Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

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

KNOWLEDGE IS POWER

ESTD. 1945

SYLLABUS

Zoology

T.Y.B. Sc.
(Semester V and VI)

Under Choice Based Credit System (CBCS)
[w. e. f. Academic Year: 2021-2

T.Y. B.Sc. Zoology (CBCS pattern)

Program Specific Outcomes (PSO):

- T.Y. B.Sc. (Zoology) graduates will have basic and applied knowledge of Zoology.
- They can acquire skills in Zoology in a global, economic, environmental, and societal context
- Information and skill of applied zoology including Lac Culture, Fisheries, Goatary, and Sericulture etc.
- They can further continue their education for a graduate terminal course and for higher studies.
- Information and skill of advanced biological techniques for experimental purpose
- Students can apply their knowledge in ethical principles and commit to professional ethics with responsibilities to build successful career.

Learning Objectives:

- To acquaint the students with various specialised subject area of Zoology.
- Inculcate in the student a fascination for nature and learn the bionomics of animal type study.
- To develop practical skills with a sound theoretical background of biological techniques, experimental skills and scientific investigation
- To apply the knowledge of various branches of Zoology and General biology meant both for a graduate terminal course and for higher studies.
- To analyse their interests among the various disciplines and execute them in their professional endeavours.

Exam Pattern:

- Each theory and practical course will be of 50 marks comprising of 10 marks internal and 40 marks external examination.

External Theory Examination (40 marks):

- External examination will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks (10 marks each) while the tentative pattern of question papers shall be as follows:
- Q1 (A), Q2 (B) and Q3 (A), each will be of 6 marks (attempt any 2 out of 3 sub-questions),
- Q4 will be of 10 marks (attempt any 2 sub-questions),

External Practical Examination (40 marks):

- Practical examination shall be conducted by the respective department at the end of the semester. Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule. There shall be 05 marks for journal, 10 marks for *viva-voce*. Certified journal is compulsory to appear for practical examination.

Internal Theory/ Practical Examination (10 marks):

- Internal theory assessment of the student by respective teacher will be comprehensive and continuous, based on written test/ assignment. The written test may comprise of both objective and subjective type questions.
- Internal practical examination should be conducted by respective department as per schedule given. For internal practical examination student should perform at least one major and one minor experiment and should have completed journal.

Structure of T.Y.B.Sc. (Zoology) Curriculum
Semester V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							Int	Ext
DSC	Core I	ZOO-351	Reproductive Biology	3	3	45	10	40
	Core II	ZOO-352	Immunology	3	3	45	10	40
	Core III	ZOO-353	Mammalian Histology	3	3	45	10	40
	Core IV	ZOO-354	Animal Biotechnology	3	3	45	10	40
	Core V	ZOO-355	Applied Zoology-II	3	3	45	10	40
	Core VI	ZOO-356	A) Insect, Vector and Diseases B)Bioinformatics	3	3	45	10	40
SEC	Skill Based	ZOO-350	Public Health and Hygiene	2	2	30	10	40
DSC	Core (Practical)	ZOO-357	Practical Based on ZOO-351 and 352	2	4 / batch	60	10	40
		ZOO-358	Practical Based on ZOO-353 and 354	2	4 / batch	60	10	40
		ZOO-359	Practical Based on ZOO-355 and 356	2	4 / batch	60	10	40

Structure of T.Y.B.Sc. (Zoology) Curriculum
Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							Int	Ext
DSC	Core I	ZOO-361	Functional anatomy of Leech and Calotes	3	3	45	10	40
	Core II	ZOO-362	Developmental Biology of Vertebrates	3	3	45	10	40
	Core III	ZOO-363	Biochemistry	3	3	45	10	40
	Core IV	ZOO-364	Microtechnique	3	3	45	10	40
	Core V	ZOO-365	Animal Physiology	3	3	45	10	40
	Core VI	ZOO-366	A) Research Methodology B) Aquatic Biology	3	3	45	10	40
SEC	Skill Based	ZOO-360	Sericulture	2	2	30	10	40
DSC	Core (Practical)	ZOO-367	Practical Based on ZOO-361 and 362	2	4 / batch	60	10	40
		ZOO-368	Practical Based on ZOO-363 and 364	2	4 / batch	60	10	40
		ZOO-369	Practical Based on ZOO-365 and 366	2	4 / batch	60	10	40

DSC: Discipline Specific Core Courses/Core Practical; **SEC:** Skill Enhancement Course;
Int: Internal examination; **Ext:** External examination

T.Y. B.Sc. (Zoology): Semester V
Discipline Specific Core (DSC) Course
ZOO-351: Reproductive Biology

Total Hours: 45 **Credits: 3**

Course objectives:

- To learn about the various aspects of reproductive biology and endocrinology
- To understand different immunological techniques used
- To understand the animal house setup and maintenance
- To learn the modern contraceptive methods

Course outcomes:

Students will be able to:

- Understand the functioning of male and female reproductive systems particularly in humans.
- Learn about the Immunological techniques.
- Learn the stages of female reproductive cycle

Unit-I: Reproductive endocrinology (08 h)

- Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones and prostaglandins, hypothalamo-hypophyseal-gonadal axis, regulation of gonadotrophin secretion in male and female

Unit-II: Functional anatomy of male reproductive system (09 h)

- Outline of male reproductive system of human
- Spermatogenesis and hormonal regulation
- Epididymal function and sperm maturation
- Function of accessory gland
- Sperm transportation in male genital tract

Unit-III: Functional anatomy of Female reproductive system (10 h)

- Outline of female reproductive system of human
- Ovulation, corpus luteum formation and regression
- Menstrual cycle of human
- Ovum transport in fallopian tube

Unit-IV: Fertilization (18 h)

- Sperm transport in the female genital tract,
- Fertilization
- Hormonal control of implantation
- Hormonal regulation
- Infertility in male and female- Causes and diagnosis.
- Concept and management of IVF.

- Modern contraceptive tools

References:

- Austin C. R. and R. V. Short (1972), Reproduction in Mammals, Vol.:1-8, Cambridge University Press.
- Gibian P. and E. J. Platz, eds.(1970), Mammalian Reproduction, Springer Verlag.
- Guide to learning in Reproductive Endocrinology and Infertility ABO+ G. First in women health. The American Board of Obstetrics and Gynecology, Inc. Vine Street: Dallas, TX 75204
- Hogarth P. J. (1978), Biology of Reproduction Wiley, New York.
- Lohar Prakash S. (2012), Endocrinology-Hormones and Human Health, MJP Publishers, Chennai.
- Perry J. S. (1971), The Ovarian cycle of animals, Oliver and Boyed.
- Williams Robert H. (1981), Text Book of Endocrinology, W. B. Saunders Company

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V

Discipline Specific Core (DSC) Course

ZOO-352: Immunology

Total Hours: 45 **Credits: 3**

Course objectives:

- To understand various immune mechanisms.
- To learn about various immune cells and organs involved in immunity.
- To understand different immunological techniques.
- To understand the auto immune mechanisms.

Course outcomes:

Students will be able to:

- Differentiate between innate and adaptive immunity.
- Understood structure and function of lymphoid organs.
- Learn about interaction between antigen and antibody.
- Understood structure and function of the different antibody classes.
- Know basic properties of cytokines and biological functions of the most common cytokines.
- Acquire knowledge about structure and function of MHC molecules and their role in antigen presentation.
- Understood the complement system and its role in the immune system. Immunological techniques

Unit-I: Fundamentals of the immune system **(10 h)**

- Introduction to basic concepts in immunology
- Components of immune system: Cells of immune system, Organs (primary and secondary lymphoid organs) of the immune system
- Types of immunity: a) Innate and Acquired immunity b) Cell mediated and Humoral immunity. Auto-immunity and leaky gut. Autoimmune diseases.
- Immune Response: Primary and Secondary
- Phagocytosis

Unit-II: Antigens **(07 h)**

- Basic properties of antigens
- B and T cell
- Epitopes, haptens and adjuvants

Unit-III: Immunoglobulins **(18 h)**

- Structure, classes and functions of Immunoglobulins
- Monoclonal antibodies
- Antigen antibody interactions
- Introduction to concepts of autoimmunity
- Structure and functions of MHC
- Exogenous and Endogenous pathways of antigen presentation and processing

- Basic properties and functions of cytokines
- Complement system: Components and pathways
- General introduction to vaccines

Unit-IV: Immuno-techniques **(10 h)**

- Precipitation, Agglutination, Immunodiffusion and Complement fixation test
- Radioimmunoassay, Immunofluorescence, ELISA
- Western blotting

References:

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006), Immunology, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006), Immunology, VII Edition, Mosby, Elsevier Publication.
- Abbas, K. Abul and Lechtman H. Andrew (2003), Cellular and Molecular Immunology. V Edition. Saunders Publication.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V
Discipline Specific Core (DSC) Course
ZOO-353: Mammalian Histology

Total Hours: 45 **Credits: 3**

Course objectives:

- To learn about the various aspects of histology of mammals.
- To study the basic structure of cells, tissues and organs and describe their contribution to normal function.
- To study the Histology of different tissues and systems of mammals.
- To develop an in depth understanding of mammalian tissue structure / function.

Course outcomes:

Students will be able to:

- Enrich themselves with histology of different tissues
- Know the gross anatomical structure of different organ Systems in Mammals
- Learn the architecture of integrative histology.

Unit-I: Introduction, Tissue and Skin (13 h)

- Definitions, History, Application of histology.
  - Differentiation and derivative of three germinal layers
- Tissue: Types and Characteristics (Definition and location only),
  - Epithelial tissues- a) Simple epithelial tissues, b) Compound epithelial tissues,
  - Connective tissue,
  - Muscular tissue and
  - Nervous tissue- a) Structure and types of neurons (nerve cell), b) Medullated and non-medullated nerve fibres.
- Structure and function of skin and its Derivatives - Horns, Nails, Hair, Sweat and Sebaceous gland.

Unit-II: Digestive and Respiratory system (08 h)

- Histology of tooth and tongue: Structure and functions.
- Histology of alimentary Canal: Oesophagus, stomach, duodenum, colon and rectum.
- Histology of digestive glands – salivary gland, liver, pancreas (exocrine and endocrine),
- Histological structure of trachea and lung.

Unit-III: Circulatory, Excretory system (08 h)

- Structure and function of blood vessels: Artery, Vein and Capillary.
- Blood: Composition, types of blood cells and their functions.
- Histology of Kidney: L.S. of Kidney, Uriniferous tubules, Juxtra Glomerular complex (JG complex), Bowman's capsule & Glomerulus.

Unit-IV: Reproductive, Endocrine system, Nervous system and Sense Organs (16 h)

- Testis: Structure of sperm
- Ovary: Structure of ovum

- Pituitary gland.
- Thyroid and Parathyroid gland.
- Adrenal gland.
- Brain meninges: Histological Structure and function.
- Spinal cord: Histological Structure and function.
- Eye: Structure- V. S. of eye ball.
- Ear: Structure of external, middle and internal ear

References:

- Lippincott, (1987), Freeman W. H: An advanced atlas of Histology
- Muzammih Ullah, (1980), Histology and Genetics: Theoretical and Applied (including Histological and Cytological Techniques, Kedar Nath Ram Nath Publisher.
- Turner and Bungera (1971), General Endocrinology, W.B. Saunders Company; 5th edition .
- Pearse A.G.E.(1985), Histochemistry – Vol. I and II, Fourth edition. Churchill Livingstone, Edinburgh.
- Tembhare D.B. (2010), Techniques in Life Sciences, Publisher Himalaya Publishing House

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V

Discipline Specific Core (DSC) Course

ZOO-354: Animal Biotechnology

Total Hours: 45 **Credits: 3**

Course objectives:

- To study animal cell and tissue culture techniques
- To know about developing genetically engineered products for human and animal welfare
- To learn about developing gene transfer technologies, cloning, transgenic animals
- To study hybridoma technique and production of antibodies
- To impart knowledge about stem cell research

Course outcomes:

Students will be able to:

- Acquire knowledge about animal cell, animal cell culture media components and their role in cell growth and tissue culture techniques.
- Come to know genetically engineered products for human and animal welfare.
- Understand Developing embryo-transfer technology, cloning, and transgenic animals.
- Understand applications of hybridoma technique and functions of antibodies.
- Acquire knowledge about stem cell research and its ethical issues.

Unit-I: Introduction and Stem Cell Biotechnology (05 h)

- Introduction, scope and significance of Biotechnology
- Stem Cell Biotechnology
- Types of Stem Cell and their uses
- Current scenario and future prospects of Stem cell Biotechnology
- Ethical issues in stem cell Biotechnology.

Unit-II: Animal Cell Culture Techniques and Applications (15 h)

- Definition and Types of culture media– Natural and Artificial media.
- Advantages and disadvantages of animal cell/tissue culture
- Laboratory facility for animal tissue culture
- Applications of animal cell and tissue culture
- Primary culture, Examples of Cell lines

Unit-III: Molecular Techniques in Gene manipulation (15 h)

- Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage,
- BAC (Bacterial Artificial Chromosomes), YAC (Yeast Artificial Chromosomes), MAC (Mammalian Artificial Chromosomes) and Expression vectors (characteristics)
- Restriction enzymes: Nomenclature with example
- Transformation techniques: Calcium chloride method and electroporation.
- Construction of genomic and cDNA libraries
- Application of genetic engineering: production of human Insulin and vaccines

Unit-IV: Genetically Modified Organisms (10 h)

- Transgenic animals: Nuclear Transplantation, DNA micro injection techniques
- Applications of transgenic animals in: pharmaceuticals, donor organs, knockout mice.
- Methods for production of monoclonal and polyclonal antibodies
- Significance of Monoclonal antibodies

References:

- Brooks G (ed.) (2002), Gene therapy. The use of DNA as a drug. Pharmaceutical Press, London.
- Gerald C. (1996), Cell and Molecular Biology – Concept and Experiment, John Wiley and Sons, Inc., U.S.A.
- Lewin, B. (2004), Genes VIII, Oxford University Press, New York
- Lohar Prakash S. (2012), Textbook of Biotechnology ISBN: 9788180941047 MJP Publishers, Chennai
- Sing, B.D. (2014), Biotechnology Expanding horizons. Kalyani Publishers, Delhi.
- Watson, J. D. et. al., (1987), Molecular Biology of Gene, 4th ed., The Benjamin / Cummings Publishing Company, Inc. U.S.A.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V
Discipline Specific Core (DSC) Course
ZOO-355: Applied Zoology-II

Total Hours: 45 **Credits: 3**

Course objectives:

- Understand the concepts of the applied subjects like Fishery, Lac culture and Goatary
- To make learners understand the importance and scope of Fishery, Lac culture and Goatary
- Understand the tools and techniques used in Fishery, Lac culture and Goatary practices.

Course outcomes:

Students will be able to:

- Understand the science of Fishery, Lac culture and Goatary.
- Know types of fishes and types of goat.
- Learn about care of different animals

Unit-I: Lac culture **(15 h)**

- Introduction, Distribution and morphology of Lac insect
- Life cycle of Lac insect
- Host plant
- Lac culture-
  - Pruning
  - Artificial Inoculation
  - Harvesting of Lac- Immature and mature harvesting and its precaution
  - Composition of Lac
  - Lac processing- Stick lac, Seed lac, Shellac and Handmade process
  - Lac products, properties and their uses- Lac dye, Lac wax, Shellac.
- Enemies of Lac-Parasites, Predators and Mammals
- Lac industry in India and potential of India in Lac production

Unit-II: Fishery: Importance and Scope **(15 h)**

- Biology of fishes
  - *Labeorohita*
  - *Catlacatla*
- Selection of site
- Construction, Excavation of ponds: Hatchery, Nursery Pond, Rearing Pond, Stock Pond and maintenance of fish farm
- Common diseases of fish
- Fish preservation and processing
  - Chilling,
  - Freezing,
  - Freeze drying.
  - Smoking,

- Drying,
- Salting,
- Canning and processing.

- Economic importance of fishes.

Unit-III: Goatary –I **(08 h)**

- Introduction
- Indian breeds, distribution and characteristics
  - North west and Central region- i. Jamunapari ii. Barbar
  - South Peninsular region- i. Osmanabadi ii. Malbari
  - Eastern region- i. Bengal ii. Ganjam
  - Northern -temperate region- i. Gaddi ii. Chigu
- Reproductive system
  - Anatomy of male and female reproductive system of goat
  - Pregnancy diagnosis in goats

Unit-IV: Goatary –II **(07 h)**

- Feeding habits of goat
- Feeding of kids
  - Feeding of pregnant goat
  - Feeding of lactating goat
- Routine operations
  - Handling of goats
  - Castration
  - Dehorning
  - Care of feet
  - Tethering and staking out the goat
- Diseases and treatment - a. Mastitis; b. Foot rot; c. Brucellosis
- Economic importance of Goatary.

References:

- Balon E.K., (1984), Patterns in the Evolution of Reproductive Styles in *Fishes, in Fish Reproduction - Strategies and Tactics*, G.W. Potts & R.J. Wootton (eds), London, Academic Press: 35-53.
- Chattopadhyay, S. (2011), Introduction to Lac and Lac culture. Department of forest and biology and tree improvement faculty of Forestry. Birsa Agriculture University, Ranchi.
- McKenzie-Lake, Angela. "Facts About Goats." *College of Engineering Sciences, Technology, and Agriculture Bulletin*, no. 2, vol. 1., 2010, pp. 1-12.
- *Nandhagopalan (2013-04-06),* "Whole mount preparation". *world of nandha*. Retrieved 2019-05-19.
- Negi, P.S. (1956), Improved methods of lac cultivation, I.L.R.I. Bulletin no. 76, 11 pp.
- Neimann, Deborah (2013), Raising Goats: Naturally. New Society Publishers.
- Pal, G., Bhattacharya, A and Jaiswal A.K. 1998. Lac production and processing assessment. I.C.A.R.News, 13 (4) : 4.
- Sam A. Branson (2012), Beginner Goat Rearing Reference Book: Learn About Pygmy

Goats, Nubian Goats, Goat Breeding, Milking Goats, Goat Diseases And Other Goat Facts On How To Raise Goats Skillfully Paperback

- Sharma, K.K., Jaiswal, A.K., Kumar, K.K., (2006), Role of lac culture in biodiversity conservation: issue at stake and conservation strategy. Current Science 91 (7), 894e898

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V

Discipline Specific Core (DSC) Course

ZOO-356 (A): Insect Vector and Diseases

Total Hours: 45 **Credits: 3**

Course objectives:

- To study the significance of insect vectors and disease transmission
- To accustom students with basic concepts the interrelationship of insects and human with examples
- To study the insect vector associations and their types.

Course outcomes:

Students will be able to:

- Understand the general features of insects
- Learn about causes, symptoms and preventive measures of diseases caused by pathogen.
- Understand the life cycle of major insect vector and parasites.

Unit-I: Introduction to Insects and Vectors (11 h)

- General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits
- Brief introduction of Carrier and Vectors (mechanical and biological vector)
- Reservoirs, Host-vector relationship
- Vectorial capacity
- Adaptations as vectors
- Host Specificity

Unit-II: Insects as Vectors (14 h)

- Classification of insects up to orders, detailed features of orders with insects as vectors
  - Diptera,
  - Siphonaptera,
  - Siphunculata,
  - Hemiptera
- Dipteran as Disease Vectors
  - Dipterans as important insect vectors –Mosquitoes, and Houseflies.
  - Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya,
  - Viral encephalitis, Filariasis;
  - Control of mosquitoes

Unit-III: Siphunculata as Disease Vectors (08 h)

- Human louse (Head, Body and Pubic louse) as important insect vectors;
- Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse.

Unit-IV: Siphonaptera and Hermpitera as Disease Vectors (12 h)

- Fleas as important insect vectors

- Host-specificity
- Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas
- Hempitera as Disease Vectors
  - Bugs as insect vectors
  - Blood-sucking bugs
  - Chagas disease,
  - Bed bugs as mechanical vectors
  - Control and prevention.

References:

- Busvine J.R., (1980), Insects and Hygiene: The biology and control of insect
- Busvine J.R., (1982), Control of Domestics Flies, Ross Institute Bulletin No.
- Chapman, R.F. (1998), The Insects: Structure and Function. IV Edition, Cambridge University Press,UK
- Chavasse et Al, (1998), Reported Complete Failure to Control flies with Hall, London.
- Imms, A.D. (1977), A General Text Book of Entomology.
- Mathews, G. (2011), Integrated Vector Management: Controlling Vectors of Malaria
- Pedigo L.P. (2002), Entomology and Pest Management. Prentice Hall Publication

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V

Discipline Specific Core (DSC) Course

ZOO-356 (B): Bioinformatics

Total Hours: 45 **Credits: 3**

Course objectives:

- To introduced to the basic concepts of Bioinformatics and its significance
- To describe generation and different types of computers with basic programing languages.
- To understand types of biological data and database search tools.
- To get exposed to computational methods, tools and algorithms employed for proteomics and genomics.

Course outcomes:

Students will be able to:

- Understand the basic concepts of Bioinformatics and its significance
- Apply their knowledge of generations, types of computers and programming languages
- Understand the process of sequence alignment methods using web resources
- Appreciate the tools used in proteomics and genomics with their significance

Unit-I: Introduction to Bioinformatics (05 h)

- Definition, Objectives and scope of Bioinformatics
- Application of Bioinformatics in various Fields.

Unit-II: Computer generations (08 h)

- Concept of Computer generations and Type of computer
- Programming Languages: PERL and Java

Unit-III: Biological Databases (12 h)

- Concept and types of databases
- Sequence alignment
  - BLAST, types and applications.
  - FASTA, format and application

Unit-IV: Proteomics and Genomics (20 h)

- Definition, Protein structure visualization tools-RasMol and SwissPDB viewer
- Protein sequence databases- PIR, SWISS-PROT, TrMBL
- Structural classification databases- SCOP, CATH,
- Protein folding and disorders
- Applications of Proteomics
- Gene, Genotype, Genome of E. coli, S. cerevisiae, C. elegans, and Homo sapiens.
- Single nucleotide polymorphisms (SNPs), Structure and application of DNA microarray.
- Nucleotide sequence database, GenBank (NCBI, EMBL and DDBJ), cDNA libraries and ESTs, Databases of metabolic pathways- KEGG.
- Genomics in medicine- disease monitoring, Drug designing and development.

References:

- Aluru, Srinivas, (2006): Ed. Handbook of Computational Molecular Biology. Chapman & Hall/Crc, ISBN 1584884061 (Chapman & Hall/Crc Computer and Information Science Series)
- Attwood, T.K., Michie, A.D. and Jones, M.L. (1996): DbBrowser: integrated access to database worldwide. TiBS. Vol. 21(5), 191.
- Barnes, M.R. and Gray, I.C. (2003): Eds., Bioinformatics for Geneticists, first edition. Wiley, ISBN 0-470-84394-2
- Curtis Jamison. (2003): Perl Programming for Biologists. By Hoboken, NJ: John Wiley & Sons, Inc.
- Prakash S.Lohar (2011): Bioinformatics ISBN 978-81-8094-066-8 MJP Publishers, Triplicane, Chennai.
- Lesk, A.M. (2001): Introduction to Protein Architecture: The Structural Biology of Proteins (Oxford: Oxford University Press)

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V

Skill Enhancement Course (SEC) Course

ZOO-350: Public Health and Hygiene

Total Hours: 30 **Credits: 2**

Course objectives:

- To make learners understand the importance of balanced diet.
- Learn about essential nutrients of food at different stages of life style practices.
- Learn the physical fitness and healthy food and habits for life style disease management.
- To motivate them to practice yoga and meditation in day-to-day life

Course outcomes:

Students will be able to:

- Learn about healthy dietary habits would be inculcated in the life style of learners in order to prevent risk of developing health hazards in younger generation due to faulty eating habits.
- Get familiarized with various aspects of environmental risks and hazards.
- Acquire knowledge regarding epidemiology, prevention, control and management of diseases of public health importance.
- Learn about diagnosis of various diseases and methods to prevent them.

Unit-I: Public Health and Hygiene **(09 h)**

- Introduction and scope,
- Nutrition and health,
- Classification of food,
- Nutritional deficiencies,
- Vitamin deficiencies,
- Hygiene: Introduction, definition and types of hygiene
  - Personal hygiene
  - Oral hygiene
  - Mental hygiene

Unit-II: Environment and health hazards **(08 h)**

- Environmental degradation,
- Pollution and associated health hazards

Unit-III: Sanitation and Diseases **(08 h)**

- Definition and concept,
- Disposal of human & animal waste, reuse sewage.

Unit-IV: Communicable and Non-communicable diseases **(20 h)**

- Cause/causative agents, symptoms, diagnostics, precaution /prevention and remedy.
  - Typhoid
  - Hepatitis-types
  - Tuberculosis

- Chikungunya
- Influenza
- AIDS.
- COVID-19
- Swine flu

Non-communicable diseases

- Cause/causative agents, symptoms, diagnostics, precaution /prevention and remedy.
  - Hypertension and Hypotension
  - Coronary Heart disease,
  - Stroke,
  - Obesity
  - Mental ill health
  - Parkinson's disease
  - Cancers
  - Diabetes
  - Asthma, Bronchitis

References:

- Mahajan B.K., M.C. Gupta, (2013), Preventive and social medicine in India, 4th Edn., Jaypee Brothers Medical Publishers, New Delhi, India.
- Park K. and Park S, (1995), Text Book of Preventive and Social Medicine. Banarsidas Bhanot Publishers, 1167 Prem Nager, Jabalpur – 482001.
- Seshu Babu V.V.R, (2006), Review of community medicine, 2nd Edn., Paras Medical Books Pvt. Ltd., Hydrabad.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester V
Discipline Specific Core (DSC) Course
ZOO-357: Practical course Based on ZOO-351 and 352

Total Hours: 60 **Credits: 2**

Course objectives:
- To learn about the various aspects of reproductive biology and endocrinology.
- To understand different immunological techniques used.
- To understand various immune mechanisms.

Course outcomes:
Students will be able to:
- Understand the functioning of male and female reproductive systems particularly in human.
- Learn about the immunological techniques.
- Understand interaction between antigen and antibody.

Sr. No.	Topic Particular	Hours
	Reproductive Biology	
1	Study of animal house: set up and maintenance of animal house(D)	04
2	Study of vaginal smear of rat (D)	04
3	Study of male reproductive system of human (D)	04
4	Study of female reproductive system of human (D)	04
5	Sperm count and sperm motility in rat/human. (E)	04
6	Study of modern contraceptive devices (D)	04
	Immunology	
7	Demonstration of lymphoid organs. (D)	04
8	Study of chemistry of immunoglobulin molecule, classes and its physiological importance.	04
9	Study of Differential count of WBCs. (E)	04
10	Determination of ABO blood group with Rh factor. (E)	04
11	Detection of presence of antigen by qualitative ELISA (Dot ELISA) (E)	04
12	Demonstration of Rocket immune electrophoresis. (D)	04
13	Demonstration of Ouchterlony's double immuno-diffusion method. (D)	04
14	Prepare and submission of the model of immunoglobulin by using suitable material (Plaster of Paris/Clay/Silicon/Card sheet etc.) (Activity base).	04

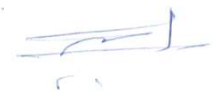
References:

- Austin C. R. and R. V. Short (1972), Reproduction in Mammals, Vol.:1-8, Cambridge University Press.
- Gibian P. and E. J. Platz, eds. (1970), Mammalian Reproduction, Springer Verlag.
- Guide to learning in Reproductive Endocrinology and Infertilitv ABO+ G. First in

women health. The American Board of Obstetrics and Gynecology, Inc. Vine Street: Dallas, TX 75204
- Hogarth P. J. (1978), Biology of Reproduction Wiley, New York.
- Lohar Prakash S. (2012), Endocrinology-Hormones and Human Health, MJP Publishers, Chennai.
- Perry J. S. (1971), The Ovarian cycle of animals, Oliver and Boyed.
- Williams Robert H. (1981), Text Book of Endocrinology, W. B. Saunders Company
- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006), Immunology, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006), Immunology, VII Edition, Mosby, Elsevier Publication.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods



T.Y. B.Sc. (Zoology): Semester V
Discipline Specific Core (DSC) Course
ZOO-358: Practical course Based on ZOO-353 and 354

Total Hours: 60 **Credits: 2**

Course objectives:

- To prepare the temporary preparation of microscopic slides and staining.
- To study the histology of different tissues and systems of mammals.
- To study animal cell and tissue culture techniques
- To know about developing genetically engineered products for human & animal welfare,
- To learn about developing gene transfer technologies, cloning, transgenic animals
- To study hybridoma technique and production of antibodies
- To impart knowledge about stem cell research

Course outcomes:

Students will be able to:

- Learn cell, tissue structure, histology of tissues and details of morphology of animals.
- Enrich with histology of different tissues and systems for study and research.
- Acquire knowledge about animal cell and tissue culture techniques.
- Come to know genetically engineered products for human and animal welfare.
- Understand applications of hybridoma technique and functions of antibodies.
- Acquire knowledge about stem cell research and its ethical issues.

Sr. No.	Topic Particular	Hours
	Mammalian Histology	
1	Study of following tissue with the help of chart / permanent slides /simulations (D). a) Squamous epithelial tissue b) Cuboidal epithelial tissue c) Columnar epithelial tissue d) Ciliated epithelial tissue e) Areolar connective tissue f) Blood smear permanent slide.	04
2	Temporary preparation of the following tissue of preserved Rat (E). a) Striated muscle fibre b) Smooth muscle fibre c) Medullated nerve fibres d) Hyaline cartilage.	04
3	Study of histological permanent slide (D) Skin V. S. of Tooth V. S. of Tongue C. S. of Salivary gland (Parotid gland) T. S. of oesophagus T. S. of stomach T. S. of duodenum T. S. of rectum	04
4	Study of following histological permanent slide (D) i) T. S. of pancreas	04

	j) C. S. of liver k) C. S. of trachea l) C. S. of lung	
5	Study of following histological permanent slide of blood vessels, excretory and reproductive systems. (D) a) T. S. of artery b) T. S. of vein c) T. S. of capillary. d) L. S. of kidney e) T. S. of testis f) L. S. of ovary	04
6	Study of following histological permanent slide of endocrine glands. (D) T. S. of pituitary gland T. S. of adrenal gland C. S. of thyroid gland	04
7	Prepare a model of any one cell type / tissue type / organ by using any suitable material (Plaster of Paris / clay / silicon / ceramic etc.) (Activity based practical)	04
	Animal Biotechnology	
8	Estimation of DNA in a given sample by Diphenylamine Method (E).	04
9	Estimation of RNA in a given sample by Orcinol method (E).	04
10	Working principle and application of CO2 incubator, Biosafety cabinet, and Inverted microscope (D)	04
11	Isolation of microorganisms on nutrient agar by streak plate and dilution plate method (E)	04
12	Production of ethanol or citric acid by fermentation using yeast. (E)	04
13	Preparation of primary culture media for cell culture (E).	04
14	Visit to dairy industry / pharmaceutical industry / tissue culture laboratory and submission of report.	04
15	Collect the any polluted sample and culture to observe the growth of microbes (Activity based practical)	04

References:

- Pearse A.G.E. (1985), Histochemistry – Vol. I and II, Fourth edition. Churchill Livingstone, Edinburgh.
- Tembhare D.B. (2010), Techniques in Life Sciences, Publisher - Himalaya Publishing House
- Muzammih Ullah, (1980), Histology and Genetics: Theoretical and Applied (including Histological and Cytological Techniques, Kedar Nath Ram Nath Publisher.
- Brooks G (ed.) (2002), Gene therapy. The use of DNA as a drug. Pharmaceutical Press, London.
- Gerald C. (1996), Cell and Molecular Biology – Concept and Experiment, John Wiley and Sons, Inc., U.S.A.
- Lewin, B. (2004), Genes VIII, Oxford University Press, New York
- Lohar Prakash S. (2012), Textbook of Biotechnology ISBN: 9788180941047 MJP Publishers, Chennai
- Sing, B.D. (2014), Biotechnology Expanding horizons. Kalyani Publishers, Delhi. Watson, J. D. et al., (1987), Molecular Biology of Gene, 4th ed., The Benjamin / Cummings Publishing Company, Inc. U.S.A.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

T.Y. B.Sc. (Zoology): Semester V
Discipline Specific Core (DSC) Course
ZOO-359: Practical course Based on ZOO-355 and 356

Total Hours: 60 **Credits: 2**

Course objectives:

Applied Biology

- To get technical awareness of Fisheries, Lac culture and Goatary technique.
- To introduce the learner to the science of Fishery, Lac culture and Goatary
- To introduce the learner the types of fish breeds, types of goat breed and lac insect
- To acquaint learner with diseases and treatment of goats.

A) Insect, Vector and Diseases

- To study the importance of hygiene with respect to epidemic diseases
- To study the significance of insect vectors and disease transmission
- To study the insect vector associations and their types.

B) Bioinformatics

- To get introduced to the basic concepts of Bioinformatics and its significance
- Explain generation and different types of computers with basic programing languages.
- Overview about types of biological data and database search tools.
- To get exposed to computational methods, tools and algorithms employed for proteomics and genomics

Course outcomes:

Students will be able to:

Applied Biology

- Learner shall comprehend the types of fishes, types of goats and diseases of goats
- Learner will get an about maintenance of aquarium in laboratory
- Understand the tools and techniques of Fishery, Lac culture and goatry.

A) Insect, Vector and Diseases

- To study the importance of hygiene with respect to epidemic diseases
- Understand the general features of insects
- Understand the causes, symptoms and preventive measures of diseases caused by pathogen.
- Understand the life cycle of major insect vector and parasites.

B) Bioinformatics

- Understand the basic concepts of Bioinformatics tools and its significance
- Apply their knowledge of generations, types of computers and programming languages
- Understand the process of sequence alignment methods using web resources
- Appreciate the tools used in proteomics and genomics with their significance

Sr. No.	Topic Particular	Hours
	Applied Zoology-II	
1	Study of fish breeds- *Labeo rohita and Catla catla*	04
2	Study of Design and layout of Fish farm	04

3	Study and observation of Lac insect life cycle (with adult Male and female)	04
4	Identification of at least any four Indian Goatary breed with reference to their distribution and breed characteristics (Malbari, Jhakrana, Sangamneri and Jhakrana)	04
5	Study of Diseases and treatment of Lac Insect, Fishes and Goats	04
6	Economic Importance of Lac culture, Fisheries and Goatary	04
7	Compulsory visit to Fishery/Lac Industry /Goatary	04
	A) Insect, Vector and Diseases	
8	Study of different kinds of mouth parts of insects-Mosquitoes, Housefly and Bedbug.	04
9	Study of following insect vectors through permanent slides/ photographs/Charts: *Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis*.	04
10	Study of life cycle of Mosquitoes. (Aedes*, Culex, Anopheles*)	04
11	Study of Animal diseases and its preventive measures- Viral encephalitis Trench fever, Chagas disease.	04
12	Study of disease-causing pathogens.	04
13	Submission of a project report on any one of the insect vector disease transmitted (Activity based practical)	04
	OR B) Bioinformatics	
8	PERL or JAVA programming translation of String of DNA.	04
9	Demonstrate dot plot method using any programming language.	04
10	Study of particular human hereditary disease using OMIM website	04
11	Evaluation of similarity percentage using sequence alignment tool.	04
12	Visualization of PDB files using SPDBV software.	04
13	Login to KEGG homepage to study of any suitable metabolic pathway.	
14	Using NCBI resources find out nucleotide database of any one gene on a chromosome of human.	04
15	Visit to any bioinformatics-based laboratory/industry	04

References:

- Balon E.K., (1984), Patterns in the Evolution of Reproductive Styles in *Fishes, in Fish Reproduction - Strategies and Tactics*, G.W. Potts & R.J. Wootton (eds), London, Academic Press: 35-53.
- Chattopadhyay, S. (2011), Introduction to Lac and Lac culture. Department of forest and biology and tree improvement faculty of Forestry. Birsa Agriculture University, Ranchi.
- McKenzie-Lake, Angela. "Facts About Goats." *College of Engineering Sciences, Technology, and Agriculture Bulletin*, no. 2, vol. 1., 2010, pp. 1-12.
- Busvine J.R., (1980), Insects and Hygiene: The biology and control of insect
- Busvine J.R., (1982), Control of Domestics Flies, Ross Institute Bulletin No.
- Chapman, R.F. (1998), The Insects: Structure and Function. IV Edition, Cambridge University Press,UK

- Imms, A.D. (1977), A General Text Book of Entomology.
- Chapman, R.F. (1998), The Insects: Structure and Function. IV Edition, Cambridge University Press, UK
- John R Baker (2005)Advances in Parasitology published by Academic press.
- Pedigo L.P. (2002), Entomology and Pest Management. Prentice Hall Publication
- Mathews, G. (2011), Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell
- Bioinformatics (2004), A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition by Andreas D. Baxevanis (Editor),B. F. Francis Ouellette (Editor).
- Practical Bioinformatics. (2013), Garland Science: New York. ISBN: (Paperback) 978-081534456-8. By Michael Agostino.
- Bioinformatics (2001), A Practical Guide to the Analysis of Genes and Proteins,Second edition,a John Wiley & Sons, Inc., Publication.
- Prakash S.Lohar (2011), Bioinformatics ISBN 978-81-8094-066-8 MJP Publishers, Triplicane, Chennai.
- Lesk, A.M. (2001), Introduction to Protein Architecture: The Structural Biology of Proteins (Oxford: Oxford University Press),
- Pocock M, Down T, Hubbard T. (2000), BioJava: Open Source Components for Bioinformatics. ACM SIGBIO Newsletter 20(2), 10-12.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-361: Study of Leech and Calotes

Total Hours: 45 **Credits: 3**

Course objectives:

- To understand taxonomic status of Leech as invertebrates and Calotes as vertebrates
- To explain the basic aspects of structural and functional details of Leech and Calotes
- To study the medical importance leech and economic importance of Calotes.

Course outcomes:

Students will be able to:

- Understand the systematic position, habit and habitat of Leech and Calotes
- Acquire the knowledge about the invertebrates and vertebrate animal type.
- Understand the structural and functional anatomy details in Leech and Calotes

Unit-I: Study of Leech **(10 h)**

- Systematic position, habit, habitat external characters, body wall.
- Digestive system, food, feeding and digestion.

Unit-II: Systems of Leech **(10 h)**

- Nervous system and sense organs.
- Reproductive system, copulation,
- Fertilization, cocoon formation, and development.

Unit-III: Study of Calotes **(05 h)**

- Systematic position, habit, habitat external characters,
- Digestive system, food feeding and digestion

Unit-IV: Systems of Calotes **(10 h)**

- Respiratory system and respiratory mechanism
- Excretory system and physiology of excretion
- Nervous system and sense organs
- Reproductive system, copulation, fertilization and development.

References:

- Hall B.K. and Hallgrimsson B. (2008), Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- Jorden E. L. (2000), Invertebrate Zoology, S. C. Chand, New Delhi.
- Jordan E. L. and P. S. Verma. (2000), Chordate Zoology, S. Chand and Company New Delhi.
- Kotpal R.L. (1991), Zoology phylum Annelida, Rastogi publication. Meerut.
- Kotpal R.L. (2016), Modern text book Vertebrate zoology. Fourth edition. Rastogi Publication, Meerut

- Lal S.S. (1996), Textbook of Practical Zoology Invertebrates, Rastogi Publications.
- Lal S. S. (1996), Textbook of Practical Zoology Vertebrates, Rastogi Publications. Prasad S. N., Life of Invertebrates.
- Young, J. Z. (2004), The Life of Vertebrates. III Edition. Oxford university press.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-362: Developmental Biology of Vertebrates

Total Hours: 45 **Credits: 3**

Course objectives:
- To introduce the students to the fundamentals of developmental biology and gametogenesis.
- To understand the basic concepts of Growth, Stem cells, Differentiation, Fate map, Regeneration, Parthenogenesis, Neoteny, teratogenesis.
- To understand development of frog.
- To understand implantation of embryo in humans, Formation of human placenta and functions, types of placenta on the basis of histology.
- To understand Programmed cell death, aging and senescence.

Course outcomes:
Students will be able to:
- Understood the process of development of animals, teratogenesis, its molecular basis and causes.
- Understood the process of gametogenesis and development of frog.
- Know implantation, physiology of placenta and knowledge about metamorphosis and the process of Programmed cell death, aging and senescence

Unit-I: Introduction to development biology (05 h)
- Definition, Scope and history
- Branches of embryology
- Developmental biology material and techniques
- Definition of: Growth, Stem cells, Differentiation, fate, map, Regeneration, Parthenogenesis, Neoteny

Unit-II: Early Embryonic Development (20 h)
- Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals.
- Vitellogenesis in birds
- Fertilization: external (amphibians), internal (mammals)
- Monospermic and polyspermic fertilization
- Early development of frog (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula)
- Types of morphogenetic movements
- Fate of germ layers
- Neurulation in frog embryo

Unit-III: Late Embryonic Development (15 h)
- Implantation of embryo in humans
- Formation of human placenta and functions
- Other types of placenta on the basis of histology
- Metamorphic events in frog life cycle and its hormonal regulation

Unit-IV: Programmed cell death, aging and senescence (05 h)

- Apoptosis
- Aging
- Senescence

References:

- Gilbert, S. F. (2006), Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008), An introduction to Embryology, International Thomson Computer Press.
- Carlson, Bruce M (1996), Patten's Foundations of Embryology, McGraw Hill, Inc.
- Dr. P S Verma and Dr. V. K. Agarwal (2010), Chordate Embryology, S. Chand Publication.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-363: Biochemistry

Total Hours: 45 **Credits: 3**

Course objectives:

- To accustom students with basic terms in biochemistry.
- To study of macromolecule such as carbohydrates, protein and fat, their types and significance.
- To learn about enzyme, vitamin and minerals

Course outcomes:

Students will be able to:

- Understand the importance of biochemistry
- Understand a deeper insight in to the fundamentals of biochemistry.
- Understand the importance of biological macromolecules
- Understand the students in understanding the classification, functions and application aspects of biomolecules

Unit-I: Introduction to biochemistry **(10 h)**

- Objectives, scope and importance.
- pH and Buffers-
  - Concept of pH and pK
  - pH value of body fluid, pH scale and significance.
  - Ionization of acids and bases.
  - Derivation of Henderson-Hassel Baltch equation.
  - Buffer- Definition, Concept, functions, types and buffers used in biological systems
- Molecular Interactions –
  - Definition, formation and examples of following chemical bonds
- Covalent bonds- peptide and disulphide bond with example.
- Non-covalent bonds- Hydrogen, Ionic and Hydrophobic bond with example..
- Other bonds- Glycosidic and phosphodiester bond with example.

Unit-II: Carbohydrates **(10 h)**

- Definition, classification and biological importance.
- Monosaccharides
  - Structure and their biological importance- trioses, tetraoses, pentose, hexoses, aldo and ketosugars.
- Diasaccharides
  - Structure and significance of Malatose, Isomaltose, Lactose and Sucrose
- Polysaccharides-
  - Starch, Glycogen, Cellulose and Chitin (Structural formulae not expected)

Unit-III: Lipids **(07 h)**

- Definition, classification with examples and their biological importance.

- Fatty acids
  - Saturated and Unsaturated.
  - Essential and Non-essential fatty acids
  - Tri-acylglycerol
  - Phospholipids
  - Glycolipids
  - Steroids

Unit-IV: Proteins, Enzyme, Vitamins and Minerals (18 h)

- Amino acids-Classification and general properties of α-amino acids, physi0logical importance of essential and non-essential α -amino acids
- Proteins-Definition, biological significance of proteins
- Classification with examples-
- Structure of proteins- primary, secondary, tertiary and quaternary
- Denaturation of proteins.
- Defensive proteins-Definition, Antigens and antibodies
- **Enzyme** –Nomenclature and classification;
  - Co-factors,
  - Specific of enzyme action;
  - Isozymes;
  - Mechanism of enzyme action;
  - Enzyme kinetics;
  - factor affecting rate of enzyme-catalyst reactions.
- **Vitamins** – Definition, Classification- Fat and Water soluble.
  - Study of Fat-Soluble- A, D, E,K Vitamins
  - Vitamins ass Coenzymes
- **Minerals-** Definition and general functions of Macro and Microminerals.

References:

- Lehninger, A. L. (2013), Biochemistry, Publisher-W. H. Freeman; 6th edition.
- Kulkarni, M. V., Thonte, S, S., Rathod and Ghiware (1996), Biochemistry, Nirali publication.
- Rastogi, S. C. (2010), Biochemistry, McGraw Hill Education; 3rd edition publication
- U. Satyanarayanan Biochemistry (2013), Publisher : Elsevier; 4th edition
- Outline of biochemistry (2006), Cohn and Stumpt, Publisher-Wiley; Fifth edition
- Thimmaiah S. K.(1999), Standard Methods of Biochemical Analysis, Kalyani Publication.
- Jain J.L. Jain S.(2007), Biochemistry, Chand Publication, Meerut.
- Powar CB and ChatwalGR (2008)–Biochemistry, Himalaya Publishing House

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-364: Microtechnique

Total Hours: 45 **Credits: 3**

Course objectives:
- To prepare the whole mounts microscopic slides and staining reactions.
- Study of microscopically sectioning techniques.
- To study the preservation and storage of histological slides.

Course outcomes:
Students will be able to:
- Study cell tissue structure, histology of tissues and details of morphology of animals.
- Understand applications and scope of Microtechnique
- Understand Cell tissue structure, histology of tissues and details of morphology of animals.
- The learner will get Job opportunities in Health institutes, Hospitals and Pathological labs.

Unit-I: Tissue and Skin Introduction, Processes of Microtechnique (16 h)
- Definition, Scope and Applications of Microtechnique.
- Collection of specimen or tissue.
- Kinds of preparation of specimen or tissue:
  - Whole mounts, Teasing and smearing.
- Preparation whole mounts: Euglena, Paramecium, Chick embryo and Insects
- Fixation: Definition and Importance and Theory of fixation.
- Qualities of good fixative.
- Types of fixative –
  - Primary-- Formalin, Ethyl alcohol. (Ethanol)
  - Compound fixatives- Bouin's fluid, Zenker's Fluid and Carnoy's fluid.

Washing, Dehydration, Clearing
- Washing:
  - Theory of washing
  - Significance of washing
- Dehydrating agents:
  - Definition and types - Ethanol, Methanol, Acetone
  - Significance and use of dehydrating agents.
- Clearing:
- Definition and importance of clearing.
- Clearing agents their merits and demerits - Xylene, Toluene, Benzene, Cedar wood oil, Clove oil.
- Cold and hot infiltration

Unit-II: Embedding, Block making, Trimming and Mounting (09 h)
- Paraffin

Selection of paraffin according to need.

- Melting and handling of paraffin.

- Types of ovens and its uses.
- Embedding:
  - Embedding containers: a) Paper trays b) L-shaped metal Pieces c) Glass dishes/Lids.
  - Embedding procedure, multiple embedding and embedding faults.
- Block making, labeling of block and storage of block.
- Trimming
- Mounting of trimmed block on microtome peg.

Unit-3: Section cutting and affixing (10 h)

- Microtome: Types, its uses, precautions and handling of Rotary and Rocking microtome.
- Microtome knives: Types, care, sharpening, honing and stropping of knife.
- Section cutting: Defects, Possible causes and remedies during section cutting.
- Affixing and processing of sections: i) Mayer's albumen, ii) Slide warmers

Unit-IV: Staining, Mounting, Clearing and camera lucida (10 h)

- Theory of staining.
  - Types of stain: Acidic, basic, neutral and vital stain.
  - Preparation of Haematoxylin, Eosin stain and Giemsa stain
  - Mordants: Definition, importance and common mordants.
  - Double staining: Processing of paraffin section during staining.
  - Special staining methods for Mitochondria and chromosomes.
- Mounting media: DPX and Canada balsam.
- Clearing, labeling and preservation of permanent slides.
- Use of camera Lucida and Micrometer scale.

References:

- Weesner., F.M. (1968), General zoological microtechniques. Maryland, U.S.A.: The Williams & Wilkins Company
- Mr. Jeremy Sanderson (1994) Biological Microtechnique by Garland Science publishers: First edition
- Baker F.I and R.E Silverton,(2008) Introduction to Medical Laboratory Technique.
- R.Marimuthu(2011) Microscopy and Microtechnique published by Mjp
- Vonnie D.C.Sheild and Thomas Heinbokel (2019) Introductory Chapter:Histological Microtechnique.
- Peter Gray(1952) Basic Microtechnique published by The blakiston company,toronto.
- Dr.M.K.Prasad (2000) Outlines of Microtechnique published by Emkay.
- Brian Bracegirdle(1978) A History of Mirotechnique published by Heinemann Educational books Ltd.
- Richard W.Horobin(1982) Histochemistry published by Butterworth Heinemann Educational books Ltd.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-365: Animal Physiology

Total Hours: 45 **Credits: 3**

Course objective:

- To provide students with a basic understanding of the fundamental processes and mechanisms of the body.
- To learn simple cellular mechanisms as well as more complex interactions between whole organ systems.
- To study tissues, digestive, respiratory, excretory, cardiovascular, reproductive and nervous system.

Course outcomes:

Students will be able to:

- Know various physiological organ-systems and their importance to the integrative functions of the human body.
- Describe interactions between different organ systems (homeostasis)
- Know the anatomy of different physiological systems and their specific functions
- Understand how changes in one system may impact a different system

Unit-I: Thermoregulation, Digestion and Circulation (15 h)

- Definition
- Poikilotherms and homeotherms
- Role of hypothalamus in thermoregulation
- Definition of digestion
- Buccal digestion – salivary secretion and digestion
- Gastric digestion – gastric secretion and digestion
- Intestinal digestion – pancreatic secretion, bile juice and digestion in small intestine
- Digestion and absorption in large intestine
- Definitions of Ulcer and Constipation
- Neurogenic and myogenic heart
- Cardiac cycle, Systole, Diastole, Double circulation
- Pace maker and its role
- Heart beats,
- Definitions of Myocardial infarction and artificial Pace maker

Unit-II: Respiration and Excretion (10 h)

- Definition of respiration
- Ventilation – Inspiration and expiration
- Transport of gases, chloride shift and Bohr's effect
- Properties and functions of respiratory pigments (Hemoglobin and Myoglobin)
- Respiratory quotient and its significance
- Definitions of Asphyxia and Hypoxia

- Physiology of urine formation: ultra-filtration, selective re-absorption and tubular secretion, counter current multiplier theory, Composition of normal urine
- Definition of Kidney failure and Gout

Unit-III: Nerve Physiology and Muscle Physiology (10 h)

- Neurotransmitters and Synapse
- Origin and conduction of nerve impulses
- Definitions of cervical spondylosis and Epilepsy
- Simple muscle twitch, summation, tetanus and muscle fatigue
- Neuromuscular junction
- Definition of Rigour mortis and Muscular dystrophy

Unit-IV: Reproduction and Endocrine glands (10 h)

- Role of sex hormones in reproduction
- Reproductive cycle – oestrous and menstrual cycle
- Definitions of Infertility, Ovarian cyst
- Endocrine glands- their hormonal secretion and functions of Pituitary gland, Thyroid gland, Adrenal gland and Pancreas
- Definition of Goiter and Diabetes.

References:

- W.S. Hoar. (1975), General and Comparative Physiology, Prentice Hall; 2nd Revised edition.
- C. L. Prosser & Brown. (1991), Comparative Animal Physiology, Wiley-Liss; Part A edition.
- H. Davson. (1978), Introduction to Physiology- (I&II), Academic Press.
- P. S. Verma, V. K. Agarwal and B. N. Tyagi (2015), Animal Physiology, S. Chand Publications, new Delhi.
- Mohan Arora (2018), Animal physiology, Himalaya Publishing House Pvt. Ltd., Mumbai.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-366 (A): Research Methodology

Total Hours: 45 **Credits: 3**

Course objectives:
- To understand some basic concepts of research and its methodologies.
- To describe various types of Sampling
- To elaborate Data Processing and Data Analysis
- To study writing of dissertations, project proposals, project reports, research papers.

Course outcomes:
Students will be able to:
- Understand some basic concepts of research and its methodologies.
- Know writing of dissertations, project proposals, project reports, research papers.
- Understand intellectual Property Rights – Biopiracy,
- Understand Copyrights, patent and traditional knowledge and plagiarism.

Unit-I: Foundations of Research **(10 h)**
- Meaning of research
- Objectives of research
- Motivation in research
- Research methods versus methodology
- Types of research
  - Analytical vs Descriptive
  - Quantitative vs Qualitative
  - Basic vs Applied
  - Conceptual vs Empirical
- Meaning of Research Design
- Need of Research Design
- Features of good Research Design
- Concepts of Research Design
- Basic principles of Experimental Design

Unit-II: Data Collection, Analysis and Presentation **(20 h)**
- Collection of Data
- Methods of data collection - Sampling Methods
- Variables - Definition, types with example
- Tabulation of data: Frequency distribution - Definition, types with example
- Measurement of central tendency – Definition and merits and demerits: mean, median and mode with examples on ungrouped and grouped data
- Standard deviation (SD) and Standard error (SE) with examples on ungrouped and grouped data and merits and demerits.
- Data presentation with examples

  - Bar chart (diagram),
  - Pie chart
  - Histogram
- Data Analysis Strategies with example
  - Chi-square test: test for goodness of fit
  - Student 't' test: small sample - test of significance of single mean

Unit-III: Technical Reports and Thesis writing (10 h)

- Prepare Title, Author and Addresses, key words and Abstract (summary and synopsis)
- Writing of technical report and thesis - IMMRAD system (Introduction, Material methods, Result and Discussion), Acknowledgement, Summary, Conclusion and References.
- Concept of scientific writing
- Meaning of scientific paper
- Write a letter to Editor of scientific journal for publishing a research paper.

Unit-IV: Ethical Issues (05 h)

- Intellectual property Rights,
- Commercialization,
- Royalty,
- Plagiarism,
- Citation,
- Impact factor,
- h-index, i-10 Index

References:

- Anthony, M, Graziano, A.M. and Raulin, M.L. (2009), Research Methods: A Process of Inquiry, Allyn and Bacon.
- Coley, S. M. and Scheinberg, C. A. (1990), "Proposal writing". Stage Publications.
- Gurumani, N. (2009), Research methodology for biological science, MJP publisher, Chennai.
- Kothari C. R. (2009), Research Methodology, New Age International
- Robert A. Day. (1924), How to write and publish a Scientific papers (4th edition),
- Wadhera, B. L. (2002), Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, Universal Law publishing
- Walliman, N. (2011),Research Methods - The Basics. Taylor and Francis, London, New York.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-366 (B): Aquatic Biology

Total Hours: 45 **Credits: 3**

Course objectives:

- To study the basic functioning of aquatic ecosystems.
- To study about the biological organisms that exist in aquatic biomes
- To acquire knowledge of diversity, organization and taxonomic status of an organism.

Course outcomes:

Students will be able to:

- Understand the importance of aquatic biomes.
- Understand physico-chemical characteristic of water.
- Understand the basic information on the importance of environment

Unit-I: Aquatic Biomes (11 h)

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

Unit-II: Freshwater Biology (12 h)

- Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry,
- Physico–chemical Characteristics: Light, Temperature, Thermal stratification,
- Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide), Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.
- Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

Unit-III: Marine Biology (11 h)

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

Unit-IV: Management of Aquatic Resources (11 h)

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

References:

- Alexander Horne and Charles Goldman (1994), Limnology, McGraw-Hill Education; 2nd edition publication.
- Anathakrishnan T. N. (1982), Bioresources Ecology 3rd Edition Oxford & IBH. University of Chicago

- Odum and Barrett (2004), Fundamentals of Ecology, 5th Edition, Brook CoIe publication
- Pawlowski (1979), Physicochemical Methods for Water and Wastewater Treatment, 1st Edition Pergamon publication.
- Robert G.Wetzel (2001), Limnology, Academic Press; 3rd edition publication.
- R.K. Trivedy, P.K. Goel. (1984), Chemical and biological methods for water pollution studies, Environmental Publication
- Welch, P.S. (1952), Limnology. 2nd Edition Vol-I and II, McGraw-Hill Book Co., New York.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Skill Enhancement Courses (SEC) Course
ZOO-360: Sericulture

Total Hours: 30 **Credits: 2**

Course objectives:
- To give scientific knowledge about mulberry cultivation.
- To give scientific knowledge of silkworm rearing techniques to the students.
- To train the students in compressive silk production techniques

Course outcomes:
Students will be able to:
- Develop an expert manpower to handle the own sericulture Units / entrepreneurship / corporate sector units.
- Provide gainful employment, economic development.
- Improve the quality of life of the people in rural area.

Unit-I: Introduction of Sericulture **(09 h)**
- Sericulture: Definition, history, present Status
- Scope of sericulture
- Silk producing centers
- Taxonomic position
- Types of silkworms and their Distribution (Muga, Eri, Tussar, Mulberry)
- Biology of Silkworm
- Life cycle of Bombyx mori w. r. t. external and internal morphology of Egg, larva, Pupa, adult
- Structure and function of silk gland and secretion of silk
- Digestive system of Bombyx mori

Unit-II: Cultivation of Mulberry **(06 h)**
- Cultivation of Mulberry
  - Selection of mulberry variety,
  - Propagation,
  - Climate,
  - Soils,
  - Planting,
  - Raising of commercial nursery,
  - Manuring,
  - Interculture,
  - Water management,
  - Prunning and
  - Quality of leaves
- Harvesting of mulberry-
  - Shoot Cutting
  - Leaf plucking and

  - Bud plucking.
- Advantages and disadvantages of shoot rearing

Unit-III: Silkworm Rearing (10 h)

- Rearing technique:
  - Selection of quality seeds,
  - Brushing,
  - Quality of food,
  - Shape and size of leaves,
  - Preparation of feed bed for different rearing methods,
  - Bed Cleaning methods,
  - Spacing, moulting, mounting,
  - Environmental conditions and care during spinning,
  - Harvesting of cocoons,
  - Sorting of cocoons and
  - Post harvest processing of cocoons.
- Rearing house
- Rearing Appliances:
  - Rearing stand,
  - Ant wells,
  - Rearing trays,
  - Paraffin paper,
  - Foam rubber strip,
  - Chopsticks,
  - Feathers,
  - Leaf chamber,
  - Chopping board,
  - Chopping knives,
  - Mats,
  - Cleaning nets,
  - Mountages,
  - Feeding stand and
  - Miscellaneous appliances

Unit-IV: Important Diseases and Pests (05 h)

- Protozoan disease: Pebrine
- Viral disease: Nuclear Polyhedrosis Virus (NPV)
- Fungal disease: Muscardine - White, green, yellow
- Pests of silkworm: Uzi flies, dermestid beetles, ants and vertebrates
- Prevention and control of diseases and pests

References:

- Anonymous (1972), Handbook of silkworm rearing: Agricultural and Technical manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan.
- Jolly Ed.M.S. (1999), Appropriate Sericulture Techniques; Director, CSR & TI Mysore.

- Krishnaswamy S. (1986), Improved Method of Rearing Young age silkworm; reprinted CSB, Bangalore.
- Narsimhanna M.N. (1988), Manual of Silkworm Egg Production; CSB, Bangalore.
- Sengupta K. (1989), A Guide for Sericulture; Director, CSIR and TI, Mysore.
- Wupang- Chun and Chen Da- Chung (1988), Silkworm Rearing, Pub. By FAO, Rome.

Methods of Teaching:

- Classroom teaching, Lecture method, ICT enabled teaching

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-367: Practical course Based on ZOO-361 and 362

Total Hours: 60 **Credits: 2**

Course objectives:

- To learn about the various aspects of reproductive biology and endocrinology.
- To study sperm, eggs, blastulae and gastrulae.
- To understand temporary mounting of chick embryo
- To identify and describe types of placenta on the basis of histology.
- To understand development of frog.

Course outcomes:

Students will be able to:

- Understand the functioning of male and female reproductive systems particularly in humans.
- Understand structure of sperm, eggs, blastulae and gastrulae.
- Identify different developmental stages of chick.
- Identify and describe different types of placenta on the basis of histology.
- Know development of frog.

Sr. No.	Topic Particular	Hours
	Study of Leech and Calotes	
1	Study of systematic position and external characters of Leech with the help of chart or diagram.	04
2	Study of Digestive system of Leech with the help of chart or diagram.	04
3	Study of Nervous system of Leech with the help of chart or diagram.	04
4	Study of Reproductive system of Leech with the help of chart or diagram.	04
5	Study of systematic position and external characters of Calotes with the help of chart or diagram.	04
6	Study of Digestive system of Calotes with the help of chart or diagram.	04
7	Study of Nervous system of Calotes with the help of chart or diagram.	04
8	Study of Reproductive system of Calotes with the help of chart or diagram.	04
	Developmental Biology of Vertebrates	
9	Study of sperms of Amphioxus, Frog, Bird and Mammal. (D)	04
10	Study of types of eggs. (D)	04
11	Study of blastulae and gastrulae of Amphioxus, Frog and Bird. (D)	04
12	Temporary Mounting of chick embryo. (E)	04
13	Study of whole mounts of chick embryos – primitive streak, 24 hrs, 33 hrs, 48 hrs and 72 hrs. (D)	04
14	Study of types of placenta on the basis of histology with suitable charts/models. (D)	04
15	Study of Metamorphosis in frog by suitable specimens/charts/models. (D)	04

16	Collection and submission of pictures of sperms of different vertebrates.	04

References:

- Jorden E. L., Invertebrate Zoology, S. C. Chand, New Delhi.
- Jordan E. L. and P. S. Verma, Chordate Zoology, S. Chand and Company New Delhi.
- Kotpal R.L (1991), Zoology phylum Annelida, Rastogi publication. Meerut.
- Kotpal R.L. (2016), Modern text book Vertebrate zoology. Fourth edition. Rastogi Publication, Meerut
- Lal S.S. (1996), Textbook of Practical Zoology Invertebrates, Rastogi Publications.
- Lal S. S. (1996), Textbook of Practical Zoology Vertebrates, Rastogi Publications. Prasad S. N., Life of Invertebrates.
- Young, J. Z. (2004), The Life of Vertebrates. III Edition. Oxford university press.
- Gilbert, S. F. (2006), Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008), An introduction to Embryology, International Thomson Computer Press.
- Carlson, Bruce M (1996), Patten's Foundations of Embryology, McGraw Hill, Inc.
- Dr. P S Verma & Dr. V K Agarwal (2010), Chordate Embryology, S. Chand Publication.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-368: Practical course Based on ZOO-363 and 364

Total Hours: 60 **Credits: 2**

Course objectives:

- To study the analyses of biomolecule for various perspectives of applied
- To acquire knowledge in the quantitative and qualitative estimation of biomolecules
- To study the influence and role of structure in reactivity of biomolecules.
- To prepare the whole mounts microscopic slides and staining reactions.
- To introduce different techniques of micro technique
- To introduce different instrument used in micro technique -Microtome, Camera Lucida and micrometer scale

Course outcomes:

Students will be able to:

- Analyze and evaluation of biochemical experimental techniques
- Understand the use and application of basic equipment in the laboratory.
- Understand the quantitative and qualitative estimation of biomolecules
- Cell tissue structure, histology of tissues and details of morphology of animals. Job opportunities in Health institutes, Hospitals and Pathological labs.
- Understand applications and scope of Microtechnique

Sr. No.	Topic Particular	Hours
	Biochemistry	
1	Study of analytical instrument (Principle and uses) of pH meter, Colorimeter, Spectrophotometer, Incubator, Electrophoresis and Centrifuge (D)	04
2	Preparation of Solutions of given percentage, normality, molarity and Buffer solution (E)	04
3	Isolation of starch from potato (E)	04
4	Isolation of casein from milk by isoelectric precipitation (E)	04
5	Qualitative Test for Fat (E)	04
6	Detection of amino acids by ascending or circular paper chromatography (E)	04
	Microtechnique	
7	Preparation of permanent whole mounts of different kinds 5 slides. (E)	04
8	Preparation of permanent slides of histological sections from different tissues-5 slides (From any Vertebrate animal). (E)	04
9	Study of Rotary and Rocking microtome. (D)	04
10	Vital staining of mitochondria by Janus green B stain. (D)	04
11	Calibration of micrometer scale of cell diameter from the given permanent slide. (E)	04
12	Sketching by camera Lucida. (E)	04
13	Submission of permanent slide (5 Whole mounts and 5 histological sections). (E)	04

References:

- Thimmaiah S. K. (1999), Standard Methods of Biochemical Analysis, Kalyani Publication.
- Plummer, T. (2017), An Introduction to Practical Biochemistry, McGraw Hill Education; 3rd edition Publication
- J. Jayaraman (2011), Laboratory Manual of Biochemistry by New International Publication.
- S. Sadasivam (2018), Biochemical Methods by New Age International Pvt Ltd Publishers; Third edition
- Weesner., F.M. (1968), General zoological microtechniques. Maryland, U.S.A.: The Williams & Wilkins Company
- Mr. Jeremy Sanderson (1994) Biological Microtechnique by Garland Science publishers: First edition
- Baker F.I and R.E Silverton,(2008) Introduction to Medical Laboratory Technique.
- R.Marimuthu(2011) Microscopy and Microtechnique published by M> J. P. Publication.
- Vonnie D.C. Sheild and Thomas Heinbokel (2019) Introductory Chapter:Histological Microtechnique.
- Peter Gray (1952) Basic Microtechnique published by The blakiston company,toronto.
- Dr. M. K. Prasad (2000) Outlines of Microtechnique published by Emkay.
- Brian Bracegirdle (1978) A History of Mirotechnique published by Heinemann Educational books Ltd.
- Richard W. Horobin (1982) Histochemistry published by Butterworth Heinemann Educational books Ltd.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

T.Y. B.Sc. (Zoology): Semester VI
Discipline Specific Core (DSC) Course
ZOO-369: Practical course Based on ZOO-365 and 366
(Animal Physiology and (A) Research Methodology OR (B) Aquatic Biology)

Total Hours: 60 **Credits: 2**

Course objectives:
- To study tissues, digestive, respiratory, excretory, cardiovascular, reproductive and nervous system.
- To elaborate Data Processing and Data Analysis
- To write dissertations, project proposals, project reports, research papers.
- To study the basic functioning of aquatic ecosystems.
- To study about the biological organisms that exist in aquatic biomes

Course outcomes:
Students will be able to:
- Understand how changes in one system may impact a different system
- Organize and conduct research project in a more appropriate manner.
- Write dissertations, project proposals, project reports, research papers.
- Understand the importance of aquatic biomes.
- Understand physico-chemical analysis technique of water.

Sr. No.	Topic Particular	Hours
	Animal Physiology	
1	Study of digestion of starch by salivary amylase (E).	04
2	Measurement of blood pressure and heart beat under normal and stress condition (E).	04
3	To determine R.Q. of any suitable animal (E).	04
4	Detection of Normal constituents of urine (Urea, Uric acid, Ammonia and Creatine) and abnormal constituents of urine (Glucose, Ketone bodies, Bile salts, protein) (E).	04
5	Study of Rigor Mortis and Study of Neuromuscular Junction (D).	04
6	Demonstration of stages of oestrous and menstrual cycle with the help of slides/pictures (D).	04
7	Study of endocrine glands of dissected rat with the help of chart or model (D).	04
8	Prepare a model of any one systems of human (Activity based practical)	04
	(A) Research Methodology	
9	Compute the mean, median and mode for the given data (design problem separately) (E).	04
10	Calculate the simple and complete frequency distribution for the given data (design problem separately) (E).	04
11	Compute the S.D. and S.E. for the given data (design problem separately) (E).	04

12	Draw a Pie chart by plotting an area of circle showing the given data (design separately). Draw Bar diagram for the given data (design problem separately). and Draw histogram for the given data (design separately) (E).	04
13	Set the problem on Large sample test [on chi square test] (E).	04
14	Set the problem on Small sample test [Student's 't' test] (E).	04
15	Prepare a mini review article (Activity based practical)	04
	OR (B) Aquatic Biology	
9	Determine the area of a lake using graphimetric and gravimetric method.	04
10	Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.	04
11	Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake / water body.	04
12	Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.	04
13	A Project Report on a visit to a Sewage treatment plant/Marine bioreserve/ Fisheries Institutes.	04

References:

- W.S. Hoar. (1975), General and Comparative Physiology, Prentice Hall; 2nd Revised edition.
- C. L. Prosser & Brown. (1991), Comparative Animal Physiology, Wiley-Liss; Part A edition.
- H. Davson. (1978), Introduction to Physiology- (I&II), Academic Press.
- P. S. Verma, V. K. Agarwal and B. N. Tyagi (2015), Animal Physiology, S. Chand Publications, new Delhi.
- Mohan Arora (2018), Animal physiology, Himalaya Publishing House Pvt. Ltd., Mumbai.
- Anthony, M, Graziano, A.M. and Raulin, M.L. (2009), Research Methods: A Process of Inquiry, Allyn and Bacon.
- Coley, S. M. and Scheinberg, C. A. (1990), "Proposal writing". Stage Publications.
- Gurumani, N. (2009), Research methodology for biological science, MJP publisher, Chennai.
- Kothari C. R. (2009), Research Methodology, New Age International
- Robert A. Day. (1924), How to write and publish a Scientific papers (4th edition),
- Wadhera, B. L. (2002), Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, Universal Law publishing
- Walliman, N. (2011), Research Methods - The Basics. Taylor and Francis, London, New York.

Methods of Teaching:

- Laboratory method, Lecture cum demonstration methods

Skill acquired and Job prospects for the Zoology students

Zoology in simple terms means Animal Biology. Zoology deals with the study of animal kingdom specially the structural diversity, biology, embryology, evolution, habits and distribution of animals, both living and extinct. As it covers a fascinating range of topics, the modern zoologists need to have insight into many disciplines. Zoologists may be involved in research, animal management, or education. Zoologists may specialize in a branch of the field that is concerned with a related group of animals, such as mammalogy (mammals), herpetology (reptiles), ichthyology (fish), or ornithology (birds), After successful completion of three-year degree course in Zoology, student will be well versed with laboratory skills and transferable skills.

- **Laboratory Skills:**

- Work safely and effectively in the field, in laboratories and in animal facilities
- Skill in observing and to some extent in analyzing various Biological Data
- Learn basic laboratory and analytical skills with interpretation of results
- Use appropriate information with a critical understanding
- Participate in animal management programmes in an effective manner as collection, organization and presentation of data
- Skillful handling of basic and advance instruments
- Imparts conceptual knowledge of general taxonomic rules on animal classification

- **Transferable Skills:**

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas which include;

- Analytical skill, Observational skill
- Good oral and written communication abilities
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, problem solving
- Report writing skill, presentation skill
- Work safely with animal handling skill

- **Job Opportunities:**

After successful completion of B.Sc., M.Sc., and Ph.D. in Zoology they may get opportunities in the public and private sectors. Candidates find jobs as Animal Behaviourist, Conservationist, Wildlife Biologist, Zoo Curator, Wildlife Educator, Zoology faculty, Forensic experts, lab technicians, Veterinarians and make career in research field also. Students have opportunity to get employment opportunity in government and private sector organizations.

- **Private Sector:**

Zoologist can work as Analyst in Manufacturing (SQC unit), Quality control, quality assurance and various Biotech companies like Pharmaceutical Industries, Chemical manufacturing companies, Health and Beauty care products, Agricultural companies, Research companies, and Laboratories as Lab Technician, Zoo curator, Animal breeders, Animal caretakers, Animal trainers, Medical Representative, Nutrition Specialist, Documentary Sales and Animal wildlife educator, Fisheries and Aquaculture Sectors.

- **Public Sectors:**

Various Public Sectors like Zoo outreach organization, Blood bank services, Paramedical Services, Research Institutes, Environmental Pollution Control, Forensic Science, Technician in Malaria office, Fisheries and Aquaculture Centers, Public Health Entities, Agriculture etc.

- **Job profiles:**

Zoologisthas a lot of career opportunities with good job scope Like Biologist, Teacher, Professor, Scientists, Staff Selection Commission always comes with lots of job vacancies, In Bank as Clerk or bank PO, Civil Servicesas IPS, IAS, IFS, IRS, Indian forest services, and wildlife trust of India, Wildlife protection society of India, Kerala Agricultural University, Indian tiger welfare society, Central Institute of fisheries technology, Bombay natural history society, Zoo outreach organization, Wildlife Trust of India, Central Zoo Authority, Wildlife information development center, Center for science and environment CSE, and Regional resource center of ministry environment and forest.

- **Opportunities in higher studies:**

After successful completion of B.Sc. in Zoology, student may continue further studies like M.Sc. in Zoology/ Animal Physiology/ Genetics / Entomology/ Reproductive Biology/ Helminthology / Fishery Science/ Aquaculture/ Biotechnology etc. and pursue higher studies. Even students can pursue other courses where graduation is essential.