



SOPHIA COLLEGE, (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Zoology

Programme Code: SBSZOO

S.Y.B.Sc. Zoology

(Choice Based Credit System with effect from the year 2022-23)

Programme Outline: SYBSc Zoology (SEMESTER III)

Course Code	Unit No	Name of the Unit	Credits
		CLASSIFICATION OF CHORDATES & DEVELOPMENTAL BIOLOGY	2
SBSZOO301	1	Classification of Chordates	
	2	Human Reproduction	
	3	Developmental Biology	
SBSZOO302		CELL BIOLOGY & GENETICS	2
	1	Cell Biology	
	2	Genetics	
	3	Nucleic Acids and Chromosomes	
SBSZOO303		RESEARCH METHODOLOGY & APPLIED ZOOLOGY - I	2
	1	Research Methodology	
	2	Parasitology	
	3	Pollution	
SBSZOO3		Practical I	3
		Practical II	
		Practical III	

Programme Outline: SYBSc Zoology (SEMESTER IV)

Course Code	Unit No	Name of the Unit	Credits
		LIFE PROCESSES	
SBSZOO401	1	Nutrition & Excretion	2
	2	Respiration & Circulation	
	3	Locomotion & Control and Coordination	
SBSZOO402		BIOCHEMISTRY & HISTOLOGY	2
	1	Enzymology	
	2	Molecular biology	
	3	Histology	
SBSZOO403		APPLIED ZOOLOGY - II	2
	1	Economic Entomology	

	2	Fisheries	
	3	Dairy Science	
SBSZOO4		Practical I	3
		Practical II	
		Practical III	

Preamble:

This syllabus of Zoology Program offered by Sophia College for Women, Mumbai has been designed under the autonomous status conferred in the academic year 2018-2019.

The syllabus tries to encompass fundamental as well as applied areas such as taxonomy, developmental biology, genetics, physiology, evolution, ecology, biochemistry, as well as applied biology disciplines like biotechnology, bioinformatics, forensic science, and many others. The syllabus is planned such that the learners who are beginning their academic journey opting for the subject of Zoology will be equipped with not only with the basic knowledge of the animal world but also the recent trends in the subject.

Learning of the subject would involve various innovative pedagogies such as experiential learning, problem-based learning, collaborative learning in addition to the traditional mode of learning. Besides sensitizing the learners towards environment and sustainability, the subject also offers career opportunities in a variety of fields such as conservation, research, education, and animal management.

PROGRAMME OBJECTIVES

PO 1	<i>To provide a holistic knowledge about animal biology such as taxonomy, comparative anatomy and physiology, behaviour, ecology and evolution.</i>
PO 2	<i>To develop experimental and research-oriented skills for future career in academia</i>
PO 3	<i>To gain field-based knowledge through experiential learning</i>
PO 4	<i>To get acquainted with the applied areas of zoology to promote employability and entrepreneurship</i>
PO 5	<i>To encourage understanding about the importance of biodiversity conservation, the threats facing ecosystems and the conservation measures used to preserve wildlife.</i>

PROGRAMME SPECIFIC OUTCOMES

PSO 1	<i>Apply the field-based and the in-class knowledge of animal biology to identify and classify the animals in their natural habitat upto class level</i>
PSO 2	<i>Identify the various types of animal behaviour, and animal interactions with the ecosystem</i>
PSO 3	<i>Conduct basic research that involves application of critical thinking and experimental skills</i>
PSO 4	<i>Get career opportunities in a variety of fields such as conservation, research, education, and animal management</i>

SEMESTER 3

NAME OF THE COURSE	CLASSIFICATION OF CHORDATES AND DEVELOPMENTAL BIOLOGY	
CLASS	FYBSC Zoology	
COURSE CODE	SBSZOO301	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To understand the classification of Chordata through the general characteristics of sub- phyla and classes and specific characters of the respective organisms.
CO 2.	To introduce the concepts of human reproductive system and its hormonal control
CO 3.	To gain knowledge about infertility and assisted reproductive techniques
CO 4.	To introduce various processes embryonic developmental

COURSE LEARNING OUTCOMES:

CLO 1.	The learners will be able to classify chordates
CLO 2.	They will be able to relate between the sub-phyla and their classes
CLO 3.	Learner would relate the complexity of the human reproductive system and its hormonal control
CLO 4.	Learner would be able to evaluate the importance of various methods of birth control and assisted reproductive techniques
CLO 5.	Learner would be able to compare the different processes of development in various animals

UNIT 1	Chordate Classification (15 LECTURES)
1.1	Phylum Hemichordata - Balanoglossus
1.2	Phylum Chordata 1.2.1 Subphylum Urochordata 1.2.2 Subphylum Cephalochordata 1.2.3 Subphylum Vertebrata
1.3	Superclass Agnatha – Class Cyclostomata
1.4	Superclass Gnathostomata 1.4.1 Class Pisces 1.4.2 Class Amphibia 1.4.3 Class Reptilia 1.4.4 Class Aves 1.4.5 Class Mammalia
UNIT 2	Human Reproduction (15 LECTURES)
2.1	Unit: 2 Human Reproduction (15 Lectures) 2.1 Human reproductive system and hormonal regulation 2.1.1 Anatomy of human male and female reproductive system 2.1.2 Hormonal regulation of reproduction and impact of age on reproduction 2.1.3 Menopause and andropause

2.2	<p>2.2 Contraception & birth control</p> <p>2.2.1 Difference between contraception and birth control</p> <p>2.2.2 Natural Methods: Abstinence, rhythm method, temperature method, cervical mucus or Billings method, coitus interruptus, lactation amenorrhea</p> <p>2.2.3 Artificial methods: Barrier methods, hormonal methods, intrauterine contraceptives, sterilization, termination, abortion</p>
2.3	<p>2.3 Female infertility</p> <p>2.3.1 Causes - Failure to ovulate; production of infertile eggs; damage to oviducts (oviduct scarring and Pelvic inflammatory disease –PID, TB of oviduct), Uterus (TB of uterus and cervix)</p> <p>2.3.2 Infertility associated disorders - Endometriosis, Polycystic Ovarian Syndrome (PCOS), Primary ovarian failure (POF), Sexually Transmitted Infections (STIs) – gonorrhoea, chlamydia, syphilis and genital herpes; Antibodies to sperm; Genetic causes- recurrent abortions</p>
2.4	<p>2.4 Male infertility</p> <p>Causes – Testicular failure, Infection of epididymis, seminal vesicles or prostate, Hypogonadism, Cryptorchidism, Congenital abnormalities, Variocoele, Blockage, Azoospermia, Oligozoospermia, Teratozoospermia, Asthenozoospermia, Autoimmunity, Ejaculatory disorders, Idiopathic infertility.</p>
2.5	2.5 Role of endocrine disruptors in male and female infertility.
2.6	<p>2.6 Treatment of infertility</p> <p>2.6.1 Removal /reduction of causative environmental factors</p> <p>2.6.2 Surgical treatment</p> <p>2.6.3 Hormonal treatment- fertility drugs</p> <p>2.6.4 Assisted Reproductive Technology (ART) –In vitro fertilization (IVF); Embryo transfer (ET); Intra-Fallopian transfer (IFT), Gamete Intra-Fallopian Transfer (GIFT) & Intra-Zygote Transfer (ZIFT); Intra-cytoplasmic Sperm Injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsy; Testicular sperm extraction (TESE).</p> <p>2.6.5 Sperm bank, cryopreservation of gametes and embryos</p> <p>2.6.6 Surrogacy</p>
UNIT 3	Developmental Biology (15 LECTURES)
3.1	Types of Eggs - Based on amount and distribution of yolk
3.2	Structure and Types of Sperm
3.3	Types of Cleavage
3.4	Types of Blastula

3.5	Types of Gastrula
3.6	Coelom -Formation and types

REFERENCES:

1. Chordate Zoology - E. L. Jordan and P.S. Verma. 14th Revised Edition, 2013. S. Chand and Co. Ltd.
2. Chordate Zoology - P. S. Dhama and J. K. Dhama, Reprint Edition, 1991. R. Chand and Co.
3. Zoology- S. A. Miller and J. B. Harley, 8th Edition, 2009. Tata McGraw Hill
4. Modern Textbook of Zoology : Vertebrates - R. L. Kotpal. 2010. Global Media Publications
5. A Textbook of Zoology, Vol. II- T. J. Parker and W. A. Haswell-Low Price Indian Edition. 1991. CBS Publications and Distributors Pvt. Ltd.
6. Developmental Biology- 5th Edition, Scot F. Gilbert, Sinauer Associates Inc.
7. Essential Reproduction-Martin H. Johnson, Wiley-Blackwell Publication.
8. Embryology- Mohan P. Arora and Himanshu Arora. 2017. Himalaya Publishing House.
9. Human Anatomy and Physiology. E. L. Marieb, Pearson Education Low Price Edition
10. The Physiology of Reproduction Vol I & II - E. K . Nobil and JU. D. Neil, Raven Press, New York.

NAME OF THE COURSE	CELL BIOLOGY AND GENETICS	
CLASS	FYBSC Zoology	
COURSE CODE	SBSZOO302	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To understand the cellular organization and the role played by various cell organelles
CO 2.	To introduce the concepts of sex determination, sex linkage, and multiple alleles and multiple genes
CO 3.	To gain knowledge about concept of linkage and crossing over
CO 4.	Learner will understand the composition and importance of nucleic acids as genetic material
CO 5.	Learner would acquire the knowledge about the structure and types of chromosomes

COURSE LEARNING OUTCOMES:

CLO 1.	Learner would be able to explain the ultrastructure and functions of various cell organelles
CLO 2.	Learner would be able to evaluate the importance of linkage and crossing over during gamete formation
CLO 3.	Learner would demonstrate the understanding of various inheritance patterns through examples
CLO 4.	Learner will be able to recall the classical experiments proving DNA & RNA as the genetic material.
CLO 5.	Learners will be able to illustrate the structure of nucleic acids and chromosomes

UNIT 1	Cell Biology (15 LECTURES)
1.1	Introduction to cell biology
	1.1.1 Definition and scope
	1.1.2 Cell theory

	1.1.3 Generalized prokaryotic, eukaryotic cell: size, shape and structure
1.2	Nucleus Ultrastructure and functions of interphase nucleus
1.3	1.3 Plasma membrane 1.3.1 Ultrastructure (Fluid Mosaic Model) and functions 1.3.2 Junctional complexes 1.3.3 Membrane receptors 1.3.4 Transport across plasma membrane: Passive and Active Transport: Diffusion and Osmosis, Endocytosis and Exocytosis
1.4	Endoplasmic reticulum (ER) 1.4.1 General morphology of endomembrane system, ultrastructure and types of ER 1.4.2 Functions of Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER)
1.5	Golgi complex: Ultrastructure of Golgi complex, functions of Golgi complex
1.6	Lysosomes: Origin, occurrence, polymorphism and functions
1.7	Peroxisomes: Origin, morphology & functions
1.8	Mitochondria: Ultrastructure, chemical composition and functions of Mitochondria
UNIT 2	Genetics (15 LECTURES)
2.1	Sex- determination 2.1.1 Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW 2.1.2 Sex determination in Honey bees- Haplodiploidy 2.1.3 Sex determination in Drosophila-Genic balance theory, Intersex, Gynandromorphs 2.1.4 Parthenogenesis 2.1.5 Hormonal influence on sex determination-Freemartin and Sex reversal.

	2.1.6 Role of environmental factors- Bonelia and Crocodile 2.1.7 Barr bodies and Lyon hypothesis
2.2	2.2 Sex linked, sex influenced and sex-limited inheritance. 2.2.1 X-linked: Drosophila, Colour-blindness, Haemophilia 2.2.2 Y-linked: Hypertrichosis 2.2.3 Sex-influenced genes 2.2.4 Sex-limited genes
2.3	2.3 Multiple Alleles and Multiple Genes 2.3.1 Concept of Multiple Alleles, Coat colour in rabbit, ABO and Rh blood group system, Bombay blood group 2.3.2 Polygenic inheritance with reference to skin colour and eye colour in humans. 2.3.3 Concept of Pleiotropy
2.4	2.4 Linkage and Crossing Over 2.4.1 Linkage and crossing over, Types of crossing over, Cytological basis of crossing over.
UNIT 3	Nucleic Acids and Chromosomes (15 LECTURES)
3.1	Genetic material 3.1.1 Griffith's transformation experiments, Avery-Macleod and McCarty, Hershey Chase experiment of Bacteriophage infection 3.1.2 Chemical composition and structure of nucleic acids 3.1.3 Double helix nature of DNA, Solenoid model of DNA 3.1.4 Types of DNA – A, B, Z & H forms 3.1.5 DNA in Prokaryotes -Chromosomal and Plasmid 3.1.6 Extra nuclear DNA -Mitochondria and Chloroplast 3.1.7 RNA as a genetic material in viruses 3.1.8 Types of RNA: Structure and function
3.2	3.2 Chromosomes 3.2.1 Types of Chromosomes–Autosomes and Sex chromosomes 3.2.2 Chromosome structure - Heterochromatin, Euchromatin 3.2.3 Classification based on the position of centromere 3.2.4 Endomitosis, Giant chromosomes- Polytene and Lampbrush chromosomes and Significance of Balbiani rings

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1. Cell Biology, Singh and Tomar, Rastogi Publication.
2. Cell and Molecular Biology, E.D.P De Robertis and E.M.R Robertis, CBS Publishers and Distributors.
3. The cell, A molecular approach, Geoffrey M. Coper ASM Press Washington D.C.

4. A textbook of cytology Suruchi Tyagi Dominant Publishers and Distributors New Delhi.
5. Cell and molecular biology, Gupta P. K., Rastogi Publication, India.
6. Cell Biology, Pawar C.B. Himalaya publication
7. Principles of Genetics. Gardner, E. J., Simmons, M.J and Snustad, D.P. John Wiley and Sons
8. Genetics- A Molecular Approach. Russell, P. J Benjamin Cummings
9. Genetics: Analysis of Genes and Genomes. Daniel L., Hartl, Elizabeth W. Jones Jones & Bartlett Publishers
10. Introduction to Genetic Analysis. Griffiths, A. J. F., Wessler. S.R., Lewontin, R.C. and Carroll, S. B. W. H. Freeman and Co
11. Cell Biology Genetics, Molecular Biology Evolution and Ecology Verma P. S. and Agrawal P.K., 9th edition, S. Chand Publication, New Delhi
12. Genetics- Weaver, Hedrick, third edition, McGraw Hill Education
13. Genetics A Mendelian approach Peter J. Russel, Pearson Benjamin Cummings
14. Genetics A conceptual approach, Benjamin A. Pierce, Southwestern University, W.H. Freeman and company, New York
15. Genetics, Third Edition, Monroe W. Strickberger
16. Genetics from gene to genome, third edition, Leeland H. Hartwell, Leeroy Hood, Michael L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education

NAME OF THE COURSE	RESEARCH METHODOLOGY AND APPLIED ZOOLOGY- I	
CLASS	FYBSC Zoology	
COURSE CODE	SBSZOO303	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To understand the concept of Scientific Research Methodology
CO 2.	To gain knowledge about the elements of research methodology
CO 3.	To understand the ethical guidelines pertaining to research and publication
CO 4.	To introduce the learner to life cycle, pathogenicity, control measures and treatment of different parasites
CO 5.	To make the learners aware of the different types of pollution, its impact on nature and abatement measures

COURSE LEARNING OUTCOMES:

CLO 1.	Understand the difference between research methods and research methodology
CLO 2.	Relate between the research and publication ethics
CLO 3.	Relate the host-parasite relationships through the study of different parasites
CLO 4.	Evaluate the adverse effects of pollution, its impact on biodiversity and control measures.

UNIT 1	Research Methodology (15 LECTURES)
1.1	<p>Process of science</p> <p>1.1.1 A dynamic approach to investigation: The Scientific method, Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery(serendipity)</p> <p>1.1.2 Scientific research: Definition, difference between method and methodology, characteristics, types</p> <p>1.1.3 Steps in the Scientific method: Identification of research problem, formulation of research hypothesis, testing the hypothesis using experiments or surveys, preparing research/study design including methodology and execution (appropriate controls, sample size, technically sound, free from bias, repeat experiments for consistency), documentation of data, data analysis and interpretation, results and conclusions</p> <p>1.1.4 Dissemination of data: Reporting results to scientific community (publication in peer- reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation)</p> <p>1.1.5 Application of knowledge: Basic research, Applied and Translational research</p>
1.2	<p>1.2 Scientific writing</p> <p>1.2.1 Structure and components of a research paper: preparation of manuscript for publication of research paper- title, authors and their affiliations, abstract, keywords and abbreviations, introduction, material and methods, results, discussion, conclusions, acknowledgement, bibliography; figures, tables and their legends</p> <p>1.2.2: Peer reviewed and Indexed journals, Citation index and Role of citations, impact factor of a journal</p>
1.3	<p>1.3 Writing a review paper</p> <p>1.3.1 Structure and components of review paper</p> <p>1.3.2 Report writing and types of report</p>

	<p>1.3.3 Computer application: Plotting of graphs, Statistical analysis of data.</p> <p>1.3.4 Internet and its application in research-Literature survey, online submission of manuscript for publication</p>
1.4	<p>1.4 Ethics</p> <p>1.4.1 Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Dissection Monitoring Committee (DMC), CPCSEA and IAEC</p> <p>12</p> <p>1.4.2 Ethics in clinical research: Approval from clinical research ethics committee or/and informed consent</p>
1.5	1.5 Plagiarism and Conflict of interest
UNIT 2	Parasitology (15 LECTURES)
2.1	<p>Introduction to Parasitology and Types of Parasites</p> <p>2.1.1 Definitions: Parasitism, Host, Parasite, Vector-biological and mechanical</p> <p>2.1.2 Types of parasite: Ectoparasite, Endoparasite and their subtypes</p> <p>2.1.3 Parasitic adaptations in Ectoparasites and Endoparasites</p> <p>2.1.4 Types of host: Intermediate and definitive, reservoir</p>
2.2	<p>Host-parasite relationship and host specificity</p> <p>2.2.1 Different types of host – parasite relationships, structural specificity, physiological specificity and ecological specificity</p>
2.3	<p>Life cycle, pathogenicity, control measures and treatment</p> <p>2.3.1 Entamoeba histolytica</p> <p>2.3.2 Fasciola hepatica</p> <p>2.3.3 Taenia solium</p> <p>2.3.4 Wuchereria bancrofti</p>
2.4	<p>Morphology, life cycle, pathogenicity, control measures and treatment</p> <p>2.4.1 Head louse (Pediculus humanus capittis)</p> <p>2.4.2. Tick (Ixora)</p> <p>2.4.3 Bed bug (Cimex lectularis)</p>
2.5	<p>Zoonosis</p> <p>Bird flu, Anthrax, Rabies, Toxoplasmosis, outbreaks of Nipah Virus and nCovid-19</p>
UNIT 3	Pollution and its effect on organisms (15 LECTURES)

3.1	Air Pollution 3.1.1: Types and sources of air pollutant 3.1.2: Effects of air pollution on organisms, its control and abatement measures
3.2	Water Pollution 3.2.1: Types and sources of water pollutant 3.2.2: Effects of water pollution on organisms, biomagnification, its control and abatement measures
3.3	Soil Pollution 3.3.1: Types and sources of soil pollutant 3.3.2: Effects of soil pollution on organisms, biomagnification, its control and abatement measures
3.4	Sound pollution 3.4.1: Different sources of sound pollution 3.4.2: Effects of sound pollution on organisms, its control and abatement measures
3.5	Pollution by radioactive substances
3.6	Pollution by solid wastes with stress on plastic pollution 3.6.1: Types and sources 3.6.2; Effects of solid waste pollution, its control and abatement measures
3.7	Pollution leading to Climate Change and Global Warming

REFERENCES:

1. Research Methodology, Methods and Techniques- by C.R. Kothari, 2nd Edition, 2004, New Age International (P) Ltd. Publishers.
2. Practical research planning and design. 2nd edition, 1980- Paul D Leedy, Macmilan Publication
3. Parasitology- Chatterjee K. D., Chatterjee Medical Publishers.
4. Textbook of Medical Parasitology-.C.K Jayaram Paniker, Jaypee Brothers.
5. Principles and Practices of Air Pollution Control and Analysis J. R. Mudakani I K International Pub. House Pvt. Ltd.
6. Text Book of Air Pollution and its Control, S. C. Bhatia Atlantic
7. Water Pollution, Kudesia V. P., Pragati Prakasan, Meerut
8. A text book of Environmental Chemistry and Pollution Control, S. S. Dogra, Swastic Pub,
9. New Delhi
10. Practical Methods for water and Air Pollution Monitoring, S. K. Bhargava, New Age International
11. Hand Book of Water and waste water Analysis, Kanwaljit Kaur, Atlantic
12. Aquatic Pollution by Edward A. Laws
13. Environmental Science and Technology, Stanely E. Manahan
14. Environmental Chemistry, A. K. De, New Age International
15. A Text Book of Environmental Studies, Gurdeep R.Chatwal, Harish Sharma, Madhu Arora

PRACTICAL COURSE SBSZOOP3

PRACTICAL I

1. Chordate classification
 - 1.1 Hemichordata : *Balanoglossus*
 - 1.2 Urochordata : *Herdmania*
 - 1.3 Cephalochordata : *Amphioxus*
 - 1.4 Cyclostomata: *Petromyzon*
 - 1.5 Pisces : Chondrichthyes: Shark, skate, sting ray/
electric ray Osteichthyes : *Sciaena*, flying fish, Puffer fish
(poisonous)
 - 1.6 Amphibia :Frog, toad, caecilian, salamander
 - 1.7 Reptilia : Chameleon, *Calotes*, turtle, tortoise, venomous (Krait, Russell's Viper, Saw-scaled Viper, Cobra and King Cobra) and non-venomous (Python, Rat snake) snakes, alligator/crocodile
 - 1.8 Aves : Kite, kingfisher, duck
 - 1.9 Mammalia : Shrew, hedgehog, guinea pig, bat
2. Detection of pregnancy from given sample of urine
3. Study of birth control measures applicable to humans – IUD, condom and hormonal pills.
4. Study of the following permanent slides, museum specimens and materials
 - 4.1 Mammalian sperm and ovum
 - 4.2 Types of egg –fish, frog and hen
 - 4.3 Cleavage, blastula and gastrula (Amphioxus, Frog and Bird)
5. Study of development of zebrafish embryo upto 72 hours (only observation without disturbing larvae)
6. Study of development of chick embryo upto 72 hours
7. Study trip to observe flora and fauna and submission of its report

PRACTICAL II

1. Study of permeability of cell through plasma membrane (osmosis in blood cells)
2. Measurement of cell diameter by occulometer (by using permanent slide)

3. Ultrastructure of cell organelles (Electron micrographs) of:
 - 3.1 Nucleus
 - 3.2 Endoplasmic reticulum (Smooth and Rough)
 - 3.3 Mitochondria.
 - 3.4 Golgi apparatus
 - 3.5 Lysosomes
4. Study of Barr body from buccal epithelium cells.
5. Study of polytene chromosome
6. Study of mitosis- temporary squash preparation of Onion root tip
7. Chromosome morphology: (photograph to be provided)
8. Detection of blood groups and Rh factor
9. Problems in Genetics
 - a) X- linked inheritance
 - b) Multiple Alleles
10. Extraction and detection of DNA
11. Extraction and detection of RNA

PRACTICAL III

1. Review writing based on programmes telecast by Doordarshan, Gyandarshan, UGC programmes or other media sources
2. Bibliography/ Abstract writing
3. Preparation of Power Point Presentation based on research paper.
4. Study of endoparasites: *Entamoeba histolytica*, *Fasciola hepatica*, *Taenia solium*, *Wuchereria bancrofti*
5. Study of ectoparasites: Head louse (*Pediculus humanus capittis*), Tick (*Ixodes* sp.), Bed bug (*Cimex lectularis*)
6. Parasitic adaptations: Scolex and mature proglottids of Tapeworm
7. Zoonosis - Bird flu, Anthrax, Rabies, Toxoplasmosis, Nipah virus disease, nCovid-19
8. Study of air microflora
9. Estimation of dissolved oxygen from the given water sample
10. Estimation of conductivity by conductometer from the given water sample
11. Study of physical properties of soil: moisture and texture

12.Study of chemical properties of soil: pH, organic matter

13.Study of sound pollution monitoring device

ASSESSMENT DETAILS:(This will be same for all the theory papers)

Maximum Marks allotted for each theory course per semester: 100 marks

- a) Internal assessment of 50 marks per course per semester shall be conducted
- b) Semester End Examination – External Assessment (50 marks)

Practical Assessment (for papers with practicals)

Maximum Marks allotted for the entire practical course per semester: 150 marks which will be distributed into the following two examination sessions and conducted as per the given question paper pattern:

- (a) Practical I examination of fifty (50) marks shall be conducted at the end of every semester.
- (b) Practical II examination of fifty (50) marks shall be conducted at the end of every semester.
- (c) Practical II examination of fifty (50) marks shall be conducted at the end of every semester.

- The duration of the practical exam will be two and a half hours.
- The students are allowed to write the paper if the attendance for practicals is more than 75%
- To appear in the practical exam, students must bring a properly certified journal.

PAPER PATTERN OF INTERNAL ASSESSMENT SBSZOO301, SBSZOO302 and SBSZOO303

**All Questions are compulsory
Figures to the right indicate full marks**

Time: 50 minutes

Total marks: 25

Q.1.	*Objective type questions	10 marks
Q.2.	Answer in one sentence OR Define the following	05 marks
Q.3.	Answer any two out of three (05 marks each)	10 marks

PAPER PATTERN OF THEORY EXTERNAL ASSESSMENT
SBSZOO301, SBSZOO302 and SBSZOO303

All Questions are compulsory
Figures to the right indicate full marks

Time: 2.5 hours

Total marks: 50

Q.1.	Based on UNIT 1 a. Answer any two out of four (10 marks) b. Answer any one out of two (04 marks each)	14 marks
Q.2.	Based on UNIT 2 a. Answer any two out of four (10 marks) b. Answer any one out of two (04 marks each)	14 marks
Q.3.	Based on UNIT 3 a. Answer any two out of four (10 marks) b. Answer any one out of two (04 marks each)	14 marks
Q.4.	Based on all three units Answer any two out of four (04 marks each)	08 marks

**PAPER PATTERN OF PRACTICAL EXAMINATION
SBSZOOP3**

PRACTICAL I EXAMINATION

Time: 2 hrs 30 min

Marks: 50

Major Question

10

Q.1 Observation of permanent slide of chick embryo and identify the stage of development

Minor Question

07

Q.2. Identify the stage of zebrafish development (photograph)

OR

Q.2. Comment on the pregnancy test given.

Q.3. Identification

18

Chordate classification (a, b and c)

Birth control measures (d)

Embryology slide (e and f)

Q.4. Report submission of study trip

05

Q.5. Viva voce based on practicals

05

Q.6. Certified Journal

05

PRACTICAL II EXAMINATION

Time: 2 hrs 30 min

Marks: 50

Major Question

13

Q.1 Extraction and detection of DNA

OR

Q.1. Extraction and detection of RNA

OR

Q.1. Study of osmosis in RBCs.

OR

Q.1. Study of mitosis-Temporary squash preparation of Onion root tip

Minor Question

08

Q.2 Study of Barr bodies / Study of Polytene chromosomes

OR

Q.2. Detection of blood groups and Rh factor

OR

Q.2. Measurement of cell diameter by occulometer using permanent slide

Q3. Problems based on Genetics (any two)

10

Q4. Identification:

09

Chromosome morphology (a)

Ultrastructure of cell organelles (b, c)

Q4. Viva voce based on practicals

05

Q5. Certified Journal

05

PRACTICAL III EXAMINATION

Time: 2 hrs 30 min

Marks: 50

Major Question

(12 marks)

Q.1 Estimation of dissolved oxygen from the given water sample.

OR

Q.1 Determination of organic matter from the given soil sample.

OR

Q.1 Estimation of conductivity by conductometer from the given water sample

OR

Q.1 Count the number of colonies on the given exposed culture plate and estimate the Microflora present in the total area.

Q.2 Determine the pH of the given soil sample. (7 marks)

OR

Q.2 Determine the texture of the given soil sample.

OR

Q.2 Determine the moisture content of the given soil sample.

Q.3. Identify and describe as per instructions (9 marks)

Endoparasite (a)

Ectoparasite (b)

Parasitic adaptation / zoonosis / sound pollution monitoring device
(c)

Q.4 From the given article, prepare the bibliography/
abstract (6 marks)

Q.5. Submission of Power Point presentation (6 marks)

Q.6 Viva voce based on practicals (5 marks)

Q.7 Certified Journal (5 marks)

SEMESTER IV

NAME OF THE COURSE	LIFE PROCESSES	
CLASS	SYBSC Zoology	
COURSE CODE	SBSZOO401	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To understand the concepts of physiology of nutrition, excretion and osmoregulation
CO 2.	To introduce the concepts of physiology of respiration and circulation
CO 3.	To gain knowledge about the mechanism of locomotion, control and coordination in different organisms

COURSE LEARNING OUTCOMES:

CLO 1.	Relate the increasing complexity of nutritional, excretory and osmoregulatory physiology in evolutionary hierarchy
CLO 2.	Compare various respiratory and circulatory organs in different classes of organisms
CLO 3.	Explain the mechanism of regulation of locomotion, control and coordination in various organisms

UNIT 1	Nutrition and Excretion (15 LECTURES)
1.1	Nutrition: 1.1.1: Comparative study of nutritional apparatus (structure and function): Amoeba, Hydra, Cockroach, Amphioxus, Pigeon and Ruminants. 1.1.2: Physiology of digestion in man.
1.2	Excretion and Osmoregulation: 1.2.1: Comparative study of excretory and osmoregulatory structures and functions. a) Amoeba - Contractile vacuoles b) Planaria - Flame cells c) Cockroach - Malpighian tubules 1.2.2: Categorization of animals based on principle nitrogenous excretory products 1.2.3: Structure of kidney, uriniferous tubule and physiology of urine formation in man
UNIT 2	Respiration and Circulation (15 LECTURES)
2.1	Respiration: 2.1.1: Comparative study of respiratory organs (structure and function): Earthworm, Spider, Any bony fish (Rohu/Anabas/ Clarius), Frog and Pigeon. 2.1.2: Structure of lungs and physiology of respiration in man
2.2	Circulation: 2.2.1: Comparative study of circulation: (a) Open and Closed type, (b) Single and Double type. 2.2.2: Types of circulating fluids- Water, Coelomic fluid, Haemolymph, Lymph and Composition of blood 2.2.3: Comparative study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon. 2.2.4: Structure and mechanism of working of heart in man.
UNIT 3	Locomotion and Control and coordination (15 LECTURES)
3.1	Control and coordination: 3.1.1: Irritability in Paramecium, nerve net in Hydra, nerve ring and nerve cord in earthworm. 3.1.2: Types of neurons based on the structure and function. 3.1.2: Conduction of nerve impulse: Resting potential, Action potential and Refractory period 3.1.3: Synaptic transmission 3.1.4: Neurotransmitters: Types of excitatory and inhibitory neurotransmitters and their functions (Acetylcholine, Epinephrine, Norepinephrine, Histamine, Glutamate, GABA, Serotonin, Dopamine)
3.2	Movement and Locomotion: 3.2.1: Locomotory organs - structure and functions of: a. Pseudopodia in Amoeba (Sol- Gel theory), Cilia in Paramecium b. legs in cockroach

	c. Tube feet in starfish d. Fins of fish e. Wings in birds 3.2.2: Structure of striated muscle fibre in human and sliding filament theory
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REFERENCES:

1. Vertebrate Zoology Volume I- Jordan and Verm , S. Chand and Co.
2. Invertebrate Zoology Volume II- Jordan and Verma , S. Chand and Co.
3. Invertebrate Zoology- Majupuria T. C., NaginS.and Co.
4. Chordate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
5. Invertebrate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
6. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition.
7. Zoology- Miller S. A. and Harley J. B., Tata McGraw Hill.
8. Modern Textbook of Zoology, Invertebrates, Kotpal R. L
9. Biological Science, Taylor D.J., Stout G.W., Green N.P.O, Soper R., Cambridge University Press.

NAME OF THE COURSE	BIOCHEMISTRY & HISTOLOGY	
CLASS	FYBSC Zoology	
COURSE CODE	SBSZOO402	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To understand the fundamental concepts of enzyme biochemistry and enzyme action
CO 2.	To gain knowledge about gene expression and regulation
CO 3.	To introduce the learner to histological structure of some of the endocrine and exocrine glands

COURSE LEARNING OUTCOMES:

CLO 1.	Classify the enzyme and compare their mode of action
CLO 2.	Apply the concept of central dogma to the molecular processes involved protein biosynthesis
CLO 3.	Recall the normal histology and interpret the histopathological changes in disease condition

UNIT 1	Enzymology (15 LECTURES)
1.1	Introduction and Nomenclature: Definition; nomenclature and classification (based on IUB – Enzyme Commission) of enzymes; chemical nature of enzyme, co-factors and coenzymes.
1.2	1.2. Enzyme Action: 1.2.1: Mechanism: Fischer's lock and Key Model, Koshland's induced fit model 1.2.2 Factors affecting enzyme activity –substrate, pH and temperature. 1.3 Enzyme Kinetics: Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of K_m , V_{max} 1.4 Enzyme Inhibition: Competitive, non-competitive and uncompetitive inhibitors and

	their kinetics; allosteric regulation.
UNIT 2	Molecular Biology (15 LECTURES)
2.1	DNA Replication in a prokaryotic and eukaryotic cell
2.2	2.2 Characteristics of Genetic code
	2.3 Transcription in a prokaryotic and eukaryotic cell
	2.4 Translation in a prokaryotic and eukaryotic cell
UNIT 3	Histology (15 LECTURES)
3.1	Liver: Normal histology and histopathological changes in hepatic toxicity
3.2	Kidney: Normal histology and histopathological changes in nephrotoxicity
3.3	Pancreas: Normal histology and histopathological changes in pancreatitis
3.4	Adrenal: Normal histology and histopathological changes in adrenopathy
3.5	Pituitary: Normal histology and histopathological changes in pituitary adenoma
3.6	Thyroid: Normal histology and histopathological changes in thyroid tumours

REFERENCES:

1. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M ,
2. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989, Freeman and Co. NY
3. Harper's Biochemistry, 1996, 26th edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA
4. Outline of Biochemistry, 1976, E.E. Conn and P.K. Stumpf. John Wiley and Sons USA
5. Biochemistry. U. Satyanarayan and U. Chkrapani. 4th Edition. 2013. Elsevier.
6. Bailey's Textbook of Histology, Frederick Randolph Bailey, Wilfred Monroe Copenhaver, Douglas E. Kelly, Richard Lyman Wood. 17th Edition. Williams & Wilkins, 1978
7. Wheater's Pathology : A Text, Atlas and Review of Histopathology by Geraldine O'Dowd, Sarah Bell, Sylvia Wright. 6th Edition. 2019. Churchill Livingstone.

NAME OF THE COURSE	APPLIED ZOOLOGY - II	
CLASS	FYBSC Zoology	
COURSE CODE	SBSZOO403	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To gain knowledge about the economic importance of Zoology
CO 2.	To impart knowledge about various types of Indian fisheries and its scope
CO 3.	To gain knowledge about different indigenous cattle breeds of India and scope of dairy industry

COURSE LEARNING OUTCOMES:

CLO 1.	Evaluate the importance various economically important process such as apiculture, sericulture and lac culture.
CLO 2.	Classify various types of insecticides and their mode of action
CLO 3.	Recall and evaluate the scope of fishery in India with respect to fishing techniques, fishery biology and fish products
CLO 4.	Classify various breeds of cattle and compare their milk production
CLO 5.	Relate the knowledge of dairy industry with its scope in the Indian

UNIT 1	Economic Entomology (15 LECTURES)
1.1	Honeybee – Social life and communication, life history, apiculture, pests, enemies, diseases, commercial importance
1.2	Lac insect – Life cycle, lac culture, composition and uses of lac
1.3	Silk moth – Life history, sericulture, Diseases and control measures ,economic importance
1.4	Life history and control measures of <i>Schistocerca gregaria</i> , Aphids, <i>Sitophilus oryzae</i> , <i>Tribolium confusum</i>
1.5	Methods of insect control 1.5.1 Chemical control by synthetic and natural chemicals 1.5.2 Biological control by <i>Bacillus thuringiensis</i> , Entomophagus insects and Parasitic insects
UNIT 2	Fisheries (15 LECTURES)
2.1	Introduction to fisheries in India – Freshwater, Marine, Brackish
2.2	Crafts & Gears used on Indian coasts: 2.2.1: Crafts – Dugout, Outrigger, Masula, Catamaran, Satpati, Trawler 2.2.2: Gears – Gill and drift net, Dol net, Cast net, Purse seine, Lines and hooks
2.3	Fishery biology of commercially important fishes : Catla, Rohu, Catfish, Mackerel, Sardine, Pomfret, Bombay duck
2.4	Fish Preservation, Processing and value addition
2.5	SONAR, GPS, Remote Sensing, Tidal and lunar pattern
UNIT 3	Dairy Science (15 LECTURES)
3.1	Indian Cattle breeds – Origin, distribution, distinguishing characters and economic uses: Malvi, Hariyana, Deoni, Red Sindhi and Khillari
3.2	Indian buffalo breeds - Origin, distribution, distinguishing characters and economic uses: Nagpuri, Bhadawari, Murrah and Jafrabadi
3.3	Dairy Processing: Filtration, cooling, chilling, clarification, pasteurization, freezing
3.4	Milk and milk products: Composition of milk, Types of milk - . Buffalo milk & Cow milk (A1 and A2), Whole milk and toned milk, Milk products
3.5	Dairy development in India: Role of dairy development in rural economy, employment opportunities

REFERENCES:

1. Bee and Bee Keeping- Roger A. Morse, Cornell University Press London
2. Economic Zoology- Shukla G.S. & Upadhyay V. B., Rastogi Publications.
3. A handbook on Economic Zoology, S. Chand & Co.
4. Candler, W., & Kumar, N. (1998). India: The dairy revolution: The impact of dairy development in India and the World Bank's contribution. World Bank Publications.
5. Milk and dairy products in human nutrition: production, composition and health. John Wiley & Sons, Park, Y. W., & Haenlein, G. F. (Eds.). (2013).
6. Dairy development in India: An appraisal of challenges and achievements. Concept Publishing Company, Venkatasubramanian, V., Singh, A. K., & Rao, S. V. N. (2003).

PRACTICAL COURSE SBSZOO4 **PRACTICAL I**

1. Urine analysis: Normal and Abnormal constituents
2. Detection of ammonia excreted by fish from aquarium water
3. Detection of uric acid from excreta of birds
4. Study of striated and non-striated muscle fibre
5. Study of nutritional apparatus (Amoeba, Hydra, Earthworm, Pigeon and Ruminant stomach)
6. Study of respiratory structures:
 - a. Gills of bony fish and cartilaginous fish
 - b. Lungs of frog
 - c. Lungs of mammal
 - d. Air sacs of Pigeon
7. Study of locomotory organs (Amoeba, Cockroach, Starfish, Fish, and Bird)
8. Study of different types of heart (Cockroach, Shark, Frog, Garden lizard, Crocodile and Mammal)

PRACTICAL II

1. Problems based on molecular biology
2. Effect of varying pH on activity of enzyme Acid Phosphatase
3. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase

4. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase
5. Effect of inhibitor on the activity of enzyme Acid Phosphatase
6. Study of histology of glands: T.S. of pituitary, thyroid, liver, kidney, pancreas, adrenal (permanent slides)
7. Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining.

PRACTICAL III

1. Study of Honey Bee:
 - 1.1 Life Cycle of Honey Bee and Bee Hive
 - 1.2 Mouthparts of Honey Bee
 - 1.3 Legs of Honey Bee
 - 1.4 Sting Apparatus of Honey Bee
2. Life cycle of silk moth
3. Life cycle of lac insect and lac
4. Study of *Schistocerca gregaria*, Aphids, *Sitophilus oryzae*, *Tribolium confusum*
5. Study of crafts and gears
6. Study of commercially important fishery (Catla, Rohu, Catfish, Mackerel, Sardine, Pomfret, Bombay duck)
7. Extraction of casein from milk and its qualitative estimation
8. Preparation of paneer, rasgulla, milk chocolate from given milk sample
9. Measurement of density of milk using different samples by Lactometer
10. Breeds of Indian cows and buffaloes
11. Study trip to dairy farm / apiculture centre / fisheries institutes / docks to observe fish landing / aquaculture farms etc.

N.B. : The practicals could be conducted by using specimens authorized by the wildlife and such other regulating authorities. However, adhering to the directions as given in the UGC Circular F14-4/2006 (CPP-II), the practicals will be taught by using photographs/audio-visual aids/simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the

relevant monitoring bodies.

ASSESSMENT DETAILS:(This will be same for all the theory papers)

Maximum Marks allotted for each theory course per semester: 100 marks

- a) Internal assessment of 50 marks per course per semester shall be conducted
- b) Semester End Examination – External Assessment (50 marks)

Practical Assessment (for papers with practicals)

Maximum Marks allotted for the entire practical course per semester: 150 marks which will be distributed into the following two examination sessions and conducted as per the given question paper pattern:

- a) Practical I examination of fifty (50) marks shall be conducted at the end of every semester.
 - b) Practical II examination of fifty (50) marks shall be conducted at the end of every semester.
 - c) Practical II examination of fifty (50) marks shall be conducted at the end of every semester.
- The duration of the practical exam will be two and a half hours.
 - The students are allowed to write the paper if the attendance for practicals is more than 75%
 - To appear in the practical exam, students must bring a properly certified journal.

PAPER PATTERN OF INTERNAL ASSESSMENT SBSZOO301, SBSZOO302 and SBSZOO303

**All Questions are compulsory
Figures to the right indicate full marks**

Time: 50 minutes

Total marks: 25

Q.1.	*Objective type questions	10 marks
Q.2.	Answer in one sentence OR Define the following	05 marks
Q.3.	Answer any two out of three (05 marks each)	10 marks

**PAPER PATTERN OF THEORY EXTERNAL ASSESSMENT
SBSZOO301, SBSZOO302 and SBSZOO303**

**All Questions are compulsory
Figures to the right indicate full marks**

Time: 2.5 hours

Total marks: 50

Q.1.	Based on UNIT 1 a. Answer any two out of four (10 marks) b. Answer any one out of two (04 marks each)	14 marks
Q.2.	Based on UNIT 2 a. Answer any two out of four (10 marks) b. Answer any one out of two (04 marks each)	14 marks
Q.3.	Based on UNIT 3 a. Answer any two out of four (10 marks) b. Answer any one out of two (04 marks each)	14 marks
Q.4.	Based on all three units Answer any two out of four (04 marks each)	08 marks

**PAPER PATTERN FOR PRACTICAL EXAMINATION
SBSZOO4**

PRACTICAL I EXAMINATION

Duration : 2 hours 30 min

Marks: 50

Major Question:

(15 marks)

Q1. Urine analysis—Normal and abnormal constituents

Minor Question:

(10 marks)

Q2. Detection of ammonia excreted by fish in aquarium water

OR

Q2. Detection of uric acid from excreta of Birds

OR

Q2. Study of striated and non-striated muscle fibre

Q3. Identification

(15 marks)

- Nutritional apparatus (a & b)
- Respiratory structure (c)
- Locomotory organ (d)
- Type of heart (e)

Q4. Viva voce based on practicals (5 marks)

Q5. Certified Journal (5 marks)

PRACTICAL II EXAMINATION

Duration : 2 hrs 30 min Marks: 50

Major Question: (15 marks)

Q.1 Demonstrate the effect of (Substrate concentration / pH variation / Enzyme concentration / Inhibitor concentration) on the activity of acid phosphatase enzyme

Minor Question: (10 marks)

Q.2 From the infiltrated tissue prepare block, trim and mount it on the block holder.

OR

Q.2 Mount the ribbon on slide from the given block.

OR

Q.2 Stain the given histological slide and identify the tissue. (10 marks)

Q.3 Identify and describe (9 marks)

a), b) and c) based on permanent slides of mammalian tissue histology

Q.4 Problems based on Molecular biology (Two) (6 marks)

Q.5 Viva voce based on practicals (5 marks)

Q.6 Certified Journal (5 marks)

PRACTICAL III EXAMINATION

Duration : 2 hrs 30 min

Marks: 50

Major Question:

(10 marks)

Sketch and Label

Q.1 Life cycle of honey bee / Life cycle of silk moth / Life cycle of lac insect

OR

Q.1 Mouth parts of honey bee

OR

Q.1 Legs of honey bee

OR

Q.1 Sting apparatus of honey bee

Minor Question

(6 marks)

Q.2 Extraction of casein from milk and its qualitative detection

OR

Q.2 Preparation of paneer from the given milk sample.

OR

Q.2 Measurement of density of different samples of milk by lactometer

Q3 Identify and describe as per instructions

(18 marks)

Fisheries (a &b)

Crafts and gears (c & d)

Breeds of cows and buffaloes (e)

Lac / insect pest (f)

Q4 Report submission based on study trip

(6 marks)

Q.5 Viva voce based on practicals

(5 marks)

Q.6 Certified Journal

(5 marks)