain; Oxidative phosphorylation; Energetics of Glucose; Metabolism; Pasteur effect; Gluconeogenesis; Cori cycle or lactic acid cycle; Uronic acid pathway; Crabtree effect,
- **Lipid metabolism:** Metabolism of lipids; Oxidation of Glycerols; Fatty Acid, Oxidation; β -Oxidation; Ketogenesis; Ketosis; Ketolysis; Biosynthesis of Fatty Acids; Biosynthesis of Triglycerides,
- **Protein Metabolism:** Deamination; Transamination; Decarboxylation; Ornithine cycle; Krebs Cycle, Citric Acid Cycle; Catabolism of the Carbon; Skeleton of amino acids; Pyruvic acid; Amino acids entering by α -Ketoglutaric Acid; Amino Acids entering by Succinyl Co-enzyme A; Catabolism of Amino Acids that are both Ketogenic and Glucogenic; Anabolism of Proteins; Energetics of amino Acids Oxidation

Unit VII: Detoxification**02 h**

- Mechanism and role of Microsomal Enzymes in Detoxification

Unit VIII: Circulatory system**08 h**

- Closed and open Circulatory system;
- General plans of Circulation: Annelid plan, Amphioxus plan, Gill plan of fishes, Lung plan of Mammals;
- Blood vessels: i) Arteries and arterioles ii) Veins and Venules, iii) Microcirculation
- Types of Heart: Pulsating Heart, Tubular Heart, Chambered Heart, Accessory heart
- Physiological types of Hearts: Neurogenic heart and Myogenic heart,
- Functions of Circulatory system in Vertebrates;
- Types of Circulation: a) Systemic circulation b) Pulmonary circulation,
- Advantages of Double Circulation;
- ECG; Heart Sound; Cardiac cycle; Cardiac output;

Unit IX: Nervous System**08 h**

- Nervous Co-ordination; Brain; Spinal cord;
- Neurons or Nerve cells; Nerve Fibres; Neuroglia; Nerve impulse; Neuromuscular junction;
- Neurotransmitters; Nerve reflexes; Reflex arc; Types of Reflexes;
- Evolution of nervous system;
- EEG

References

- Tortora, G. J., & Derrickson, B. (2006). Principle of Anatomy and Physiology, 11th, John Wiley & Sons. Inc., USA.
- Hoar, W. S. (1983). General and comparative physiology (No. 591.1 H6 1983).
- Chatterjee, C. C. (1992). Human physiology: Volume-I. Medical Allied Agency.
- Chatterjee, C. C. (1992). Human physiology: Volume-II. Medical Allied Agency.
- Goel, K. A., & Sastri, K. V. (1984). A TextBook of animal physiology. Rastogi Publications.
- Nielsen, K. S. (1964). Animal physiology (Vol. 7). Prentice-Hall of India (Private) Limited.
- Bell, G. H., Davidson, J. N., & Scarborough, H. (1959). Textbook of physiology and biochemistry. Academic Medicine, 34(6), 621.
- Withers, P. C. (1992). Comparative animal physiology. Philadelphia: Saunders College Pub.
- Arora M. P.(2018). Animal Physiology. Himalaya Publishing House Pvt. Ltd.
- Sobti, R. C. (2008). Animal physiology. Alpha Sci. International.
- Jabde, P. V. (2005). Text Book Of General Physiology. Discovery Publishing House.
- Berry, A. K. (1981). Textbook of Biochemistry and Animal Physiology: Emkay.

M.Sc. (Zoology): Semester-III
ZOO-301: Fishery Science I

Total Hours: 60

Credits: 4

Course objectives:

- To know scope and importance of Fishery Science.
- To understand classification of commercially important fishes.
- Enable students to understand external and internal morphology.
- To know the special adaptive features in fishes like Coloration, Migration, light producing, Poison glands, Sound producing organs etc.

Course outcomes:

- Students will be capable to differentiate morphological features of various species of fishes.
- Learn aspects of the internal body organization using relevant conventions, terminology.
- Student will be acquainting valuable skills in fish anatomy and physiology including regulatory mechanisms.
- Enables student to understand about different fishery activity.

Unit I: Introduction, definition, scope and importance of fishery science. 06 h

- Origin and Evolution of fishes: General characters and classification of Fresh and marine water fishes. Classification of fishes up to species level. General characters of bony and cartilaginous fishes and phylogeny of fishes.

Unit II: Integument and its Derivatives: 02 h

- Types of Scales

Unit III: Digestive system and physiology of digestion 06 h

- Feeding habits in fishes: Herbivorous, Omnivorous and Carnivorous fishes and Physiology of digestion.

Unit IV: Respiration in fishes: 06 h

- Mechanism of breathing of fishes, types of gills. Accessory respiratory organs of fishes.

Unit V: Blood Vascular system: 06 h

- Blood, Heart, Working of heart, Arterial system and Venous System.

Unit V: Excretion and Osmoregulation: 06 h

- Structure of Kidney, Control of osmoregulation.

Unit VI: Nervous System: 06 h

- Brain in different fishes, Spinal cord in fishes, Peripheral nervous system and Autonomous nervous system. Cranial and Spinal Nerves of Shark and Labeo

Unit VII: Reproduction: 08 h

- Embryonic and larval development of freshwater fishes. Spawning habits, Gonadosmatic index, fecundity and breeding. Age and Growth: Length-weight relationships. Vital pondral index, condition factor.

Unit VIII: Fish Diseases and Management: 04 h

- Viral diseases, prophylaxis and preventive measures
- Bacterial, fungal, protozoan infections and treatment

Unit IX: General Topic: 10 h

- 1) Coloration in fishes, physiology of coloration,
- 2) Migration in Fishes: Types of migration
- 3) Bioluminescence and physiology of light production in fishes.
- 4) Venom and venomous glands, electric organ in fishes.
- 5) Air bladder- Location of air bladder, different types of air bladder, their Structure and functions.
- 6) Weberian ossicles in fishes – structure and functions.

References

1. Bal D.V. and Veerabhandra Rao, K (1990): Marine fisheries of India., Tata McGraw-Hill., New Delhi.
2. Day, F. (1967): The fishes of India, Vols. 1 and 2. Jagamander Book Agency, New Delhi.
3. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, ICAR, (2006), DIPA, New Delhi, INDIA.

4. Hickling, C.F., (1961): Tropical inland fisheries. London, Longman, 287 p.
5. Jayaraman K. C. (1999) : Fishes in India., Narendra Publishing House, 1999
6. Jhingran V.G. (1975): Fish and Fisheries of India., Hindustan Publishing corporation (India) New Delhi.
7. Khanna S. S. (1996): An Introduction of Fishes., Central Book Depot. Allahabad.
8. Misra S.R. (2012): Fisheries in India., Aph Publishing Corporation.
9. Pandey K. and Shukla J. P. (2005): Fish and Fisheries., Rastogi Publications India.
10. Shafi, S.M. (2003): Applied fishery science (Vol. I & II), Atlantic Publication.
11. Sharma V. and Grover S. P. (1982): An Introduction to Indian fisheries., Dehra Dun, India : Bishen Singh Mahendra Pal Singh.
12. Shrivastava C.B.L. (2006): A textbook of fishery science and Indian fisheries., Kitab Mahal.
13. Shrivastava U. K. and Reddy, D. M. (1983): Fisheries development of India., Some Aspects of Policy Management., Concept Publishing Company., New Delhi.
14. Shrivastava U. K. and Vathsala, S. (1984): Strategy for Development of Inland Fishery Resource in India., Concept Publishing Company.
15. Talwar, P.K. and Jhingran, A.G., (1991): Inland Fishes of India and Adjacent countries, Vols. 1 and 2. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

M.Sc. (Zoology): Semester-III

ZOO-302: Developmental Biology

Total Hours: 60

Credits : 4

Course objectives:

- To understand the processes that lead from the fertilisation of an egg cell (or equivalent) to the formation of a well-structured and functional multicellular organism

Course outcomes:

Student will be able to

- Students will come to understand how their level of understanding of a biological process increases by using an embryological approach to science.
- Acquire advanced information on developmental biology topics like fertilization, gene action in development, Potency, induction, competence, determination (specification & commitment) and differentiation.

- Study Development in-depth using model Systems such as *Drosophila melanogaster* and *Caenorhabditis elegans*.

Units I: Basic concepts of development: 12 h

- Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Unit II: Gametogenesis, fertilization and early development: 12 h

- Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis.

Unit III: Morphogenesis and organogenesis in animals: 12 h

- Cell aggregation and differentiation; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination

Unit IV: Programmed cell death, aging, senescence, Regeneration 12 h

Unit V: Placenta 12 h

- Definition and significance,
- Types of placenta in Mammals – A) With reference to morphological peculiarities - i] Deciduate, ii] Indeciduate and iii] Contra-deciduate placenta; B) With reference to the foetal and maternal tissue involved - i] Diffuse, ii] Cotyledonary, iii] Zonary and iv] Decidual; C) With reference to histological peculiarities – i] Epithelio-chorial ii] Syndesmo-chorial iii] Endothelio-chorial iv] Haemo-chorial, v] Hemo-endothelial placenta.

References

1. Gilbert, S. F. (1997). *Developmental biology*. Sinauer Associates, Incorporated.
2. Sussman, M. (1961). Animal growth and development. *Soil Science*, 92(2), 152.
3. Newth, D. R. (1970). Animal growth and development. *Animal growth and development*.
4. Patten, B. M. (1920). *The early embryology of the chick*. P. Blakiston's son & Company.

5. Patten, B. M. (1958). Foundations of embryology. *Foundations of embryology*.
6. Arumugam N. (2014). A Text Book of Embryology (Developmental Zoology). Saras Publication

M.Sc. (Zoology): Semester-III **ZOO-303: Practical based on ZOO-301**

Total Hours: 120

Credits: 4

Course objectives:

- The laboratory component of the course is designed to reinforce the topics discussed in lecture, as well as to familiarize students with some of the laboratory techniques and equipment used in the acquisition of physiological data.

Course outcomes:

Student will be able to

- To perform various physiological experiments
- To perform logically research related experiments.

Practical corresponding to ZOO 301 (B) Animal Physiology - I

1. Preparation of Phosphate and Bicarbonate Buffers, given Normality solutions, Physiological Mammalian Saline Solution
2. To demonstrate the principle of dialysis
3. To demonstrate the principle of Osmosis
4. Determination of Salivary Enzyme digestion and Effect of Temperature on Enzyme Activity
5. Determination of GFR
6. Determination of Nitrogenous Excretory Product – Uric acid
7. Estimation of SGOT/SGPT from a given biological sample.
8. Antioxidant activity of any suitable material.
9. Determination of Fatty acids and Amino Acid from Lipid and Protein Digestion respectively.
10. Reflexes in man.
11. Estimation of plasma proteins by copper sulphate specific gravity method.
12. Estimation of Blood Glucose level.

OR

ZOO-303: Practical based on ZOO-301

Total Hours: 120

Credits: 4

Course objectives:

- To acquaint the students with the theoretical and practical aspects of the Fishery Science
- To impart basic practical skills in different aspects of Fishery Science
- To understand identification and classification of commercially important fishes.
- To know about identification, external and internal morphology.
- To know the special adaptive features in fishes like Coloration, Migration, light producing, Poison glands, Sound producing organs etc.

Course outcomes:

Student will be able to

- Establish and maintain an appropriate Branch and Specialist section structure to meet the local, specialist and overall needs of fisheries interests.
- Impart practical training on fisheries in identification and fishery related research.
- Learn aspects of the internal body organization using relevant conventions, terminology.
- Acquaint valuable skills in fish anatomy and physiology including regulatory mechanisms.
- Understand about different fishery activity.

Practicals

1. Identification of importance of local food fishes, Prawn, Molluscs and cultivable fishes
2. Study of freshwater and marine water fishes with respect to following systems
 - Digestive System
 - Respiration : Accessory respiratory organs and types of gills
 - Blood Vascular System
 - Nervous System
3. Mounting of various scales using wastes from recognized fish markets.
4. Compilation of Length- Weight relationship and indices on the basis of observation of fish population
5. Study of cranial nerves in suitable/ available freshwater fish with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

6. Fish diseases, prophylaxis and preventive measures (Bacterial, Fungus, Viral and Protozoan)
7. Study of Electric organ in fishes
8. Study of accessory respiratory organs in some air breathing fishes with the help of already preserved material/ ICT tools/ charts/ models/ photographs etc.
9. Study of weberian ossicles in suitable/ available freshwater fish with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.

M.Sc. (Zoology): Semester-III

ZOO-304: Practical based on ZOO-302

Total Hours: 120

Credits: 4

Course objectives:

- To understand the processes that lead from the fertilisation of an egg cell (or equivalent) to the formation of a well-structured and functional multicellular organism

Course outcomes:

Student will be able to

- Students will come to understand how their level of understanding of a biological process increases by using an embryological approach to science.
- Acquire advanced information on developmental biology topics like fertilization, gene action in development, Potency, induction, competence, determination (specification & commitment) and differentiation.

Practical corresponding to ZOO -302 (Experimental)

1. Study of different types of eggs.
2. Study of cleavages- Snail, Amphioxus, fish, frog, birds and mammals
3. Study of Blastulae- Amphioxus, frog and birds.
4. Study of Gastrulae- Amphioxus, frog and birds.
5. Study of types of placenta.
6. Permanent preparation of chick embryo

References

1. Gilbert, S. F. (1997). *Developmental biology*. Sinauer Associates, Incorporated.
2. Sussman, M. (1961). Animal growth and development. *Soil Science*, 92(2), 152.

3. Newth, D. R. (1970). Animal growth and development. *Animal growth and development*.
4. Patten, B. M. (1920). *The early embryology of the chick*. P. Blakiston's son & Company.
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6. Arumugam N. (2014). A Text Book of Embryology (Developmental Zoology). Saras Publication

M.Sc. (Zoology): Semester-III

ZOO-305: Biostatistics

Total Hours: 60

Credits: 4

Course objectives:

- Students understand all the primary concepts regarding to the biostatistics.
- Student can able to organize, summarize the quantitative data.
- The students can interpret the Standard deviation, correlation, regression and other statistics for observed experimental data.

Course outcomes:

Student will be able to

- Student will be able to apply statistical methods to biological research, medical and public health research.
- Student will be able to use basic computational methods to generate the result.
- Student will be able demonstrate basic of statistical data

Unit 1: Introduction

12h

- Definition of biostatistics.
- Application and uses of Biostatistics.
- Sample and Sampling methods: Simple random sampling, Systematic sampling, Stratified sampling, Non- random sampling.

Unit 2: Collection and presentation of Data

12h

- Collection of data, classification of data.
- Types of classification.
- Terms and fundamentals concepts of biostatistics: Class boundaries, Class width, Class Interval: overlap and non- overlapping class interval method.

- Frequency distribution, relative frequency distribution, cumulative frequency distribution.
- Graphical representation of grouped data: Bar diagram, Histogram, Pi diagram, Frequency polygon, Ogive curve.
- Problems and Exercise.

Unit 3: Measures of central tendency

12h

- Measures of central tendencies- Mean, mode, median
- Measures of dispersion- Range, Standard deviation, Variance and Covariance
- Problems and Exercise.

Unit 4: Probability and Correlation and Regression

12h

- Probability: Definition, Types of Probability, Important terms in probability.
- Bivariate data scatter diagram and its uses, Karl Pearson's correlation coefficient.
- Regression equation and its uses.
- Problems and Exercise.

Unit 5: Testing of hypothesis

12h

- Statistical Hypothesis, Null hypothesis, Alternative hypothesis, critical region, acceptance region, Type I error, Type II error, Level of significance, one tailed and two tailed tests.
- Tests Based on large samples: test of significance of mean, test of significance of difference of means.
- Tests based on small samples:
 - t- test: Testing single population mean, two population means, paired t-test.
 - χ^2 – test for testing independence of attributes, single population variance.
 - F- Test for testing two population variances.
- Problems and Exercise.

References

1. Gurumani, N. (2002). An introduction to Biostatistics. MJP publisher.
2. Khan I. and Khanum A. (2009). Fundamentals of biostatistics. 3rd edition. Ukaaz publication, Hyderabad
3. Prasad S. (2012). Fundamentals of biostatistics [Biometry]. Emkay publications, Delhi 110 051
4. Mahajan, B. K. (2002). Methods in biostatistics. Jaypee Brothers Publishers.

5. Dixit J.V. Principles & Practice of Biostatistics. Banarsidas Bhanot (Publishers).

M.Sc. (Zoology): Semester-III

ZOO-306: Toxicology

Total Hours: 60

Credits: 4

Course objectives:

- It is a discipline overlapping with biology, chemistry, medicine that involves the study of toxicants, their mechanism of action.
- It involves the study of the adverse effects of chemical substances on living organisms.

Course outcomes:

Student will be able to

- Skill development in environmental and occupational Toxicology
- It provides opportunities for students research projects, internships in assessing the effects of toxic pollutants on the environment and in the food chain

Unit 1: Introduction

04 h

- Definition, basic divisions of toxicology- Environmental toxicology, Forensic toxicology, Economic toxicology, Clinical toxicology
- Scope of toxicology

Unit 2: Toxicants

06 h

- Definition, classification of toxicants on the basis of the human organ/ system affected – environmental carcinogens, cardio-toxicants, immuno-toxicants, teratogens, occupationally absorbed toxicants, hepato-toxicants, and Mutagenic toxicants.
- Effects of toxicants – acute, chronic and sub chronic effects.

Unit 3: Absorption, Translocation and Excretion

06 h

- Routes of absorption- gastrointestinal tract, skin, lungs, parenteral administration.
- Translocation.
- Excretion-principal organs of excretion of chemicals- kidney, gastrointestinal tract, liver, lungs, sweat glands, mammary glands, salivary glands, and vagina.

Unit 4: Toxicity tests

07 h

- Definition

- Types of toxicity tests- a) Acute toxicity tests, LC 50 value, LD 50 value, EC 50 value. b) Sub-acute toxicity test. c) Chronic toxicity test.

Unit 5: Selective and Sub cellular toxicity

07 h

- Definition, Need of selective toxicity.
- Advantages of selective toxicity.
- Cell injury- causes
- Injury to Mitochondria, Endoplasmic reticulum, Golgi complex

Unit 6: Toxicants of public health hazard

10 h

- Effects of toxicants on human health- pesticides, carbon monoxide, Sulphur dioxide, Fertilizers, Food additives, psychoactive substances.
- Metal toxicity- a) General principle of metal toxicity. b) Effects of toxic metals on humans and other animals- Arsenic, Lead, Mercury, Chromium, Cadmium, Copper.

Unit 7: Tissues and systems level toxicity

12 h

- Effects of toxicants at the tissues and systems- Dermatotoxicity, Respiratory tract toxicity, hepatotoxicity, Gastrointestinal toxicity, Nephrotoxicity, Cardio toxicity, Haematotoxicity, Endocrine toxicity, Reproductive toxicity, Neurotoxicity.

References

1. Pande, Shukla and Trivedi, (2011), Fundamentals of toxicology, 4th Revised edition, New Central Book Agency, New Delhi.
2. Sharma P. D., (2018), Toxicology, Rastogi prakashan, Meerut
3. Dr. M. A. Subramanian, (2010), Toxicology: Principles and methods, MJP publishers, Chennai.

M.Sc. (Zoology): Semester-IV ZOO-401: Animal Physiology II

Total Hours: 60

Credits: 4

Course objectives:

- The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.
- To understand how these principles are incorporated into the adaptations of different animal groups;
- To provide experience in researching, discussing, and answering questions about animal physiology;
- To provide practical experience in investigating physiological questions, and collecting, analyzing, interpreting, and reporting experimental data; and

- To provide experience in reading published primary physiology literature and incorporating it into your knowledge.

Course outcomes:

Student will be able to

- With the study of this paper students gain knowledge in the areas of responses to environment with study of receptors CNS integration of behavior
- Understanding of the functions of effectors in all aspects as well as the circulatory physiology and reproduction and adaptations by animals to environment
- The students will be well equipped to become very competent in research. CO4 The course provides employability in teaching fields

Unit I: Water Relation and Ionic Regulation

08 h

- Role of membranes in osmotic and ionic regulation; Role of body fluid;
- Adaptation to marine habitat; Adaptation to brackish water habitat; Adaptation to Fresh water habitat; Adaptation to terrestrial habitat

Unit II: Physiology of Muscles

14 h

- Types: a) Phasic muscles b) Tonic Muscles c) Striated Muscles d) Smooth muscles e) Cardiac muscles;
- Chemical Composition of Muscle: Water; Proteins; Actin; Myosin; Tropomyosin; Troponin; Actinin;
- Neuromuscular junction; Motor unit; Membrane excitation;
- Mechanism of muscle contraction; Sliding filament theory;
- General properties of Muscles; Properties of Voluntary muscles; Physical and Chemical aspects of muscle contraction; Molecular basis of Muscle contraction; Control of Muscle contraction;
- Role of Regulatory proteins and calcium in muscle contraction; Changes during muscle contraction; Single muscle twitch; Latent phase or period; Contraction phase; Relaxation phase;
- Invertebrate muscle,
- Tetanus

Unit III: Respiration

10 h

- Introduction;
- Mechanism of respiration in man;
- Tidal volume and Vital capacity;
- Control of respiration;
- Respiratory pigments: a) Hemoglobin, b) Haemocyanin, c) Haemoerythrin, d) Chlorocruorin, e) Molpadin, f) Pinnaglobin, g) Vanadium, h) Echinochrome;
- Haemoglobin as an Oxygen Carrier; Transport of Gases-Oxygen transport: Oxygen, Dissociation Curve; Bohr's effect; Respiratory Quotient;
- Transportation of Carbon dioxide in the blood; Dissociation Curve of Carbon dioxide; Chloride shift;
- Anaerobiosis

Unit IV: Reproductive System**08 h**

- Patterns of Animal Reproduction
 - i) Asexual reproduction-Fission, Budding, Spore, Formation, Fragmentation, Parthenogenesis, Gynogenesis and Androgenesis
 - ii) Sexual Reproduction; Male Reproductive System- Spermatogenesis, Transportation of sperm, Composition of Semen; Female Reproductive System- Puberty; Oogenesis; Graafian Follicles; Menstrual cycle; Ovulation; Fertilization; Implantation; Oestrus Cycle:
- Hormonal Control of Reproductive Cycle; Menopause;
- Hormonal Control of Pregnancy; Parturition;
- Hormonal Control of Lactation

Unit V: Endocrine System**12 h**

- Properties and types of Hormones, Mechanism of Hormone action
- The Pituitary Gland: Pituitary Gland in Different Chordates, It's Hormones,
- Gigantism, Acromegaly, Dwarfism;
- Thyroid Gland: Cretinism, myxoedema, exophthalmic goitre;
- Parathyroid Gland: Functions of PTH, Disorders of parathyroid;
- Pancreas: Islets of Langerhans: Diabetes
- Adrenal Gland: Addison's disease, Cushing's syndrome;
- Thymus Gland: Thymosin;
- The pineal Gland: Melatonin,
- Reproductive glands; Testes; Ovary; Placenta;
- Gastrointestinal hormones; Renal Hormones; Prostaglandins;
- Endocrine Glands in Invertebrates: Neurosecretory cells and Neurosecretion; Neurosecretion in Insects; Pheromones

Unit VI: Sensory Physiology**08 h**

- Sensory coding - Transduction, Relationship between Stimulus Intensity and Response, Central control of Sensory Reception;
- Chemoreception - Gustation and Olfaction;
- Thermoreceptors and Infrared reception;
- Mechanoreception, Mechanotransduction - Invertebrate and vertebrate Mechanoreceptors - Muscles spindle,
- Acoustico lateralis System,
- Echolocation;
- Electoreception;
- Magnatoreception

References

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M.Sc. (Zoology): Semester-IV

ZOO-401: Fishery Science II

Total Hours: 60

Credits: 4

Course objectives:

- To understand identification of commercially important fishes.
- To acquaint knowledge on fishes useful to mankind
- Develop an understanding of the role of growth rate, aquatic weeds and economic value.
- To know about hill stream fishes

Course outcomes:

Student will be able to

- Understand the role of taxonomy in identification of fishes.
- Identify common species available in and around their region using morphological keys.
- Identifies, describes and evaluates the scientific and economic importance of fish taxonomy.
- Understand entrepreneurship in Fishery as its career.
- To gain knowledge on fish farming in different culture systems.

Unit I: Fish identification techniques. **10 h**

- Study of morphometric characters in fishes.
- Study of meristic characters in fishes
- Study of anatomical characters in fishes.

Unit II: Importance of marine, estuarine and inland fisheries of India with reference to the commercially important fisheries such as :- **10 h**

- Mackerel fishery
- Sardine fishery;
- Bombay duck fishery
- Sale fishery.
- Hilsa fishery.
- Prawn fishery and
- Molluscan fishery.

Unit III: Fish Growth: **08 h**

- Isometric and allometric growth, the cube law, analysis of growth check on hard parts(Scale, otolith, vertebrae), Marking and tagging of fish for growth studies, length-weight relationship, poderal index, relative condition factor and gonadosomatic index.

Unit IV: Aquatic weeds and their control: **08 h**

- Introduction methods of control manual and mechanical control.

Unit V: Economic values of fishes: **08 h**

- Fish as human food, as food of cattle, Fish oil, Fish glue, and isinglass, Fish leather, Biological control, In manufacture of artificial pearl, Industries, Harmful fishes.

Unit VI: Planning and management of freshwater fish farm. **06 h**

- Site selection, Pond Layout
- Hatchery, Nursery pond
- Rearing pond; Stock pond.

Unit VII: Fishes of the hill streams fishes. **10 h**

- Biology of culturable indigenous carps.
- Biology of culturable exotic carps.
- Fisheries of major river systems in India.
- Larvivorous fishes and their relation to public health.

References

1. Pandey A. K. and Sandhu G. S. (): Encyclopedia of Fishes and Fisheries of India –Vol I to IV, Amol Publications, New Delhi.
2. Biswas, K.P., 1996. A Text Book of Fish, Fisheries and Technology, II ED. Narendra Publishing House, Delhi, India, 396 pp.
3. Dholakia, A.D., 2004. Fisheries and Aquatic resources of India. Daya Publishing House, Delhi.413 pp.
4. James, W. Meade, 1998. Aquaculture Management, CBS pub., New Delhi.

5. Khanna S. S. and Singh H. R. (2003 Ed.): Text book of Fish Biology and Fisheries - By Narendra Publishing House, Delhi – 110006
6. King, M., 1995. Fisheries Biology, Assessment and Management. Fishing News Books, Black well science Ltd., 341 pp.
7. Modern Textbook of Zoology, R. L. Kotpal, Rastogi Publications, Meerut.
8. Nelson, J.S, 2006. Fishes of the World, 4th edition, John Wiley & Sons, Inc., Hoboken, New Jersey, USA, 601 pp.
9. Robert R. Stickney (ed.), 2000. Encyclopedia of Aquaculture. John Wiley and Sons, Inc., New York.
10. Santhanam, R. (1990): Fisheries Science., Daya Publishing House.
11. Shanmugam, K., 1990. Fishery Biology and Aquaculture. Leo Pathippagam, Madras, India. 698pp.
12. Srivastava C B L (1999): A text book of fishery science and Indian fisheries., Kitab Mahal.
13. Stickney, (1995): Introduction to Aquaculture. John Wiley & Sons, New York.

M.Sc. (Zoology): Semester-IV

ZOO 402: Inheritance of biology

Total Hours: 60

Credits: 4

Course objectives:

- To understand how nucleic acids transport genetic information
- To understand experiments that showed the role of nucleic acids for genetic information
- To learn which enzymes are involved in genetic information flow
- To distinguish mechanisms of genetic exchange
- To understand mutations
- To familiarize with molecular biology tools

Course outcomes:

Student will be able to

- Students will understand what is genetics and the concept of heredity and variation.
- To recognize the characters in an individual which are transmitted from the parents and also recognize variations in the genetic traits of different individuals in a population.
- To test and verify their mastery of genetics by applying this knowledge in a variety of problem-solving situations.

Unit I: Introduction:

04 h

- Concept of gene, Allele, multiple alleles, pseudoallele, complementation tests.

Unit II: Extensions of Mendelian principles:

- Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Unit III: Gene mapping methods: 06 h

- Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in *Drosophila*.

Unit IV: Mutation: 05 h

- Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

Unit V: Structural and numerical alterations of chromosomes: 05 h

- Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Unit VI: Recombination: 05 h

- Homologous and non-homologous recombination, including transposition, site-specific recombination.

References

- Dobzhansky, T., (1972), Genetics of the Evolutionary process, Columbia University Press
- Pawar C.B., (2018), Genetics Vol I and II, Himalaya Publishing House, Mumbai
- Stricberger M.W., (1984), Genetics, 4th Edition, MacMillan public Com. Inc, New York
- Lewin B., (2009), Genes Xth edition, Wiley Eastern Limited, New Delhi
- Winchester, (1977), Genetics, 5th Revised edition, Houghton Mifflin Harcourt (HMH)
- Sinnott Dunn A. M. and Dobzhansky, (1958), Principles of Genetics, McGraw-Hill Book Company
- Kotpal R. L., (2020), Concept of Genetics, 6th Edition, Rastogi Publication, Meerut.

M.Sc. (Zoology): Semester-IV

ZOO-403: Practical based on ZOO-401

Total Hours: 120

Credits: 4

Course objectives:

- The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.
- To understand how these principles are incorporated into the adaptations of different animal groups;
- To provide experience in researching, discussing, and answering questions about animal physiology;
- To provide practical experience in investigating physiological questions, and collecting, analyzing, interpreting, and reporting experimental data; and
- To provide experience in reading published primary physiology literature and incorporating it into your knowledge.

Course outcomes:

Student will be able to

- With the study of this paper students gain knowledge in the areas of responses to environment with study of receptors CNS integration of behavior
- Understanding of the functions of effectors in all aspects as well as the circulatory physiology and reproduction and adaptations by animals to environment
- The students will be well equipped to become very competent in research.
- The course provides employability in teaching fields

Practical Corresponding to ZOO 401 Animal Physiology – II

1. Study of adaption in Brackish, Fresh, Marine water and Terrestrial habitat.
2. Recording of lung volumes and capacities by spirometry
3. Determination of oxygen consumption of any suitable animal.
4. Study of different types of muscles.
5. Super-ovulation in Rat
6. To study the estrous cycle by vaginal smear method.
7. Assessing skin sensitivity - locating different receptors
8. Study of Endocrine glands with the help of Slides/ Photographs
9. Perform Semen analysis (Motility, Sperm count, Morphology of sperm)
10. Isolation of Haemoglobin

OR

Practicals corresponds to 401 Fishery Science II

Course objectives:

- To learn about depth knowledge and field exposure on sustainable fishery practices
- To learn about fishery practice management of commercially important cultivable fishes.
- To impart basic practical skills in different aspects of fishery practices as by-products and preservation methods.
- To know about Fishing Net and Gears.
- To impart knowledge on the role and relevance of fisheries

Course outcomes:

Student will be able to

- To understand identification of commercially important fishes.
- To acquaint knowledge on fishes useful to mankind
- Learn skill of fish farm Design, Hatchery and Management
- Impart theoretical and practical knowledge for sustainable development of Fishery.
- Acquired the skills regarding advanced technologies of fisheries.

Practicals corresponds to 401 Fishery Science II

1. Identification of any fish by using Keys.
2. Study of commercially important Marine, Estuarine and Inland fishes of India: Mackerel, Sardine, Bombay duck, Sole, Hilsa, Prawn and Mollusc fishery.
3. Observation of otoliths from point of view of estimation of age and growth of fishes
4. Identification of common weed and their control
5. Fishing Net and Gears: Identification and Use
6. Study of fish from following categories: hill stream, indigenous, exotic and larvivorous fishes (Any one example from each category)
7. Adaptations in fishes
8. Study of fish products and by-products.
9. Method of fish preservation and canning.
10. Visit to Fish farm to study the layout, planning and management of Fish Farm.

Reference

- Tortora, G. J., & Derrickson, B. (2006). *Principle of Anatomy and Physiology*, 11th, John Wiley & Sons. Inc., USA.
- Hoar, W. S. (1983). *General and comparative physiology* (No. 591.1 H6 1983).
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- King, M., 1995. *Fisheries Biology, Assessment and Management*. Fishing News Books, Black well science Ltd., 341 pp.
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- Stickney, (1995): *Introduction to Aquaculture*. John Wiley & Sons, New York.

M.Sc. (Zoology): Semester-IV
ZOO-404: Practical Based on ZOO-402 and Dissertation

Total Hours: 120

Credits: 4

Course objectives:

- To understand how nucleic acids transport genetic information
- To understand experiments that showed the role of nucleic acids for genetic information
- To learn which enzymes are involved in genetic information flow
- To distinguish mechanisms of genetic exchange
- To understand mutations
- To familiarize with molecular biology tools

Course outcomes:

Student will be able to

- Upon successful completion of the laboratory portion of this course, the students will be able to describe, identify, explain, perform, and/or measure: Basic principles of analog and digital data acquisition.
- The important sections of a scientific paper (e.g., Abstract, Introduction, Methods, Results, Discussion, References), and how a laboratory report should be written in this format.

ZOO-404: Practical Based on DSC-ZOO-402

1. Calculation of gene frequency of PTC testing in the given human population
2. Drosophila morphology, sexual dimorphism- Normal and Abnormal
3. Study of Monohybrid and Dihybrid Cross ratio
4. Study of Sex linked character in Drosophila-White, Bar and Sepia Eye
5. Study of genetic diversity in some morphological characters of Drosophila
6. Calculation of gene frequency of ABO blood group in human population
7. To detect synaptic pairing of chromosomal Aberration in meiotic stages (Prophase-I) of Grasshopper/insect
8. Gene expression in prokaryotic organism (bacteria)

Dissertation

Students should perform work in single or in group of three, and submit research dissertation submit includes following points;

- Make research proposal
- Construct tool of data collection
- Learn fieldwork modalities
- Understand the process of data analysis
- Writing research report

- The students will be able to describe, identify, explain, perform, and/or measure: Basic principles of analog and digital data acquisition.
- The important sections of a scientific paper (e.g., Abstract, Introduction, Methods, Results, Discussion, References), and how a laboratory report should be written in this format.

References

- Dobzhansky, T., (1972), Genetics of the Evolutionary process, Columbia University Press
- Pawar C.B., (2018), Genetics Vol I and II, Himalaya Publishing House, Mumbai
- Stricberger M.W., (1984), Genetics, 4th Edition, MacMillan public Com. Inc, New York
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- Kothari, C. R. (2009). Research methodology: new age international 2nd edition.
- Coley, S. M., & Scheinberg, C. A. (2008). Proposal writing: effective grantsmanship. Sage.

M.Sc. (Zoology): Semester-III **ZOO-405: Research Methodology**

Total Hours: 60

Credits: 4

Course objectives:

- Make special use of language for their expression
- To make accurate use of English language in their respective field and communicate effectively
- Make proficient in English language to improve their employability.
- Do close textual analysis of literary works
- Do critical analysis and interpretation
- Acquire significant knowledge on various aspects related to scientific paper writing and paper presentation skills.
- Acquire significant knowledge on various aspects related to IPR and its regulations.

Course outcomes:

Student will be able to

- Understood how do to the literature survey about a particular scientific problem.
- Understood the digital sources available for the literature collection.
- Understood the methods of doing scientific research and how to write scientific papers.
- Learned about the data analysis.

- Learned about data presentation skills.

Unit I: Introduction **10 h**

- Meaning and objectives of research, Motivation in research, Types of research, Significance of research, Research methods Versus methodology, Research and scientific methods, Research process, Criteria of good research.

Unit II: Research Design **10 h**

- Meaning of research design, Need of research design, Features of good design, Concepts of research design, Basic principles of experimental design.

Unit III: The components of Research Report **13 h**

- Types of Reports, Planning of Report Writing,
- Concept of scientific writing
- Write a letter to editor of scientific journal
- Meaning of a scientific paper
- Prepare an Abstract and Title

Project writing: Acknowledgement, Introduction, Review of Literature, Materials and Methods, Data and Data Analysis, Results and Discussion, Conclusion, References, Preparation of cue card.

Unit IV: Communication **12 h**

- Communication: Meaning, types and characteristics of communication. Effective communication: Verbal and Non-verbal, Inter-Cultural and group communications, Classroom communication and Group Discussion. Barriers to effective communication. Mass-Media and Society.

Unit V: Presentation skill: **10 h**

- planning, audience, purpose, time subject pattern
- preparing drafting talk
- practicing
- presentation to different group
- **Use of visual aid for effective presentation:** (synopsis, summary, abstract, tables, graphs, power point presentation Poster presentation: title, author, affiliation, introduction material and methods, results, summary, selection of appropriate Font size, table, figure etc.

Unit VI: Ethical Issues

05 h

- Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

References

1. Graziano, A. M., & Raulin, M. L. (1993). Research methods: A process of inquiry. HarperCollins College Publishers.
2. Walliman, N. (2011). Research theory, Research methods: the basics.
3. Wadehra, B. L. (2006). Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications: Including Semiconductor Integrated Circuits and Layout-design; Protection of Plant Varieties & TRIPS. Universal Law Publishing Company.
4. Kothari, C. R. (2009). Research methodology: new age international 2nd edition.
5. Coley, S. M., & Scheinberg, C. A. (2008). Proposal writing: effective grantsmanship. Sage.

M.Sc. (Zoology): Semester-III

ZOO-406: Insect Pest Management

Total Hours: 60

Credits: 4

Course objectives:

- To sensitize the students on the theory and practice regulations principal of harmful Insect pest.
- To train the students with theory and practice of biological control of Insect pest.

Course outcomes:

Student will be able to

- Understand the basics of animal structure and function and have a good knowledge of entomology.
- Reflect on the importance of agriculture sector in Indian economy, agricultural intensification and the development of the need for integrated approaches to crop protection.
- Characterize the major components of pest management strategies and compare their relative merits for different pests and crops.
- Critically reflect on use of newer technology, emerging trends, advances and developments in applied zoology.
- Demonstrate professional attitude and identify the ethical issues related to the different technical experiments in the laboratory and its application in the agriculture fields, promote eco-friendly methods and sustainable development.

Unit 1: Introduction, Concept of pest and Pest resurgence.	02 h
Unit 2: Types of Pests <ul style="list-style-type: none"> • General biology of important pests of crops cultivated in Maharashtra in particular and Indian in general w.r.t. habits, habitat, marks of identification, life cycle, nature of damage and control measures. • Pests of Cotton (mention all pests and explain in details i. Red Cotton bug and ii. The Pink Ballworm) • Pests of Sugarcane (mention all pests and explain in details i. The Sugarcane stem borer and ii. Leaf hopper) • Pests of Pulses (mention all pests and explain in details i. Greavy Cut worm and ii. The Plume moth) • Pests of Vegetables (mention all pests and explain in details i. The potato tuber moth and ii. The Brinjal shoot and fruit borer) • Pests of Stored grains (mention all pests and explain in details i. The red flour beetle and ii. Rice moth) • Non-insect Pests (mention all pests and explain in details i. Deer and ii. Squirrel) 	20 h
Unit 3: Important pests <ul style="list-style-type: none"> • forest trees and steps taken to check their infestation: Termites, forest defoliators, borers, sap suckers etc. 	04 h
Unit 4: Medical importance of vectors <ul style="list-style-type: none"> • Medical and Veterinary entomology with reference to important Vectors and their control measures 	06 h
Unit 5: Household pests and their control. <ul style="list-style-type: none"> • Household Pest- Cockroach, Housefly 	04 h
Unit 6: Role of insects in forensic science. <ul style="list-style-type: none"> • Insect population and the developing larval stages 	04 h
Unit 7: Insect control measures. <ul style="list-style-type: none"> • Physical and Mechanical control. • Chemical control and safe handling of pesticides. • Biological control. • Hormones and pheromones as control agents. 	18 h
Unit 8: Integrated pests Management (I.P.M.). <ul style="list-style-type: none"> • broad-based approach that integrates practices for economic control of pests • Physical and Mechanical control. • Chemical control and safe handling of pesticides. • Biological control. • Hormones and pheromones as control agents. 	03 h

References

- Pfadt R.E., (1971), Fundamental of Applied Entomology, Mac Millan, New York, 2nd Ed.)
- Short JRI, (1963), Introduction to Applied Entomology, Longmans Green London)
- Roy D. N. and Brawn A WA, (1970), Entomology, The Bangalore Printing and Publ. Co. Ltd.
- Simi KGV, (1973), Insects and other Arthropods of Medical importance, Trustees of BritmusLondon.
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- Richards O. W. and Davies R. G., (1977), Imm's text book of entomology, Mathuen and com, London,
- Snodgrass R.E., (1978), Principles of insect morphology vol.I and II, Tata Mc Graw Hill Bombay.
- Foxz R. M. and Fox J. W, (1964), Introduction to comparative Entomology, Reinhold, NewYork.
- Chapman R. E., (1972), The Insect- Structure and Function, ELBS and EUP London.
- Nayar K.K., Anantha Krishan T.N. and David B.V., (1976), General Applied Entomology, TataMcGraw Hill, New Delhi.

Skill imparted:

In addition to studying and conducting experiments, animal physiologists typically have a wide variety of duties. They may develop research plans, protocols, and testing procedures. Physiologists also study reproductive cells and chromosomes. They may evaluate hormonal status and presence of abnormal changes in exfoliated or abraded cells.

Animal physiologists may assess animal metabolism and nutrition. They might evaluate animal housing to ensure that it meets optimum temperature, humidity, and space requirements for animal health. Physiologists also study and analyze animal tissue microscopically.

Animal physiologists study and research cellular and organ structure in animals. They also study animal functions such as reproduction, movement, and growth in natural and artificial environments. Physiologists may perform controlled experiments to see if certain factors have an affect on animal nutrition, breeding, or health.

Animal physiologists may be employed by pharmaceutical companies, research organizations, or museums for their expertise. They also may work in schools, instructing students who aspire to work as veterinarians, animal scientists, or physiologists. Builders may employ physiologists as consultants for advice on housing environments for livestock. Feed suppliers might consult with physiologists on animal dietary needs.

Since research and experiments are often team-based, it's helpful for animal physiologists to be able to communicate and work well with others. Patience and endurance are also useful characteristics for conducting lengthy and thorough research projects.

Job opportunity:

A degree in animal physiology can lead to opportunities in a wide variety of areas, including fisheries, veterinary schools and pharmaceutical research.

- Zookeeper
- Wildlife Rehabilitation Jobs
- College Professor
- Animal Physiologist

- Veterinarian
- Wildlife biologist
- Biophysicist
- Animal scientists
- Animal physiologist
- Mammalogist, herpetologist (Specialist in reptiles and amphibians)
- Ornithologist (Specialis in birds)
- Wildlife Physiologist
- Laboratory Assistant
- Embryo Transfer Specialist
- Brood Feed Conversion Worker
- Biological Scientist
- Associate Research Scientist
- In scientific journals as Technical Writer & Proofreader
- In Pharmaceutical industry as **Medical Coder**
- Helps in Research writing in Ph. D. Degree and manuscript preparation
- Fishery / Aquaculture Sector
- Fisheries Survey of India
- State and Central Government agencies
- Technical entry cadres in Fisheries Department
- Environmental protection industry and Agencies
- Research leading to Ph. D. degree
- Self-entrepreneurship