



Resolution No.: _____

Approved in the BOS meeting on 18-11-2021 and to be implemented from 2022-2023

Bharatiya Vidya Bhavan's

M. M. College of Arts, N.M. Institute of Science, H.R.J. College of Commerce. (Bhavan's College) Autonomous

(Affiliated to University of Mumbai)



Syllabus for: S.Y BSc

Program: BSc.

**Program Code: BH. B.Sc
Course Code: (BH. ZOOLOGY)**

Choice Based Credit System (CBCS)

with effect from academic year 2022-23



PROGRAM OUTCOMES

	PO Description
PO	The B.Sc. programme is formulated based on the inputs received from the members of Board of Studies of Bhavan's College (Autonomous) and is geared meets the standards prescribed by general science education. Our students are allowed to choose from any of the three subjects from the cluster of physics, chemistry botany, zoology, statistics mathematics and microbiology. Some learning outcomes include:
PO 1	Disciplinary Knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more other disciplines that form a part of an undergraduate programme of study. This programme helps students in building a solid foundation for further higher studies and research
PO 2	Critical Thinking & Competency in Skills: Take informed actions after identifying the assumptions that frame our thinking and actions. Critically evaluate practices, policies and theories by following scientific approach to knowledge development. Obtain proficiency in analytical reasoning, critical understanding, analysis and synthesis in order to solve theoretical and practical problems. This can orient students towards applications of their subject in other disciplines and, can also be utilized in modelling and solving real life problems.
PO 3	Communication Skills: Ability to express thoughts and ideas effectively in writing and orally; communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully; and present complex information in a clear and concise manner to different groups.
PO 4	Social Interaction: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group and act together as a group or a team in the interests of a common cause. Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO 5	Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.
PO 6	Interdisciplinary and Research Skills: A sense of inquiry and capability for asking relevant/ appropriate questions, Ability to



	recognize cause- and- effect relationships, define problems, formulate hypotheses, interpret and draw conclusions from data, ability to plan, execute and report the results of an experiment or investigation which will enable them to apply one's learning to real life situations
PO 7	Proficiency in Employments: This programme will help students to enhance their employability for Government jobs, related to science, data analysis jobs, and jobs in various other public and private enterprises.



PROGRAM SPECIFIC OUTCOMES

PSO	Description
	A student completing Bachelor's Degree in B.SC. program in the subject of ZOOLOGY will be able to:
PSO 1	To gain the knowledge of the basic concept of classification and they will be able to identify the invertebrates by applying the knowledge of general characters.
PSO 2	To study treasure of Biodiversity, its importance and to create awareness about its conservation
PSO 3	To grasp the concept of interdependence and interactions of physical, chemical and biological factors in the environment and lead to better understanding about implication of loss of fauna specifically on human being, to understand the importance of conservation of all flora and fauna
PSO 4	To understand the increasing complexity of respiratory, locomotory and nutritional physiology in evolutionary hierarchy. and also be able to correlate the habit and habitat with respiratory, locomotory and nutritional structures
PSO 5	Understand recent advances in the subject and their applications for the betterment of mankind; and that the young minds would be tuned to think out of the box.
PSO 6	To apply their knowledge how to work safely in the laboratory and avoid occurrence of accidents (mishaps) which will boost their scholastic performance and economy in use of materials/chemicals during practical sessions.
PSO 7	To get an idea of basic characters of phylum's and the organisms. And to identify the organisms based on their External features.
PSO 8	To get an idea about the origin of life and to get acquaint with various theories put forth.
PSO 9	To get an idea about the developmental process through evolutionary evidences.
PSO 10	To understand the increasing complexity of excretory, osmoregulatory and reproductive physiology in evolutionary hierarch and to correlate the habit and habitat with excretory, osmoregulatory and reproductive structures.
PSO 11	Understand and apply the principles of inheritance, concept of multiple alleles, linkage and crossing over.
PSO 12	To select and operate suitable instruments for the studies of different components of Zoology of this course and also of higher classes including research.



PROGRAM OUTLINE

Semester	Core course 14 CREDIT(T+ P) =2+1 /COURSE	Ability enhanceme nt course CREDIT 2	Skill enhancement course CREDIT 2	Discipli ne specific elective* CREDI T 3	Generic elective CREDIT 4	TOTAL CREDITS
1	C1: Paper 101 of 3 courses selected	English Communic ation/ Environme ntal Sc (FC)				20
	C2: Paper 102 of 3 courses selected					
II	C3: Paper 201 of 3 courses selected	English Communic ation/ Environme ntal SC (FC)				20
	C4: Paper 202 of 3 courses selected					
III	C5: Paper 301 of 2 courses selected		(FC)		(SWAYA M/ Coursera)	20



					Optional for ECC	
	C6: Paper 302 of 2 courses selected					
	C7: Paper 303 of 2 courses selected					
IV	C8: Paper 401 of 2 courses selected		SEC2 (FC)		GE4 (SWAYA M/ Coursera) Optional for ECC	20
	C9: Paper 402 of 2 courses selected					
	C10: Paper 403 of 2 courses selected					



V	C11: Paper 501 of 1 course selected 3 Credits		Practical's based on 2 papers(C11&12) - 2 Credits	Paper 503 of 1 course selected - 3 Credits	Applied component T+ P (3+1=4 credits)	20
	C12: Paper 502 of 1 course selected 3 Credits		Practicals based on 2 DSE papers- 2 Credits	Paper 504 of 1 course selected - 3 Credits		
VI	C13: Paper 601 of 1 course selected 3 Credits		Practical's based on 2 papers(C13&14) - 2 Credits	Paper 603 of 1 course selected - 3 Credits	Applied component T+P (3+1=4 credits/EC)	20
	C14: Paper 602 of 1 course selected 3 Credits		Practicals based on 2 DSE papers- 2 Credits	Paper 604 of 1 course selected - 3 Credits		
	TOTAL CREDITS					120



Note-

- 1. The final year B.Sc students will have the options under DSE (Discipline specific Elective) to drop of one the core paper and do dissertations under the guidance of the departmental faculty/ Any research institute of national importance for both semester V & VI.**
- 2. CBCS system will allow the students from science streams in their final year to study the applied component of any of the science subjects available in the college (Eg- Final year Zoology student can have the choice to select any one of the Applied components available with Botany, Microbiology, Chemistry, Statistics, Physics, Mathematics, etc.).**
- 3. Students in semester- III & IV will have the option for selecting the Generic elective (GE) courses prescribed by Swayam/ Coursera/ etc. The students will be evaluated by conducting examinations at college level. The students will also have the options to get certificate from SYAWAM by qualifying their proctored examination.**



YEAR	SEMESTER	COURSE TYPE	COURSE CODE	COURSE TITLE	CREDITS
F.Y.B.Sc	I	Core course	BH.USZO101	Animal diversity - I	02
F.Y.B.Sc.	I	Core course	BH.USZO102	Life Processes - I	02
F.Y.B.Sc.	I	Core course	BH.USZOP1	Practical based on (Course I & II)	02
F.Y.B.Sc.	II	Core course	BH.USZO201	Animal diversity - II	02
F.Y.B.Sc.	II	Core course	BH.USZO202	Life Processes - II	02
F.Y.B.Sc.	II	Core course	BH.USZOP2	Practical based on (Course I & II)	02
S.Y.B.Sc	III	Core course	BH.USZO301	Genetics and molecular Biology	02
S.Y.B.Sc	III	Core course	BH.USZO302	Animal Physiology	02
S.Y.B.Sc	III	Core course	BH.USZO303	Ethology, Parasitology and Economic Zoology -I	02
S.Y.B.Sc	III	Core course	BH.USZOP3	Zoology practical (practical i, ii & iii)	03
S.Y.B.Sc	IV	Core course	BH.USZO401	Population evolution, Genetics and Ecology	02
S.Y.B.Sc	IV	Core course	BH.USZO402	Cytology	02
S.Y.B.Sc	IV	Core course	BH.USZO403	Embryology, Human Reproduction and Economic Zoology - II	02
S.Y.B.Sc	IV	Core course	BH.USZOP4	Zoology practical (practical i, ii & iii)	03
T.Y.B.Sc.	V	Core course	BH.USZO501	Taxonomy – Invertebrates and type study	03
T.Y.B.Sc.	V	Core course	BH.USZO502	Haematology and Immunology	03
T.Y.B.Sc.	V	Skill enhancemen t course	BH.USZOP5	Practical paper i&ii (based on 501&502)	02



T.Y.B.Sc.	V	Discipline specific electiv	BH.USZO503	Histology, Toxicology, Pathology and Biostatistics	03
T.Y.B.Sc.	V	Discipline specific electiv	BH.USZO504	Anatomy and Developmental Biology	03
T.Y.B.Sc.	V	Skill enhancement course	BH.USZOP6	Practical paper iii&iv (based on 503&504)	02
T.Y.B.Sc.	V	Generic elective	BH.USZOAC FB501	Fishery biology – I	03
T.Y.B.Sc.	V	Generic elective	BH.USZOAC FB5P1	Practicals based on Fishery biology – I	01
T.Y.B.Sc.	VI	Core course	BH.USZO601	Taxonomy - Chordates and Type study	03
T.Y.B.Sc.	VI	Core course	BH.USZO602	Physiology and Tissue culture	03
T.Y.B.Sc.	VI	Skill enhancement course	BH.USZOP7	Practical paper i&ii (based on paper 601 &602)	02
T.Y.B.Sc.	VI	Discipline specific electiv	BH.USZO603	Genetics and Bioinformatics	03
T.Y.B.Sc.	VI	Discipline specific electiv	BH.USZO604	Environmental Biology and Zoopharmacognosy	03
T.Y.B.Sc.	VI	Skill enhancement course	BH.USZOP8	Practical paper iii & iv (based on paper 603 &604)	02
T.Y.B.Sc.	VI	Generic elective	BH.USZOAC FB601	Fishery biology –II	03
T.Y.B.Sc.	VI	Generic elective	BH.USZOAC FB6P1	Practicals based on Fishery biology –II	01
				Total	70



DETAILED SYLLABUS – SEMESTER III AND IV

PREAMBLE

As Bhavan;s college has received academic autonomy, we have made an attempt to revise the S.Y.B.sc syllabus so as to make it more appropriate to the students and their future. The committee has tried to maintain the links of topic from F.Y.B.Sc syllabus revised last year. The former syllabus lacked new concepts and ideas and students were unable to imbibe scientific reasoning and thinking abilities. Due to rapid advancement in technology, a number of rapid new ideas and concepts, and an ocean of information being generated every day that necessitates updating the students in this present era of exponential information and knowledge

Looking at the employment generating potential and need of trained human resource in various service sectors in our state, it was became imperative to make a breakthrough from the traditional practice of revising syllabus; and instead giving an opportunity to the stakeholders to adapt and acclimatize with the changes around them and imbibe knowledge which shall enable them to develop entrepreneurship and / or employment avenues and opportunities after pursuing the coveted degree.

With this intention, the Board of Studies in Zoology took decision to put before the S. Y. B. Sc. Zoology students one elective, so that they can study topics of their interest. All the committee members worked extensively and exhaustively; and prepared draft of the syllabus. New syllabus was introduced but it is revived immediately after two years with inclusion of new concepts and techniques. Care has been taken to inculcate the latest technology and research topics to increase the student's knowledge and also to inculcate a scientific reasoning ability in them. The revised syllabus aims at making the student's self-sufficient and knowledgeable which will help them in their future endeavors and form the basis for further studies. Due care is taken to make the syllabus interdisciplinary, flexible and choice based. All the member teachers have tried their level best to come out with "Need Based Syllabus" that may spark motives in all the stakeholders. We hope that the stakeholders will enjoy the learning of this syllabus in the classrooms, laboratories and on the field.



Programme: Science				Semester: III		
Course: ZOOLOGY				Course Code: BH.USZO 301 BH.USZO 302 BH.USZO.EA303		
Teaching Scheme				Evaluation Scheme (Theory)		
Lecture (Periods per week)	Practical (Periods per week per batch)	Tutorial (Periods per week per batch)	Credits (Theory +Practical)	Continuous Internal Assessment (CIA)		End Semester Examination (ESE)
06	03	NIL	6+3 =9	20	20	60
Pre-requisites: 40 % PASSING						
COURSE OBJECTIVES						
PAPER 1:						
<ul style="list-style-type: none"> ● To familiarize the learners with the structure, types and classification of chromosomes and to introduce the concept of sex determination and its types, sex influenced and sex-limited genes. ● To introduce the concept of human genetics and cancer genetics. ● To introduce the learner to the classical experiments proving DNA as the genetic material. ● To introduce the learner to the structure of nucleic acids and the concept of central dogma of molecular biology and to familiarize the learner with the concept of gene expression and regulation. 						
PAPER 2:						
<ul style="list-style-type: none"> ● To understand the functional anatomy, differences and similarities of Digestive and Excretory System ● To study the Physiological, anatomical and regulatory function of Respiration and Circulation ● To impart knowledge and understanding of structural organisation of Nervous system and its coordination in locomotion of organism ● To introducing the learner the physiological disorder associated to various organ system of the body 						
PAPER 3:						
<ul style="list-style-type: none"> ● To equip learners with the knowledge of animal interaction with one another and their environment. ● To enable the learner to understand different behavioural patterns. ● To acquaint the learner with the concepts of parasitism and its relationship with the host. ● To introduce the learner to modes of transmission of parasites and diseases. ● To disseminate information on economic aspects of animals like apiculture, vermiculture and dairy science. ● To encourage young learners for self-employment. 						



COURSE OUTCOMES

PAPER 1:

- Learner will comprehend the structure of chromosomes and its types and the mechanisms of sex determination.
- Learner would be able to correlate the disorders linked to a particular sex chromosome.
- Learners will gain a basic knowledge of recombination and gene mapping and on cancer genetics.
- Learners will understand the importance of nucleic acids as genetic material.
- Learner would comprehend and appreciate the regulation of gene expressions.

PAPER 2:

- The learner will be able to differentiate between the life Processes, its functional aspect with respect to mechanism of Digestion and Excretion in an organism
- The learner will gain insight knowledge of fundamental process and physiological balancing pertaining to Respiratory and Circulatory system in animals
- The learner will perceive in depth understanding of underlying concept of Nervous System and its synchronization to coordinate and command locomotion of an organism
- The learner will be able to gain comprehensive knowledge related to the abnormal functioning of the System and Disorders Analogous to it.

PAPER 3:

- Learner would gain insight into different types of animal behaviour and their role in biological adaptations.
- Learner would be sensitized to the feelings which are instrumental in social behaviour.
- Learner would understand the general epidemiological aspects of parasites that affect humans and take simple preventive measures for the same.
- Learner would comprehend the life cycle of specific parasites, the symptoms of the disease and its treatment
- Learner would gain knowledge on animals useful to mankind and the means to make the most of it.
- Learner would learn the modern techniques in animal husbandry.
- Learner would pursue entrepreneurship as a career.

INDEX

Paper	Description	Periods
1	BH.USZO 301 Genetics and Molecular biology	45
2	BH.USZO 302 Animal Physiology	45
3	BH.USZO EA303 Ethology, Parasitology, Economic Zoology-I	45
4	Practicals based on BH.USZO 301, BH.USZO 302 and BH.USZO EA 303	45
	Total	180



BH.USZO301: GENETICS AND MOLECULAR BIOLOGY		
UNIT	DETAILED DESCRIPTION	LECTURE
1	<p style="text-align: center;"><u>UNIT 1: CHROMOSOMES AND HEREDITY</u></p> <p>1.1 Chromosomes 1.1.1 Types of Chromosomes–Autosomes and Sex chromosomes 1.1.2 Chromosome structure - Heterochromatin, Euchromatin 1.1.3 Classification based on the position of centromere 1.1.4 Endomitosis, Giant chromosomes- Polytene and Lampbrush chromosomes Significance of Balbiani rings</p> <p>1.2 Sex- determination 1.2.1 Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW 1.2.2 Sex determination in Honey bees- Haplodiploidy 1.2.3 Sex determination in Drosophila-Genic balance theory, Intersex, Gynandromorphs and Parthenogenesis 1.2.4 Hormonal influence on sex determination-Freemartin and Sex reversal 1.2.5 Role of environmental factors- Bonellia and Crocodile 1.2.6 Barr bodies and Lyon hypothesis</p> <p>1.3 Sex linked, sex influenced and sex-limited inheritance. 1.3.1 X-Linked (dominant and recessive): Rett syndrome, Duchenne muscular dystrophy, Colour-blindness, Haemophilia 1.3.2 Y-linked: Hypertrichosis, Ichthyosis hystrix gravior 1.3.3 Sex-influenced genes.</p>	15 L
2	<p style="text-align: center;"><u>UNIT 2: RECOMBINATION AND HUMAN GENETICS</u></p> <p>2.1 Recombination and mapping 2.1.1 Linkage and crossing over 2.1.2 Homologous and non-homologous 2.1.3 LOD score- linkage and crossing over</p> <p>2.2 Human genetics 2.2.1 Chromosomal aberrations</p>	15 L



	<p>(i) Euploidy and Aneuploidy (ii) Deletion, Duplication, Inversion, Translocation 2.2.2 Diagnostic tests a) Amniocentesis b) Chorionic Villus sampling c) Banding of chromosomes</p> <p>2.3 Genetics of Cancer 2.3.1 Oncogenes and types of genetic mutations involved in cancer 2.3.2 Hereditary basis of cancer with examples (Breast cancer and cancer caused due to tobacco consumption) 2.3.4 Environmental causes of cancer 2.3.5 Introduction to Gene therapy as a treatment for cancer</p>	
3	<p style="text-align: center;"><u>UNIT 3: MOLECULAR BIOLOGY</u></p> <p>3.1 Genetic material 3.1.1 Griffith's transformation experiments, Avery-Macleod and McCarty 3.1.2 Hershey Chase experiment of Bacteriophage infection 3.1.3 Chemical composition and structure of nucleic acids • Double helix nature of DNA, Solenoid model of DNA • Types of DNA – A, B, Z & H forms • DNA in Prokaryotes -Chromosomal and Plasmid • RNA as a genetic material in viruses • Types of RNA: Structure and function</p> <p>3.2 Flow of genetic information in a prokaryotes and eukaryotes 3.2.1 DNA Replication 3.2.2. Transcription of mRNA 3.2.3 Genetic code 3.2.4 Translation</p> <p>3.3 Gene expression and regulation 3.3.1 One gene-one enzyme hypothesis /one polypeptide hypothesis 3.3.2 Concept of Operon • Lac Operon • Trp Operon</p>	15 L
	BH.USZO302: ANIMAL PHYSIOLOGY	
UNIT	DETAILED DESCRIPTION	LECTURE



<p>1</p>	<p style="text-align: center;"><u>UNIT 1: NUTRITION AND EXCRETION</u></p> <p>1.1 Physiology of digestion in Human</p> <p>a) Overview of Digestive system Buccal cavity- Salivary gland, Stomach- Gastric secretion, Intestinal Juices(Succus Entericus), Liver and Gall bladder - bile secretion and Pancreatic secretion</p> <p>b) Enzymatic digestion: Protein-proteases, Polysaccharide-amylose and cellulose, Lipids-lipase</p> <p>c) Absorption of Nutrients (Small and Large Intestine)- Monosaccharide, Peptide and Fatty acid- chylomicron</p> <p>1.2 Comparative study of excretory and osmoregulatory structures and functions.</p> <p>a) <i>Paramoecium</i> - Contractile vacuoles</p> <p>b) <i>Planaria</i> - Flame cells</p> <p>c) Flatworm- Protonephridia</p> <p>d) Cockroach- Malphigian tubules and Green Gland</p> <p>e) Birds- Salt gland</p> <p>1.3 Nitrogenous waste production and excretion process :</p> <p>1.3.1 Ammonotelic-Deamination</p> <p>1.3.2 Ureotelic-Ornithine Cycle</p> <p>1.3.3 Uric acid - AMP and GMP metabolism.</p>	<p>15 L</p>
<p>2</p>	<p style="text-align: center;"><u>UNIT 2: RESPIRATION AND CIRCULATION</u></p> <p>2.1 Respiratory pigments:</p> <p>2.1.1 Haemoglobin</p> <p>2.1.2 Haemocyanin</p> <p>2.1.3 Chlorocruorin</p> <p>2.1.4 Hemerythrin</p> <p>2.2 Physiology of Respiration in Human</p> <p>2.2.1 Mechanism of respiration</p> <p>2.2.2 Pulmonary ventilation</p> <p>2.2.3 Control of Respiration.</p> <p>2.3 Transport of Oxygen and Carbon dioxide.</p> <p>2.4 Hematopoiesis-Erythropoiesis, composition of blood and their Functions</p> <p>2.5 Circulatory Fluid:</p> <ul style="list-style-type: none">● Systemic,● Pulmonary	<p>15 L</p>



	<ul style="list-style-type: none">● Lymphatic <p>2.6 Blood coagulation- 2.6.1 Extrinsic and intrinsic pathway 2.6.2 Blood group and transfusion</p> <p>2.7 Structure and working of conducting myocardial fibres <ul style="list-style-type: none">● Pacemaker, pace setter and purkinje fibres conduction.</p> <p>2.8 Cardiac output and Cardiac cycle.</p> <p>2.9 Circulatory disorders (Definition and causes) 2.9.1 Arteriosclerosis 2.9.2 Hypertension</p> <p>2.10 Maintenance of homeostasis of heart during exercise</p>	
3	<p><u>UNIT 3: CONTROL AND CO-ORDINATION, LOCOMOTION AND MOVEMENT</u></p> <p>3.1 Control and coordination a) Central ganglion- Anterior cephalization in Flatworms b) Nerve ring and nerve cord in earthworm. c) Centralised nervous system in Squid d) General organisation of vertebrate nervous system: CNS and PNS</p> <p>3.2 Reflex action and reflex arc- sensory motor pathway</p> <p>3.3 Conduction of nerve impulse: <ul style="list-style-type: none">● Resting membrane potential● Action potential● Refractory period● Graded potential</p> <p>3.4 Neurological disorder <ul style="list-style-type: none">● Alzheimer's (Definition and causes)</p> <p>3.5 Movement and Locomotion 3.5.1 Locomotory organs- structure and functions; a. Flagellar movement of Sperm b. Foot modification in Snail. c. Tube feet in starfish d. Wings and legs in cockroach</p> <p>3.6 Ultrastructure of skeletal muscle in Vertebrate</p> <p>3.7 Neuromuscular junction and calcium ion regulation in contraction of muscle.</p>	15 L



	3.8 Impact of modern sedentary lifestyle on motor movement of skeletal muscles	
	BH.USZO303 EA ECONOMIC ZOOLOGY - I	
1	<p style="text-align: center;"><u>UNIT 1: ETHOLOGY</u></p> <p>1.1 Introduction to Ethology 1.1.1 Definition, History and Scope of Ethology 1.1.2 Animal behaviour : Innate and Learned behaviour 1.1.3 Types of learning: Habituation, Imprinting, and 1.1.4 Types of imprinting - Filial and sexual, Classical conditioning 1.1.5 Cognitive learning theories: benefits strategies and examples</p> <p>1.2 Aspects of animal behavior 1.2.1 Communication in bees and ants 1.2.2 Mimicry and colourations 1.2.3 Displacement activities, Ritualization 1.2.4 Migration in fish, schooling behaviour 1.2.5 Habitat selection, territorial behavior</p> <p>1.3 Social behaviour 1.3.1 Social behaviour in primates- Hanuman langur 1.3.2 Elements of socio-biology: Altruism and Kinship.</p>	15 L



2	<p style="text-align: center;"><u>UNIT 2: PARASITOLOGY</u></p> <p>2.1 Introduction to Parasitology and types of parasites 2.1.1 Definition-Parasitism ,Host ,Parasite ,Vector -Biological and mechanical 2.1.2 Parasitic adaptations in endoparasites and ectoparasites 2.1.3 Types of hosts - Intermediate and definitive reservoir.</p> <p>2.2.Host-Parasite relationship -Host specificity 2.2.1 Definition- Structural ,physiological and ecological specificity</p> <p>2.3 Life cycle , pathogenicity ,control measures and treatment of endoparasites a) <i>Leishmania donovani</i> b) <i>Plasmodium falciparum</i> c) <i>Taenia solium</i> d) <i>Wuchereria bancrofti</i></p> <p>2.4 Life cycle , pathogenicity ,control measures and treatment of ectoparasites a) <i>Leech (Hirudo medicinalis)</i> b) Head louse (<i>Pediculus humanus capitis</i>) c) Bed bug (<i>Cimex lectularis</i>) d) Mite (<i>Sarcoptes scabiei</i>)</p> <p>2.5 Parasitological significance- Zoonosis --Bird flu, Anthrax, Rabies, Toxoplasmosis.</p>	15 L
3	<p style="text-align: center;"><u>UNIT 3 APPLIED ZOOLOGY- I</u></p> <p>3.1 Apiculture 3.1.1Methods of beekeeping and management</p> <ul style="list-style-type: none">● An introduction to different species of honey bees used in apiculture.● Selection of flora and bees for apiculture.● Advantages and disadvantages of traditional and modern methods of apiculture.● Pests and Bee enemies- Wax moth, wasp, black ants, bee-eaters, king crow and disease control <p>3.1.2 Economic importance</p> <ul style="list-style-type: none">● Honey- Production, chemical composition and economic importance● Bee wax- Composition and economic importance.● Role of honey bee in pollination.	15L



	<p>3.2 Vermiculture</p> <p>3.2.1 Rearing methods, management and economic importance</p> <ul style="list-style-type: none">● An introduction to different species of earthworms used in vermiculture.● Methods of vermiculture.● Maintenance and harvesting● Economic importance: advantages of vermiculture, demand for earthworms; market for vermicompost and scope for entrepreneurship. <p>3.3 Dairy Science</p> <p>3.3.1 Composition of Milk</p> <p>3.3.2 Properties of Milk</p> <p>3.3.3 Milk Processing :- Filtration, clarification, pasteurization</p> <p>3.3.4 Milk and milk products.</p>	
	<p style="text-align: center;">Practicals based on BH.USZO 301 PAPER I</p> <ol style="list-style-type: none">1. Extraction and detection of DNA by DPA method.2. Extraction and detection of RNA by Orcinol method.3. Mounting of Barr bodies.4. Study of polytene chromosomes.5. Problems on Linkage and Mapping6. Chromosome morphology: (photograph to be provided)7. Pedigree analysis: (Autosomal and X-linked: dominant and recessive inheritance)8. Problems based on molecular biology9. Karyotype analysis (chromosomal aberrations).	
	<p style="text-align: center;">Practicals based on BH.USZO 302 PAPER II</p> <ol style="list-style-type: none">1. Urine analysis—Normal and Abnormal constituents.2. Preparation of Haemin Crystals using Human Blood.3. Study of Osmosis from the Given Blood Sample.4. Study of striated (chicken thigh) and non-striated muscle fibre (chicken-stomach/intestine).5. Demonstrate the contraction of muscle through Glycerinated Muscle Fibres.6. Study of mouthparts/ wings/ legs of mosquito/ House fly.7. To determine Bleeding time and Clotting time.8. Demonstrate Lung Capacity of Humans.9. Identification<ol style="list-style-type: none">a) T.S of artery and Vein (Mammal)b) Medullated and Non Medullated nerve fibrec) T.S of Stomach and Duodenum (Mammal)d) T.S of Liver and Pancreas (Mammal)	



	<p>e) T.S of Lungs and L.S kidney (Mammal)</p> <p>f) Project on Nutrient Rich food Sources (vegetable and Fruits) their seasonal availability and Price / Study of Nutrition value using Labeling on Selected Packed Food materials. / Computational calculation of nutritional value of food.</p>	
	<p style="text-align: center;">Practicals based on BH.USZO 303 EA PAPER III</p> <p>a) Extraction of casein from milk and its qualitative estimation.</p> <p>b) Measurement of density of milk using different samples by Lactometer.</p> <p>c) Study of Honey Bee: a) Life Cycle of Honey Bee and Bee Hive b) Mouthparts of Honey Bee c) Legs of Honey Bee d) Sting Apparatus of Honey Bee.</p> <p>d) Study of ethological aspects: a) Warning colouration b) Animal instinct c) Imprinting d) Communication in animals: Chemical signals and Sound signals e) Displacement activities in animals: Courtship and mating behaviour in animals and Ritualization.</p> <p>e) Study of Protozoan parasites: a. <i>Trypanosoma gambiense</i> b. <i>Giardia intestinalis</i>.</p> <p>f) Study of Helminth parasites: a) <i>Ancylostoma duodenale</i> b) <i>Dracunculus medinensis</i>.</p> <p>g) Parasitic adaptations: Scolex and mature proglottid of Tapeworm.</p> <p>h) Study of Ectoparasites: a) Leech b) Tick c) Mite.</p> <p>i) Project- Suggested topics on economic zoology (e.g. Apiculture/ Sericulture/ Lac culture / Vermicompost technique / Construction of artificial beehives /Animal husbandry/ Aquaculture, etc)</p>	
<p>Reference Books:</p> <p>UNIT I : GENETICS AND MOLECULAR BIOLOGY</p> <ol style="list-style-type: none">1. Cell Biology Genetics, Molecular Biology Evolution and Ecology Verma P.S. and Agrawal P.K., 9th edition, S. Chand Publication, New Delhi2. Principles of Genetics – Eight edition- Eldon John Gardner, Michael J. Simmons, D. Peter Snustad3. Genetics- Weaver, Hedrick, third edition, McGraw Hill Education4. Genetics A Mendelian approach Peter J. Russel, Pearson Benjamin Cummings5. Modern text book of Zoology - Invertebrates; Eleventh; Edition Professor R.L. Kotpal; Rastogi publication Invertebrate Zoology by E. L. Jordan & P. S. Verma Rev. edition, 2009, Chand publications Invertebrate Zoology by P. S. Verma, edition, 2009, Chand publications Zoology for degree students, Non chordates by V.K. Agarwal 2011, S. Chand Publication.6. Introductory Practical Biochemistry – S.K. Sawhney and Randhir Singh (Narosa Publishing House)		



7. Methods in Biostatistics – B. K. Mahajan, (Jaypee Publications)
8. Microscopy and Cell Biology - V. K. Sharma, (Tata McGraw Hill Publishing Co. Ltd.)
9. Biochemistry –Satyanarayana

UNIT II :ANIMAL PHYSIOLOGY

1. Animal physiology by P.S. Verma.
2. Introduction to Animal Physiology - Dr Ian Kay.
3. Essentials Of Animal Physiology Paperback – S. C. Rastogi

UNIT III: ECONOMIC ZOOLOGY - I

1. Animal Behaviour- David Mc Farland
2. Animal Behaviour- Mohan Arora
3. Animal Behaviour- Reena Mathur
4. An introduction to Animal Behaviour- Dawkins
5. Animal Behaviour-Agarwal
6. Animal Behaviour- Tinbergen
7. Parasitology- Chatterjee K.D., Chatterjee Medical Publishers.
8. Medical Parasitology- Arora
9. Textbook of Medical Parasitology-. C.K Jayaram Paniker, Jaypee Brothers.
10. A text book of Parasitology- Kochhar S.K. Dominant Pub. & Dis, New Delhi.
11. Essentials of Parasitology- Gerald and Schmidt: Universal Bookstall, New Delhi.
12. Parasitology- Sharma P.N.and Ratnu L.N., Chand S & Co.Pvt.Ltd.
13. Economic Zoology- Biostatistics and Animal behaviour – S.Mathur, Rastogi Publicatons.
14. Economic Zoology- Shukla G.S. & Upadhyay V.B., Rastogi Publications.
15. A handbook on Economic Zoology, S.Chand & Co.
16. Principles of Dairy Chemistry R. Jenness, S. Patton John Wiley and Sons Inc.
17. 2. Fundamentals of dairy chemistry B.H. Webb, A.H. Johnson, J.A. Alford Avi Pub. Co.
18. 3. Food Chemistry Owen R. Fennema CRC Press
19. 4. Food Chemistry John M. De Man Springer
20. 5. Technology of Dairy Products Early, Ralph. Academic & Professional, 1998
21. 6. Quality of milk production and processing technology D.K. Thompkinson and lathasabikhi
22. New India Publishing agency, New delhi
23. 7. Outlines of Dairy Technology Sukumar De Oxford UniversityPress, New delhi

24.

Self-study topics –

- 1. Self learning and self paced courses on Swayam platform on related topics.**
- 2.You tube videos on related topics**

**Details of Conduct of Practical Examination (Evaluation Scheme):**

Particulars	Paper I BH.USZO 301	Paper II BH.USZO 302	Paper III BH.USZO 303
Laboratory work	40	40	40
Journal	5	5	5
Viva	5	5	5

Total 150 marks shall be converted to 100.

The students are required to present a duly certified journal for appearing at the semester end practical examination, failing which they will not be allowed to appear for the examination. In case of report of loss of Journal, a “Lost Certificate”, should be obtained from Head/ Coordinator of the department; failing which the student will not be allowed to appear for the practical examination.

Programme: Science				Semester: IV		
Course: ZOOLOGY				Course Code: BH.USZO 401 BH.USZO 402 BH.USZO EA403		
Teaching Scheme				Evaluation Scheme (Theory)		
Lecture (Periods per week)	Practical (Periods per week per batch)	Tutorial (Periods per week per batch)	Credits (Theory +Practical)	Continuous Internal Assessment (CIA)		End Semester Examination (ESE)
09	9	NIL	6+3=9	20	20	60
Pre-requisites: 40 % Passing						
COURSE OBJECTIVES						

**PAPER 1:**

- To impart scientific knowledge about how life origin of life on our planet
- To develop an understanding of genetic variability within a population and learn as to how the change in the gene pool leads to evolution of species.
- To develop an understanding of the basic facts of population, community and ecosystem level ecology.
- To acquaint the learner with the concepts of hydrology essential for the environment and life.

PAPER 2:

- To study the structural and functional organization of cells with an emphasis on nucleus, plasma membrane and cytoskeleton.
- To acquaint the learner with ultrastructure of cell organelles and their functions
- To give learners insight into the structure of biomolecules and their role in sustenance of life.

PAPER 3:

- To comprehend the functioning of various aspects of dairy industry.
- To study the process of boat building, materials used and to study various types of nets used in fishery.

COURSE OUTCOMES**PAPER 1:**

- Learners will gain insights into the origin of life.
- Learners will analyze and critically view the different theories of evolution.
- Learner would understand the forces that cause evolutionary changes in natural populations
- Learner would comprehend the mechanisms of speciation
- Learners will be able to distinguish between microevolution, macroevolution and mega evolution.
- Learners will comprehend knowledge about various ecological aspects and their interrelationships.

PAPER 2:

- Learner would acquire knowledge of the composition of the transport mechanisms adopted by the cell, constituents of and its division.
- Learners would acquire knowledge of the endomembrane system.
- Learner would understand the interlinking of endomembrane system for functioning of cell
- The learner will realize the importance of biomolecules and their clinical significance
- Learners will gain an understanding about hydrology and its aspects.

**PAPER 3:**

- To comprehend the functioning of various aspects of dairy industry.
- Learner shall comprehend boat building techniques and to understand the operations of various types of nets.

INDEX

Unit	Description	Periods
1	BH.USZO 401 Population Evolution , Genetics and Ecology	45
2	BH.USZO 402 Cytology	45
3	BH.USZO EA 403 Reproductive biology and Economic Zoology -II	45
4	Practicals based on BH.USZO 401, BH.USZO 402 and BH.USZO EA 403	45
	Total	180



Detailed syllabus		
Units	Detailed descriptions BH.USZO401	Lecture period /unit
1	<p style="text-align: center;">UNIT 1: EVOLUTION</p> <p>1.1 Introduction 1.1.1 Origin of the Universe 1.1.2 Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory 1.1.3 Origin of life 1.1.4 Origin of eukaryotic cell</p> <p>1.2 Evidences in favour of organic evolution Evidences from geographical distribution, palaeontology, anatomy, embryology, physiology and genetics</p> <p>1.3 Theories of organic evolution 1.3.1 Theory of Lamarck 1.3.2 Theory of Darwin and Neo- Darwinism 1.3.3 Mutation Theory 1.3.4 Modern synthetic theory 1.3.5 Weismann's Germplasm theory</p> <p>1.4 Geological Time Scale 1.4.1 Eras, Periods, Epochs 1.4.2 Evolution of Horse</p>	15L
2	<p style="text-align: center;">UNIT 2. EVOLUTIONARY GENETICS</p> <p>2.1 Genetic variation: Genetic basis of variation-mutations and recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random union of gametes during fertilization).</p> <p>2.2 Nature of genetic variations: Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism-Heterozygote advantage and frequency dependent selection: a. Neutral variations b. Geographic variation (Cline)</p>	15 L



	<p>2.3 Species concept: Biological species concept and evolutionary species concept</p> <ul style="list-style-type: none">a. Speciation and Isolating mechanisms: Definition and modes of speciation (allopatric, sympatric, parapatric and peripatric).b. Geographical isolation.c. Reproductive isolation and its isolating mechanisms (prezygotic and postzygotic).d. Macroevolution and megaevolution: Concept and Patterns of macroevolution (stasis, preadaptation /exaptation, mass extinctions, adaptive radiation and coevolution), Megaevolution	
3	<p style="text-align: center;"><u>UNIT 3: ECOLOGY</u></p> <p>3.1 Population Ecology:</p> <ul style="list-style-type: none">3.1.1 Characteristics of a population;3.1.2 Population growth curves;3.1.3 Population regulation;3.1.4 Life history strategies (r and K selection);3.1.5 The concept of metapopulation – demes and dispersal, inter demic extinctions, age-structured populations. <p>3.2 Species Interactions:</p> <ul style="list-style-type: none">3.2.1 Types of interactions- interspecific competition, herbivory, carnivory, pollination, symbiosis. <p>3.3 Community Ecology:</p> <ul style="list-style-type: none">3.3.1 Nature of communities<ul style="list-style-type: none">a. Community structure and attributesb. Levels of species diversity and its measurementc. Edges and ecotones. <p>3.4 Ecological Succession:</p> <ul style="list-style-type: none">3.4.1 Types and mechanisms3.4.2 Changes involved in succession3.4.3 Concept of climax. <p>3.5 Hydrology:</p> <ul style="list-style-type: none">3.5.1 Water Cycle3.5.2 Water Vapour3.5.3 Atmospheric Humidity3.5.4 Measurement of Humidity3.5.5 Atmospheric elements	15L



Units	BH.USZO402 CYTOLOGY	Lecture period/ unit
1	<p style="text-align: center;"><u>UNIT 1: CELL BIOLOGY</u></p> <p>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</p> <p>1.2 Nucleus 1.2.1 Size, shape, number and position 1.2.2 Ultrastructure of nuclear membrane and pore complex 1.2.3 Nucleolus: general organization, chemical composition & functions 1.2.4 Nuclear sap/ nuclear matrix 1.2.5 Nucleocytoplasmic interactions</p> <p>1.3 Plasma membrane 1.3.1 Fluid Mosaic Model 1.3.2 Junctional complexes 1.3.3 Membrane receptors 1.3.4 Modifications: Microvilli and Desmosomes</p> <p>1.4 Transport across membrane 1.4.1 Diffusion and Osmosis 1.4.2 Transport: Passive and Active 1.4.3 Endocytosis and Exocytosis</p> <p>1.5 Cell division 1.5.1 Mitosis 1.5.2 Meiosis 1.5.3 Cell cycle checkpoints</p>	15L
2	<p style="text-align: center;"><u>UNIT 2: ENDOMEMBRANE SYSTEM</u></p> <p>2.1 General morphology of endomembrane system, ultrastructure, types of ER and biogenesis of ER</p> <p>2.2 Endoplasmic reticulum (ER) 2.2.1 Rough Endoplasmic Reticulum(RER)- ultrastructure and functions 2.2.2 Smooth Endoplasmic Reticulum(SER)-ultrastructure and functions.</p>	15L



	<p>2.3 Golgi complex: 2.3.1 Ultrastructure of Golgi complex, 2.3.2 Functions of Golgi complex (protein glycosylation, lipid and polysaccharide metabolism, protein sorting and secretion, Golgi Anti-Apoptotic Protein -GAAP)</p> <p>2.4 Lysosomes: 2.4.1 Ultrastructure of lysosomes. 2.4.2 Polymorphism and Functions. 2.4.3 Peroxisomes: morphology & functions.</p> <p>2.5 Mitochondria: 2.5.1 Ultrastructure. 2.5.2 Functions of mitochondria and bioenergetics (Chemical energy & ATP, Krebs cycle, respiratory chain and oxidative phosphorylation).</p>	
3	<p style="text-align: center;"><u>UNIT 3: BIOMOLECULES</u></p> <p>3.1 Biomolecules: Concept of micromolecules and macromolecules</p> <p>3.2 Carbohydrates: 3.2.1 Definition, classification, properties and isomerism, glycosidic bond 3.2.2 Types of carbohydrates - Monosaccharides (glucose and fructose); Dissacharides (maltose, lactose and sucrose) Oligosaccharides (stachyose and raffinose); Polysaccharides (starch, glycogen and chitin). 3.3.3 Biological role and clinical significance of carbohydrates</p> <p>3.3 Proteins: 3.3.1 Definition, classification of amino acids, properties, peptide bond 3.3.2 Types of amino acids - Essential and Non-essential amino acids. 3.3.4 Structure of Proteins : Primary, Secondary, Tertiary, Quaternary 3.3.3 Structural protein (collagen) and functional proteins (haemoglobin) 3.3.5 Biological role and clinical significance of proteins</p> <p>3.4 Lipids: 3.4.1 Definition, classification of lipids with examples, properties, ester linkage. 3.4.2 Types of fatty acids: Saturated and unsaturated fatty acids, Essential and non-essential fatty acids. 3.4.3 Triacylglycerols; Glycerophospholipids (lecithin and cephalin); Glycolipids (Gangliosides), Steroids (cholesterol). 3.4.4 Biological role and clinical significance of lipids.</p>	15L



Units	BH.USZO403 EA REPRODUCTIVE BIOLOGY AND ECONOMIC ZOOLOGY -II	Lecture period /unit
1	UNIT 1: COMPARATIVE EMBRYOLOGY 1.1 Types of Eggs- Based on amount and distribution of yolk 1.2 Structure and Types of Sperms 1.3 Types of Cleavages 1.4 Types of Blastulae 1.5 Types of Gastrulae 1.6Coelom -Formation and types	15L



2	<p style="text-align: center;"><u>Unit 2: Aspects of Human Reproduction</u></p> <p>2.1 Human reproductive system and hormonal regulation</p> <p>2.1.1 Anatomy of human male and female reproductive system</p> <p>2.1.2 Hormonal regulation of reproduction and impact of age on reproduction - menopause and andropause.</p> <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> <p>2.3 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> <p>2.3.3 Role of endocrine disruptors.</p> <p>2.4 Treatment of infertility</p> <p>2.4.1 Removal /reduction of causative environmental factors</p> <p>2.4.2 Surgical treatment</p> <p>Hormonal treatment- fertility drugs</p> <p>2.4.3 Assisted Reproductive Technology (ART) - <i>In-vitro</i> 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 biopsies; Testicular sperm extraction (TESE).</p> <p>2.4.5 Sperm banks, cryopreservation of gametes and embryos</p> <p>2.4.6 Surrogacy</p>	15L
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	<p>Practical I based on BH.USZO 401 PAPER I</p> <ol style="list-style-type: none">1. Study of population density by Line transect method & Quadrant method and calculate different diversity indices.<ol style="list-style-type: none">A. Index of DominanceB. Index of frequencyC. Rarity IndexD. Shannon Weinner IndexE. Index of species diversity2. Study of prokaryotic cells (bacteria) by Crystal violet staining technique3. Study of eukaryotic cells (WBCs) from blood smear by Leishman's stain4. Identification and study of fossils<ol style="list-style-type: none">a. Arthropods: Trilobiteb. Mollusca: Ammonitec. Aves: Archaeopteryx5. Identification of<ol style="list-style-type: none">a. Allopatric speciation (Cyprinodont species)b. Sympatric speciation (Hawthorn fly and Apple maggot fly)c. Parapatric speciation (Snail)6. Estimation of Dissolved oxygen (DO) from the given water sample.7. Estimation of pH and salinity from the given water sample.8. Estimation of total alkalinity and total dissolved solids (TDS) from the given water sample.	45L
	<p><u>Practical II based on BH.USZO 402 PAPER II</u></p> <ol style="list-style-type: none">1. Study of mitosis- temporary squash preparation of Onion root tip.2. To study the lipid solubility of membranes.3. Qualitative tests for carbohydrate (Molisch test, Barfoed test, Benedict test)4. Qualitative tests for proteins (Ninhydrin test, Biuret test, Millon test)5. Qualitative tests for lipids (Sudan III test, Solubility test)6. Quantitative test for cholesterol7. Ultrastructure of cell organelles (Electron micrographs)<ol style="list-style-type: none">a. Nucleusb. Endoplasmic reticulum (Smooth and rough)c. Mitochondriad. Golgi apparatuse. Lysosomes8. Study of clinical disorders due to carbohydrates, proteins and lipids imbalance:<ol style="list-style-type: none">a. Hyperglycemia,b. Hypoglycemia,c. Kwashiorkor,d. Obesity,	45L



	e. Atherosclerosis.	
	<p style="text-align: center;"><u>Practical III based on</u> BH.USZO 403 EA PAPER III</p> <ol style="list-style-type: none"> 1. Morphometric and Meristic characters of fish. 2. Mountings of scales in fish. 3. Study of tail fins/Caudal fins in fish. 4. Detection of pregnancy hormone from a given sample of urine/birth control pill. 5. Study of the following permanent slides, museum specimens and materials <ol style="list-style-type: none"> a. Mammalian sperm and ovum b. Egg types –fish egg, frog egg, hen's egg c. Cleavage, blastula and gastrula (Amphioxus, Frog and Bird). 6. Identification of fish: Fresh/Marine and Brackish water. 7. Identification of Crafts and Gears 8. Study of morphology and life cycle of <i>Bombyx mori</i> 9. Field visit to local fish market/Fish landing center. 	45L

Text books

Reference Books:

USZO401 POPULATION EVOLUTION , GENETICS AND ECOLOGY

1. Theory of Evolution- Smith, Cambridge Press, and Low price Ed
2. Evolution - Strickberger, CBS publication
3. Evolution- P.S.Verma and Agarwal
4. Introduction to Evolution by Moody
5. Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
6. Biology -The Unity and Diversity of Life. C. Starr, R. Taggart, C. Evers, L.Starr, Brooks/Cole Cengage learning International Edition
7. Handbook of Applied Hydrology, Second Edition, Vijay P. singh.
8. Introduction to Population Ecology, Larry L. Rockwood
9. Population Ecology: *First Principles - Second Edition*, John H. Vandermeer and Deborah E. Goldberg

USZO402 CYTOLOGY



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. A textbook of cytology Surbhi Tyagi Dominant Publishers and Distributors New Delhi.
4. Cell and molecular biology Gupta P.K ,Rastogi Publication, India.
5. Cell Biology Pawar C.B. Himalaya publication
6. Molecular Biology of the cell (6thed) by the Insertus
7. Campbell Biology (9thEd.)
8. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M ,
9. Biochemistry, Dushyant Kumar Shurma, 2010, Narosa Publishing house PVT.Ltd.
10. Fundamentals of Biochemistry, Dr AC Deb, 1983, New Central Book Agency Ltd.
11. A Textbook of Biochemistry, 9th edition, Dr. Rama Rao A.V.S.S and Dr A Suryalakshmi.
12. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989 , Freeman and Co. NY
13. Harper's Biochemistry, 1996, 26th edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA

USZO403 EA ECONOMIC ZOOLOGY II

- 1) Developmental Biology- 5th Edition, Scot F.Gilbert, Sinauer Associates Inc.
2. Developmental Biology- Subramoniam T., Narosa Publishers.
3. Developmental Biology-Berril N.J., Tata McGraw –Hill Publication.
4. Essential Reproduction-Martin H. Johnson, Wiley-Blackwell Publication.
5. Chick Embryology- Bradley M. Pattern.
6. Embryology-Mohan P. Arora.
7. Chordate Embryology-Dalela, Verma and Tyagi
8. Human Anatomy and Physiology. E. L. Marieb, Pearson Education Low Price Edition
9. Biological Science. Taylor, Green and Stout. Cambridge Publication
10. Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
11. Human Biology-Daniel D Chiras Jones and Bartlett
12. The Physiology of Reproduction Vol I & II - E.K .Nobil and JU. D.Neil, Raven Press, New York.
- Latest Aquaculture, Principles and Practices by Pillay T.V.R. – Fishing News Books (1988).
16. Course Manual in Fishing Technology by Latha Shenoy, CIFE, Versova, Mumbai.
17. Prawn and Prawn Fisheries by Kurian and Sebastian
18. Freshwater aquaculture - R.k. rathy Scientific publication
- 19 A text book of fish biology and fisheries - Khanna & Singh Narendra Publication
- 20 Handbook of fisheries and aquaculture - Yadav ICAR
- 21 Fish processing technology – Gopakumar ICAR
- 22 Ornamental fish farming - Saroj. K, Swain ICAR
- 23 Sport fisheries of India - K.I. Sehgal ICAR
- 24 Coldwater fisheries of India V.g. Jhingran ICAR
- 25 Fish nutrition in aquaculture - Sena S. Desilva ICAR
- 26 Practical course manual fishery and gear technology - Lathashenoy, CIFE, Mumbai
- 27 Breeding and seed production of finfish and shellfish - Thomas, Rath Daya pub.
- 28 Fundamental of fish taxonomy - Jayaram, KC Narendra



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Self study topics –

- 1. Self learning self paced courses on Swayam platform on related topics.**
- 2. You tube videos on related topics.**

Details of Conduct of Practical Examination (Evaluation Scheme):

Particulars	Paper I BH.USZO 401	Paper II BH.USZO 402	Paper III BH.USZO 403
Laboratory work	40	40	40
Journal	5	5	5
Viva	5	5	5

Total 150 marks shall be converted to 100

The students are required to present a duly certified journal for appearing at the semester end practical examination, failing which they will not be allowed to appear for the examination. In case of report of loss of Journal, a “Lost Certificate”, should be obtained from Head/ Coordinator of the department; failing which the student will not be allowed to appear for the practical examination.

MODALITY OF ASSESSMENT: SEMESTER III and IV

A) Internal Assessment- 40%: 40 marks

SR. NO.	CONTENT	MARKS
1.	Test (CIA 1)	20 M
2.	Assignment (CIA 2)	20 M

Assignment types can include:

Sr.No.	Semester	Format of CIA-2- Zoology	Type of Skill Developed
1.	III	Surveys	Analytical thinking and questioning skills



2.	III	Case studies/Report writing	Writing Skills and comprehension.
3	III	Model making	Creative thinking and its application in real time.
4	III	Seminar Presentation	Self-confidence, Speaking skills, presentation skills, application of powerpoint etc.
5.	IV	Self-study assignments	Self awareness and development, goal making ability, decision making skill.
6.	IV	Small Research Projects	Scientific and critical thinking. Application of scientific research knowledge.
7	IV	Societal Subject related venture (Kitchen waste composting, safe water drinking, hygiene of orphan homes, old-age homes etc).	Social awareness and implementation of knowledge gained previously. Enhance traits like empathy, gratitude, sustainable decision making skills.
8	IV	Oral Seminar Presentation	Self-confidence, Speaking skills, presentation skills, application of powerpoint etc.

B) External examination: 60%

a) Semester End Theory Assessment- 60%: 60 Marks



i) Duration – These examinations shall be of two and a half hours duration for each paper.

ii) Theory Question Paper Pattern:

- Each unit will carry a total of 20 marks.

The theory paper is divided as follows

Subjective Based Questions (45 marks)	Each unit will contribute 15 marks. There shall be one question consisting of two parts: A) I- 8 marks and II-7 marks questions OR B) Three questions of 5 marks. The learner has to attempt either A or B.
Subjective Based Questions (short notes only- 15 marks)	Each unit will contribute 5 marks. There shall be two questions of 5 marks from each unit. The learner has to attempt either one 5 marks question from each unit.

b) Practical: 50 Marks

Paper Pattern:(Semester end Examination III & IV)

MARKS: 60

DURATION: 2.5 HOURS.

Question	Options	Marks	Questions based on	Nature of questions
Q1.	Either A (8+ 7) or B (3Q x 5)	15	unit 1	Subjective
Q2.	Either A (8+7) or B (3Q x 5)	15	unit 1	Subjective
Q3.	Either A(8+ 7 or B (3Q x 5)	15	unit	Subjective
Q4	Compulsory 3Q.	15	all 3 units	Subjective
	Total	60		

Overall Examination & Marks Distribution Pattern

Semester III

Course	BH.UZO 301			BH.UZO 302			BH.UZO 303			Practical	Total
	CIA	ESE	TOTAL	CIA	ESE	TOTAL	CIA	ESE	TOTAL		
Theory	40	60	100	40	60	100	40	60	100	100	400



Semester IV

Course	BH.UZO 401			BH.UZO 402			BH.UZO 403				
	CIA	ESE	TOTAL	CIA	ESE	TOTAL	CIA	ESE	TOTAL	Practical	Total
Theory	40	60	100	40	60	100	40	60	100	100	400

Rubrics of evaluation for ESE

Unit	Knowledge	Understanding	Analysis & critical thinking	Total marks/unit
1	03	06	06	15
2	03	06	06	15
3	03	06	06	15
4	03	06	06	15
Total per objective	12	24	24	60
% weightage	20	40	40	100

Rubrics of evaluation for CIA-2 assignment

Class: _____ Roll No _____ Topic _____

Parameters	Max Marks	80 – 100% Excellent	60 -80% Good	40 – 60% Satisfactory	20 – 40% Poor	0-20% very poor
CONTENT	10					
Content: Introduction –	02					
Content: Development	03					
Content:– Conclusion -	03					
Content: - Bibliography	02					



Effective Research Skills	10					
Language, Style and Structure;	05					
Aids	05					
Total	20					

Name of evaluator _____

PRACTICAL (SEMESTER III)
USZOP3 (Course - V)
Skeleton-Practical Examination Question Paper Pattern

Time: 2hrs 30 min

Marks: 50

Major Question	15
Q1. Extraction and detection of DNA OR Q1. Extraction and detection of RNA	
Minor Question	07
Q2. Mounting of Barr bodies OR Q2. Mounting of Polytene chromosomes	
Q3. Problems based on Molecular biology and Linkage & Mapping (01 problem each)	10
Q4. Identification A. Chromosome morphology B. Pedigree analysis	08
Q5. Viva	05
Q.6 Journal	05



PRACTICAL (SEMESTER III)
BH.USZOP3 (Course - VI)

Skeleton-Practical Examination Question Paper Pattern

Time: 2hrs 30 min

Marks: 50



Q.1 Urine analysis—Normal and Abnormal constituents	
OR	08
Q.1 Study of Osmosis from the Given Blood Sample	08
Q.2 Preparation of Haemin Crystals using Human Blood	
OR	06
Q.2 Demonstrate Lung Capacity of Humans.	06
Q.3 Illustrate with a diagram striated (chicken thigh) and non-striated muscle fibre (chicken-stomach/intestine).	05
OR	
Q.3. Demonstrate the contraction of muscle through Glycerinated Muscle Fibres.	05
Q.4 Sketch and draw the mouthparts/wings/legs of mosquito/ House fly	04
OR	
Q.4 To determine Bleeding time	04
OR	
Q.4 To determine Clotting time	04
Q.5. Identify and describe as per instructions.	09
a) T.S of artery and Vein (Mammal)/Medullated and Non Medullated nerve fibre	
b) T.S of Stomach/Duodenum/ Liver and Pancreas	
c) T.S of Lungs and L.S kidney (Mammal).	
Q.6 Project on Nutrient Rich food Sources (vegetable and Fruits) their seasonal availability and Price / Study of Nutrition value using Labeling on Selected Packed Food materials. / Computational calculation of Nutritional Food Value	08
Q5. Viva	05
Q.6 Journal	05



PRACTICAL (SEMESTER III)
USZOP3 (Course – VII EA)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min

Marks: 50

Major Question	12
Q1. Extraction of casein from milk and its qualitative detection OR Q1. Measurement of density of different samples of milk by lactometer	
Minor Question (Sketch and label)	08
Q2. Life cycle of honey bee OR Q2. Mouthparts of honey bee OR Q2. Legs of honey bee OR Q2. Sting apparatus of honey bee	
Q3. Identify and describe as per instructions a. Ethology b. Protozoan parasites c. Helminth parasites d. Ectoparasites e. Parasitic adaptations	15
Q4. a) Project submission b) Viva based on project	06 04
Q5. Journal	05



**PRACTICAL (SEMESTER IV)
USZOP4 (Course - VIII)**

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min	Marks: 50
Major Question	
Q1. Study Population density by Line transect or Quadrant method and calculate Biodiversity Indices (any 2)	12
OR	
Q.1 Estimation of pH and salinity in a given water sample.	
OR	
Q.1 Estimation of salinity and pH in given water sample.	
OR	
Q.1 Estimation of Total alkalinity and TDS in given water sample.	
Minor Question	10
Q2. Prepare a smear to show prokaryotic cell	
OR	
Q2. Prepare a smear to show eukaryotic cell	
Q3. Identify and describe as per instructions	08
a. Fossil	
b. Speciation	
Q5. Problems based on Hardy Weinberg principle (TWO)	10
Q6. Viva	05



Q.7.Journal

05

**PRACTICAL (SEMESTER IV)
USZOP4 (Course IX)**

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min

Marks: 50

Major Question

15

Q1. Study of mitosis- temporary squash preparation of Onion root tip.

OR

Q.1 Demonstrate the solubility of lipid membrane.



Minor Question	10
Q2. Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test)	
OR	
Q2. Qualitative tests for proteins (Ninhydrin test, Biuret test, Millon's test)	
OR	
Q2. Qualitative test for lipids (Solubility test, Sudan III test)	
OR	
Q2. Quantitative estimation of Cholesterol	
Q3. Identify and describe as per instructions	15
i. Ultrastructure of cell organelles (a, b & c)	
ii. Clinical disorders (d & e).	
Q4. Viva	05
Q5 Journal	05



**PRACTICAL (SEMESTER IV)
USZOP4 (Course X)**

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min

Marks: 50

Major question

- Q.1 To study the morphometric and meristic characters of fish. 12
OR
Mounting of fish scales (placoid, ctenoid, cycloid) and study of fish tail fins.
- Q.2 Detection of pregnancy hormone from given sample of urine/**birth control pill** 05
- Q.3 Identification w.r.t embryology and reproduction (a,b) 06
a. Types of eggs / mammalian sperm and egg
b. Cleavage / blastula / gastrula.
- Q.4 Identification w.r.t fishery and sericulture 12
a. Marine / freshwater / brackish water fish
b. Crafts / Gears / Fish products and by-products
c. Identify the stages of the life cycle of silkworm.
- Q.5 Report on Field visit to local fish market/Fish landing center. 05
- Q.6 Viva based on field visit 05
- Q.7 Journal 05





SEMESTER 3			
PAPER	UNIT	DELETED PORTION	REASON



<p>Paper 1: (BH.USZ O 301)</p> <p>GENETICS AND MOLECULAR BIOLOGY</p>	<p>Unit 1 – Chromosomes and Heredity</p>	<p>Deletion.</p> <p>1.1 Introduction to Genetics Definition, Scope and Importance of Genetics. Classical and Modern concept of Gene (Cistron, Muton, Recon). Brief explanation of the following terms: Allele, Wild type and Mutant alleles, Locus, Dominant and Recessive traits, Homozygous and Heterozygous, Genotype and Phenotype, Genome.</p> <p>1.2 Mendelian Genetics Mendelian Genetics: Monohybrid & Dihybrid Cross, Test Cross, Back Cross, Mendel's Laws of Inheritance, Mendelian Traits in Man. Exceptions to Mendelian inheritance: Incomplete dominance, Codominance, Lethal Genes, Epistasis - Recessive, Double recessive, Dominant and Double dominant. Chromosome theory of inheritance. Pedigree Analysis-Autosomal dominant and recessive, X- linked dominant, and recessive.</p> <p>1.3 Multiple Alleles and Multiple Genes. Concept of Multiple Alleles, Coat colour in rabbit, ABO and Rh blood group systems. Polygenic inheritance with reference to skin colour and eye colour in humans. Concept of Pleiotropy.</p> <p>1.4 Linkage and Crossing Over. Linkage and crossing over, Types of crossing over, Cytological basis of crossing over.</p>	<p>Included in Semester 2</p>
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	Unit 2 – Recombination and Human Genetics	Deleted and shifted to Unit 1 (Paper 1)	Shifted to Unit 1
	Unit 3 – Molecular Biology	No Deletion	-----
Paper 2: (BH.USZ O302) ANIMA L PHYSIO LOGY	Unit 1 – Nutrition and Excretion	Deletion 1.1 Comparative study of nutritional apparatus (structure and function): Amoeba, Hydra, Cockroach, Amphioxus, Pigeon, Ruminants. 1.2 Physiology of digestion in man. 1.3 Comparative study of excretory and osmoregulatory structures and functions. a) Amoeba -Contractile vacuoles. b) Planaria -Flame cells c) Cockroach-Malphigian tubules and Green Gland 1.4 Categorization of animals based on principle nitrogenous excretory products 1.5 Structure of kidney, uriniferous tubule and physiology of urine formation in man	Shifted to Semester 2



	Unit 2 – Respiration and Circulation	Deletion 2.1 Comparative study of respiratory organs (structure and function): Earthworm, Spider, Any bony fish (Rohu/Anabas/Clarius), Frog and Pigeon. 2.2 Structure of lungs and physiology of respiration in man 2.3 Comparative study of circulation: (a) Open and Closed type, (b) Single and Double type 2.4 Types of circulating fluids- Water, Coelomic fluid, Haemolymph, Lymph and Composition of blood 2.5 Comparative study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon. 2.6 Structure and mechanism of working of heart in man	Shifted to Semester 2
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	Unit 3 – Control and Coordination, Locomotion and Reproduction	<p>Deletion</p> <p>3.1 Control and coordination. Irritability in Paramecium, nerve net in Hydra, nerve ring and nerve cord in earthworm. Types of neurons based on the structure and function. Conduction of nerve impulse: Resting potential, Action potential and Refractory period. Synaptic transmission</p> <p>3.2 Movement and Locomotion. Locomotory organs- structure and functions; a. Pseudopodia in Amoeba (Sol-Gel theory), Cilia in Paramecium b. Wings and legs in cockroach c. Tube feet in starfish d. Fins of fish</p> <p>3.3 Structure of striated muscle fibre in human and sliding filament theory</p> <p>3.4 Reproduction a. Asexual Reproduction- Fission, Fragmentation, Gemmule formation and Budding. b. Sexual reproduction i. Gametogenesis ii. Structure of male and female gametes in human iii. Types of fertilization iv. Oviparity, Viviparity, Ovo-viviparity</p>	Shifted to Semester 2
Paper 3: (BH.USZ O303 EA) ECONO MIC	Unit 1 - Ethology	No deletion	-----



ZOOLOGY – I			
	Unit 2 – Parasitology	Deletion 2.1 Introduction to Parasitology and types of parasites. Types of parasites-Definitive, Intermediate, Ectoparasite, Endoparasite and their subtypes	To maintain the no of lectures to complete portion
	Unit 3 – Economic Zoology I	No deletion	-----



SEMESTER 4

PAPER	UNIT	DELETED PORTION	REASON
Paper 1: (BH.USZO 401) POPULATION EVOLUTION, GENETICS AND ECOLOGY	Unit 1 – Evolution	No deletion.	-----



	<p>Unit 2 – Recombination and Human Genetics</p>	<p>Deletion</p> <p>2.1 Introduction to Population genetics</p> <p>Definition</p> <p>Brief explanation of the following terms: Population, Gene pool, Allele frequency, Genotype frequency, Phenotype frequency, Microevolution</p> <p>2.2 Population genetics</p> <p>Hardy- Weinberg Law</p> <p>Factors that disrupt Hardy Weinberg equilibrium: Mutation, Migration (gene flow), Non-random mating (inbreeding, inbreeding depression, assortative mating (positive and negative), disassortative mating, Genetic drift (sampling error, fixation, bottleneck effect and founder effect)</p> <p>Natural Selection: Patterns of Natural Selection- Stabilizing selection, Directional selection (examples: peppered moth, antibiotic resistance in bacteria, pesticide resistance) and Disruptive selection</p> <p>2.3 Evolutionary genetics</p> <p>Genetic variation: Genetic basis of variation-mutations and recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random</p>	<p>To include a new topic</p>
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union of gametes during fertilization)

Nature of genetic variations: Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism Heterozygote advantage and frequency dependent selection.

Neutral variation.

Geographic variation (Cline)

Species concept: Biological species concept and evolutionary species concept

Speciation and Isolating mechanisms: Definition and modes of speciation (allopatric, sympatric, parapatric and peripatric)

Geographical isolation

Reproductive isolation and its isolating mechanisms (prezygotic and postzygotic)

2.4 Macroevolution and megaevolution: Concept and Patterns of macroevolution (stasis, preadaptation /exaptation, mass extinctions, adaptive radiation and coevolution), Megaevolution



	Unit 3 – Ecology	<p>Deletion</p> <p>3.1 Process of science: A dynamic approach to investigation: The Scientific method, Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery (serendipity) Scientific research: Definition, difference between method and methodology, characteristics, types 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 Dissemination of data: Reporting results to scientific community (publication in peer-reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation)</p>	Decided to be shifted in Semester 5
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		<p>Application of knowledge: Basic research, Applied research, Translational research, Patent</p> <p>3.2 Scientific writing: 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>3.3 Writing a review paper Structure and components of research report: Report writing, Types of report Computer application: Plotting of graphs, Statistical analysis of data. Internet and its application in research- Literature survey, online submission of manuscript for publication</p> <p>3.4 Ethics Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Dissection Monitoring Committee (DMC)</p>	
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Ethics in clinical research: Approval from clinical research ethics committee or/and informed consent
Approval from concerned/ Appropriate Authorities: National Biodiversity Authority, State Biodiversity Board, Forest Department
Conflict of interest
3.5 Plagiarism



Paper 2: (BH.USZO402) CYTOLOGY	Unit 1 – Cell biology	Deletion 1.2 Cytoskeletal structures Microtubules: Composition and functions Microfilaments: Composition and functions	To maintain the no of lectures to complete portion
	Unit 2 – Endomembrane system	Deletion 2.3 Lysosomes: Origin, occurrence.	To maintain the no of lectures to complete portion
	Unit 3 – Biomolecules	Deletion 3.6 Vitamins: Water soluble vitamins(e.g. Vit C, Vit B12) Lipid soluble vitamins (e.g. Vit A, Vit D) Biological role and clinical significance	To maintain the no of lectures to complete portion
Paper 3: (BH.USZO403 EA) REPRODUCTIVE BIOLOGY AND ECONOMIC ZOOLOGY 2	Unit 1 – Comparative embryology	No deletion	-----
	Unit 2 – Aspects of Human Reproduction	No deletion	-----



	<p>Unit 3 – Economic Zoology II</p>	<p>Deletion</p> <p>3.1 Air Pollution Types and sources of air pollutants Effects of air pollution on organisms, its control and abatement measures</p> <p>3.2 Water Pollution Types and sources of water pollutants Effects of water pollution on organisms, its control and abatement measures</p> <p>3.3 Soil Pollution Types and sources of soil pollutants Effects of soil pollution on organisms, its control and abatement measures</p> <p>3.4 Sound pollution Different sources of sound pollution Effects of sound pollution on organisms, its control and abatement measures</p> <p>3.5 Pollution by radioactive substances</p> <p>3.6 Pollution by solid wastes Types and sources, Effects of solid waste pollution, its control and abatement measures</p> <p>3.8 Pollution – Climate Change and Global Warming</p>	<p>To include a new topic</p>
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