

Janardan Bhagat Shikshan Prasarak Sanstha's
Changu Kana Thakur
Arts, Commerce and Science College, New Panvel
(Autonomous)
Re-accredited A+ Grade by NAAC



Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester III and IV

(Credit Based Semester and Grading System with effect from
the academic year 2020-2021)

Syllabus for
S.Y.B.Sc.

Course – ZOOLOGY

1. Preamble
2. Aims
3. Syllabus Semester III & IV
4. Questions paper pattern (Theory & Practical)
5. References and Additional Reading

PREAMBLE

Changu Kana Thakur Arts, Commerce and Science College, New Panvel (Autonomous) has initiated several measures to bring competency and excellence in the Education. The significant measures taken to enhance academic standards and quality in higher education include innovation and improvements in the curriculum. Board of Studies in Zoology constituted for the revising of S.Y.B.Sc. Zoology course will be effective from the Academic year 2020-2021 and follow the semester mode. During the meeting Committee prepared syllabus keeping in view of requirements of B.Sc. Zoology learners.

The content has been drawn up to accommodate the widening horizons of the discipline of the Biological sciences. Learners pursuing course would have to develop in-depth understanding various aspects of the subject. The working principles, design guidelines and experimental skills associated with different fields of Zoology such as Genetics, Cell Biology, Physiology, Developmental Biology etc.

Diversity in the life forms needs to be understood by a Zoologist for its socioeconomic capital, in case a student is interested in entrepreneurship, through applied aspects of Zoology. It provides students with the knowledge and skill base that would enable them to undertake further studies in Zoology and help to develop a range of various skills that are relevant to wage employment, self-employment and entrepreneurship.

A special feature of this program has been the introduction of Sericulture, Apiculture and Dairy science and Aquaculture in the areas of applied sciences. The course content also lists the new practical's exercises so that the learners get hands on training experiences of the latest techniques that are in current usage.

Aims

- To nurture interest in the students for the subject of Zoology
- To create awareness of the basic and modern concepts of Zoology
- To study of heredity and its variations
- To orient students to study of the origin of animals and their adaptation to their environments
- To motivate the students for self-employment in various applied branches of Zoology.
- To inculcate good laboratory practices in students and to train them about scientific handling of important instruments.

Outcomes of the syllabus

- Demonstrate in-depth knowledge and understanding about the fundamental concepts, principles and processes in the field of Applied Zoology and its different subfields.
- To deliver procedural knowledge and skills that creates different types of professionals in the field of Zoology and related fields such as, Apiculture, Aquarium fish keeping, Aquaculture, and Sericulture, etc.
- To learn the complexity of life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.
- To study concepts, principles and theories related with animal behavior and welfare.
- To understand and interpret biological data to design and conduct experiments to test a hypothesis.
- To accept the legal restrictions & ethical considerations placed for animal welfare
- To understand fundamental aspects of animal science relating to management of animals

S.Y.B.Sc.					
Semester III			Semester IV		
Course 5	Course 6	Course 7 Elective 1	Course 8	Course 9	Course 10 Elective 2
Unit 1 Fundamentals of Genetics	Unit 1 Study of Nutrition & Excretion	Unit 1 Developmen tal biology	Unit 1 Origin and Evolution of life	Unit 1 Cell Biology	Unit 1 Sericulture
Unit 2 Chromosome & Heredity	Unit 2 Respiration & Circulation	Unit 2 Ethology	Unit 2 Population Genetics and Evolution	Unit 2 Endomembrane System	Unit 2 Apiculture, and Dairy Science
Unit 3 Nucleic Acids	Unit 3 Nervous System in Invertebrates, Control and Coordination Locomotion & Reproduction	Unit 3 Parasitology	Unit 3 Scientific Aptitude, Methodology, Writing & Ethics	Unit 3 Biomolecules	Unit 3 Aquaculture
Practical I	Practical II	Practical III	Practical I	Practical II	Practical III

Syllabus for S.Y.B.Sc.
Course – ZOOLOGY
To be implemented from Academic year 2020-21
SEMESTER - III

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO301	I	Fundamentals of Genetics	2	1
	II	Chromosomes and Heredity		1
	III	Nucleic acids		1
USZO302	I	Nutrition and Excretion	2	1
	II	Respiration and Circulation		1
	III	Nervous System in Invertebrates, Control and coordination, Locomotion and Reproduction		1
USZO303	I	Developmental Biology	2	1
	II	Ethology		1
	III	Parasitology		1
USZOP3		Practical's based on all three courses	3	9

**Syllabus for S.Y.B.Sc.
Course – ZOOLOGY
Semester IV**

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO401	I	Origin and Evolution of Life	2	1
	II	Population genetics and evolution		1
	III	Scientific Aptitude, Methodology, Writing & Ethics		1
USZO402	I	Cell Biology	2	1
	II	Endomembrane System		1
	III	Biomolecules		1
USZO403	I	Sericulture	2	1
	II	Apiculture and Dairy Science		1
	III	Aquaculture		1
USZOP4		Practical's based on all three courses	3	9

Syllabus
for
S.Y.B.Sc.

Course – ZOOLOGY

1. Syllabus Semester III & IV (Theory and Practical)
2. References and Additional Reading
3. Scheme of Examination and Paper Pattern (Theory and Practical)

S.Y.B.Sc .SYLLABUS DRAFT

SEMESTER III

USZO301 COURSE-5

Fundamentals of Genetics, Chromosomes and Heredity, Nucleic acids

Sr. No	USZO301 COURSE-5	No. of lecture allotted	Learning pleasure
	Fundamentals of Genetics, Chromosomes and Heredity, Nucleic acids		
	Unit 1: Fundamentals of Genetics	15L	25hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To introduce basic terms of genetics.</i> ➤ <i>To develop conceptual clarity of Mendelian principles of inheritance and other forms and pattern of inheritance</i> 		
	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner would comprehend and apply the principles of inheritance to study heredity.</i> ➤ <i>Learner will understand the concept of multiple alleles, linkage and crossing over.</i> 		
1.1	<p>Introduction to Genetics</p> <ul style="list-style-type: none"> ● 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. 	2L	2hrs

1.2	<p>Mendelian Genetics</p> <ul style="list-style-type: none"> ● Mendelian Genetics: Monohybrid & Dihybrid Cross, Test Cross, Back Cross, Mendel 's Laws of Inheritance, Mendelian Traits in Man. ● Exceptions to Mendelian inheritance: Incomplete dominance, Co- dominance, 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. 	8L	12hrs
1.3	<p>Multiple Alleles and Multiple Genes</p> <ul style="list-style-type: none"> ● Concept of Multiple Alleles, Coat colour in rabbit, ABO and Rh blood group system ● Polygenic inheritance with reference to skin colour and eye colour in humans. ● Concept of Pleiotropy. 	03L	06hrs
1.4	<p>Linkage and Crossing Over</p> <ul style="list-style-type: none"> ● Linkage and crossing over, Types of crossing over, Cytological basis of crossing over. 	02L	05hrs
Unit: 2: Chromosomes and Heredity		15L	26hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To familiarize the learners with the structure, types and classification of chromosomes.</i> ➤ <i>To introduce the concept of sex determination and its types, sex influenced and sex-limited genes.</i> 		

	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner will comprehend the structure of chromosomes and its types.</i> ➤ <i>Learner will understand the mechanisms of sex determination.</i> ➤ <i>Learner would be able to correlate the disorders linked to a particular sex chromosome.</i> 		
2.1	<p>Chromosomes</p> <ul style="list-style-type: none"> ● Types of Chromosomes–Autosomes and Sex chromosomes ● Chromosome structure - Heterochromatin, Euchromatin ● Classification based on the position of centromere ● Endomitosis, Giant chromosomes- Polytene and Lampbrush chromosomes and Significance of Balbiani rings 	04L	08hrs
2.2	<p>Sex- determination</p> <ul style="list-style-type: none"> ● Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW ● Sex determination in Honey bees: Haplo-diploidy ● Sex determination in <i>Drosophila</i>- Genic balance theory, Intersex, Gynandromorphs ● Parthenogenesis ● Hormonal influence on sex determination- Freemartin and Sex reversal. ● Role of environmental factors- <i>Bonelia</i> and Crocodile ● Barr bodies and Lyon hypothesis 	07L	10hrs
2.3	<p>Sex linked, sex influenced and sex-limited inheritance.</p> <ul style="list-style-type: none"> ● X-linked: Colour-blindness, Haemophilia ● Y-linked: Hypertrichosis ● Sex-influenced genes ● Sex-limited genes 	04L	08hrs

	Unit: 3. Nucleic acids	15L	30hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To introduce the learner to the classical experiments proving DNA as the genetic material.</i> ➤ <i>To introduce the learner the structure of nucleic acids and the concept of central dogma of molecular biology.</i> ➤ <i>To familiarize the learner with the concept of gene</i> 		
	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner will understand the importance of nucleic acids as genetic material.</i> ➤ <i>Learner would comprehend and appreciate the regulation of gene expressions.</i> 		
3.1	<p>Genetic material</p> <ul style="list-style-type: none"> ● Griffith's transformation experiment, Avery-Macleod & McCarty experiment and Hershey Chase experiment of Bacteriophage infection ● 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 ● Extra nuclear DNA - Mitochondria and Chloroplast ● RNA as a genetic material in virus ● Types of RNA: Structure and function 	07L	14hrs
3.2	<p>Flow of genetic information in a eukaryotic cell</p> <ul style="list-style-type: none"> ● DNA Replication ● Transcription of mRNA ● Translation ● Genetic code 	05L	08hrs

3.3	Gene expression and regulation <ul style="list-style-type: none">● One gene-one enzyme hypothesis /one polypeptide hypothesis● Concept of Operon● Lac Operon	03L	08hrs
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USZO302 COURSE-6

Study of Nutrition and Excretion, Respiration and circulation, Control and coordination, Locomotion and Reproduction

SEMESTER – III			
Sr. No.	USZO302 (COURSE-VI)	No. of lectures allotted	Learning pleasure
	Nutrition and Excretion, Respiration and Circulation, Nervous system in Invertebrates, Control and Coordination, Locomotion and Reproduction		
	Unit: 1 Nutrition and Excretion	15L	23hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To introduce the concepts of physiology of nutrition, excretion and osmoregulation.</i> ➤ <i>To expose the learner to various nutritional apparatus, excretory and osmoregulatory structures in different classes of organisms.</i> 		
	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner would understand the increasing complexity of nutritional, excretory and osmoregulatory physiology in evolutionary hierarchy.</i> ➤ <i>Learner would be able to correlate the habit and habitat with nutritional, excretory and osmoregulatory structures.</i> 		
1.1	Comparative study of nutritional apparatus (structure and function): Amoeba, Hydra, Cockroach, Amphioxus, Pigeon, Ruminants.	05L	06hrs
1.2	Physiology of digestion in man.	02L	04hrs

1.3	Comparative study of excretory and osmoregulatory structures and functions. a) Amoeba -Contractile vacuole b) Planaria -Flame cells c) Cockroach- Malpighian tubules	05L	08hrs
1.4	Categorization of animals based on principle nitrogenous excretory products	01L	01hrs
1.5	Structure of kidney, uriniferous tubule and physiology of urine formation in man	02L	04 hr
Unit: 2 Respiration and Circulation		15L	27hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To introduce the concepts of physiology of respiration and circulation</i> ➤ <i>To expose the learner to various respiratory and circulatory organs in different classes of organisms.</i> 		
	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner would understand the increasing complexity of respiratory and circulatory physiology in evolutionary hierarchy.</i> ➤ <i>Learner will be able to correlate the habit and habitat of animals with respiratory and circulatory organs.</i> 		
2.1	Comparative study of respiratory organs (structure and function): Earthworm, Spider, Any bony fish (Rohu / <i>Anabas /Clarius</i>), Frog and Pigeon.	03L	06hrs
2.2	Structure of lungs and physiology of respiration in man	02L	03hrs
2.3	Comparative study of circulation: (a) Open and Closed type, (b) Single and Double type.	02L	04hrs

2.4	Types of circulating fluids- Water, Coelomic fluid, Haemolymph, Lymph and Composition of blood	02L	03hrs
2.5	Comparative study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon.	04L	07hrs
2.6	Structure and mechanism of working of heart in man.	02	04hrs
	Unit: 3 Nervous system in Invertebrates, Control and Coordination, Locomotion and Reproduction	15L	25hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To introduce the concepts of physiology of control and coordination, locomotion and reproduction.</i> ➤ <i>To expose the learner to various locomotory and reproductive structures in different classes of organisms.</i> 		
	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner would understand the process of control and coordination by nervous and endocrine regulation.</i> ➤ <i>Learner would be amazed by various locomotory structures found in the animal kingdom.</i> ➤ <i>Learner would be acquainted with various reproductive strategies present in animals.</i> 		
3.1	<p>Nervous system in Invertebrate</p> <ul style="list-style-type: none"> ● Irritability in <i>Paramecium</i>, nerve net in <i>Hydra</i>, nerve ring and nerve cord in earthworm. <p>Control and Co-ordination</p> <ul style="list-style-type: none"> ● Types of neurons based on the structure and function. ● Conduction of nerve impulse: Resting potential, Action potential and Refractory period 	05L	08hrs

3.2	<p>Movement and Locomotion</p> <p>Locomotory organs- structure and functions;</p> <p>a. Pseudopodia in Amoeba (Sol- Gel theory), Cilia in <i>Paramecium</i></p> <p>b. Wings and legs in cockroach</p> <p>c. Tube feet in starfish</p> <p>d. Fins of fish</p>	04L	08hrs
3.3	Structure of striated muscle fibre in human and sliding filament theory	02L	02hrs
3.4	<p>Reproduction</p> <p>a. Asexual Reproduction- Fission, Fragmentation, Gemmule formation and Budding</p> <p>b. Sexual reproduction</p> <p>i. Gametogenesis</p> <p>ii. Structure of male and female gametes in human</p> <p>iii. Types of fertilization</p> <p>iv. Oviparity, Viviparity, Ovo-viviparity</p>	04L	07hrs

USZO 303 COURSE-7
Amazing animals, Ethology and Parasitology

SEMESTER III			
USZOE1303 (COURSE-VII)			
Developmental Biology, Ethology and Parasitology,			
Unit 1: Developmental Biology		15L	23hrs
Objectives:			
➤ <i>To acquaint the learner with key concepts of embryology</i>			
Desired Outcome:			
➤ <i>Learner will be able to understand and compare the different types of eggs and sperms</i>			
➤ <i>Learner will be able to understand and compare the different pre- embryonic stages</i>			
1.1	Introduction of developmental biology	03L	5hrs
1.2	Structure and Types of Eggs and Sperm	02L	4hr
1.3	Fertilization: process and significance	02L	4hr
1.4	Cleavage and Blastulation : Definition, pattern, structure of blastula and its types	02L	4hrs
1.5	Gastrulation and Morphogenetic movements in early development	03L	5hr
1.6	IVF: Technique, Advantages and Disadvantages.	03L	5hr
Unit: 2 Ethology			
Objectives:			
➤ <i>To equip learner with a sound knowledge of how animals interact with one another and their environment.</i>			

	<p>➤ <i>To enable the learner to understand different behavioural patterns.</i></p>		
	<p>Desired Outcome:</p> <p>➤ <i>Learner would gain insight into different types of animal behaviour and their role in biological adaptations.</i></p> <p>➤ <i>Learner would be sensitized to the feelings which are instrumental in social behaviour.</i></p>		
2.1	<p>Introduction to Ethology:</p> <ul style="list-style-type: none"> ● Definition, History and Scope of Ethology ● Animal behaviour : Innate and Learned behaviour ● Types of learning: Habituation, Imprinting and Types of imprinting - Filial and sexual, Classical conditioning ● Instrumental learning and insight learning. 	04L	06hrs
2.2	<p>Aspects of animal behavior:</p> <ul style="list-style-type: none"> ● Communication in bees and ants ● Mimicry and colorations ● Displacement activities, Ritualization ● Migration in fish, schooling behaviour ● Habitat selection, territorial behavior 	07L	12hrs
2.3	<p>Social behaviour:</p> <ul style="list-style-type: none"> ● Social behaviour in primates-Hanuman langur ● Elements of socio-biology: Altruism and Kinship 	04L	08hrs
Unit: 3 Parasitology		15L	27hrs
	<p>Objectives:</p> <p>➤ <i>To acquaint the learner with the concepts of parasitism and its relationship in the environment.</i></p> <p>➤ <i>To introduce the learner to modes of transmission of</i></p>		

	<i>parasites.</i>		
	<p>Desired Outcome:</p> <ul style="list-style-type: none"> ➤ 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. 		
3.1	<p>Introduction to Parasitology and host specificity</p> <ul style="list-style-type: none"> ● Definitions: Parasitism, Host, Parasite, Vector-biological and mechanical ● Parasitic adaptations in Ectoparasites and Endoparasites ● Host Specificity- - parasite relationship, structural specificity, physiological specificity and ecological specificity 	04 L	06hrs
3.2	<p>Life cycle, pathogenicity, control measures and treatment</p> <ul style="list-style-type: none"> ● <i>Leshmania donovani</i> ● Liver fluke ● Leech ● Flea 	06L	06hrs
3.3	<p>Parasitological significance</p> <ul style="list-style-type: none"> ● Zoonosis- Bird flu, Anthrax, Rabies and Toxoplasmosis 	05L	03hrs

SEMESTER III
PRACTICAL USZOP1 (COURSE V)

Practical USZOP1 (COURSE V)	
1	Extraction and detection of DNA
2	Extraction and detection of RNA.
3	Mounting of Barr bodies.
4	Study of Polytene chromosome.
5	Study of mitosis- temporary squash preparation of Onion root tip
6	Detection of blood groups and Rh factor.
7	Problems in genetics
8	Chromosome morphology: Metaphase spreadsheet (photograph to be provided)
9	Pedigree analysis
10	Problems on molecular biology

SEMESTER III
PRACTICAL USZOP2 (COURSE VI)

PRACTICAL USZOP2 (COURSE VI)	
1	Urine analysis—Normal and abnormal constituents
2	Detection of ammonia in water excreted by fish
3	Detection of uric acid from excreta of Birds
4	Study of striated and nonstriated muscle fiber
5	Study of nutritional Apparatus (Amoeba, Hydra, Earthworm, Pigeon, Ruminant stomach)
6	Study of respiratory structures: a. Gills of Bony fish and Cartilaginous fish. b. Lungs of Frog c. Lungs of Mammal. d. Accessory respiratory structure in Anabas (Labyrinthine organ) e. Air sacs of Pigeon
7	Study of locomotory organs (Amoeba, Unio, Cockroach, Starfish, Fish, and Birds)
8	Study of hearts (Cockroach, Shark, Frog, Calotes, Crocodile, Mammal)
9	Study of permanent slides on topic of Reproduction a. Sponge gemmules b. Hydra budding c. T.S. of mammalian testis d. T.S. of mammalian ovary
10	Field visit- Visit to vermicomposting unit or Visit to Aquarium or wild life sanctuaries and submission of report. (Report may be submitted in a group not exceeding five students).

SEMESTER III
PRACTICAL USZOP3 (COURSE VII)

PRACTICAL USZOP3 (COURSE VII)	
1	Study of the following permanent slides- Mammalian sperm and ovum
2	Classification of Eggs – fish, frog and hen
3	Study of the following permanent slides - Cleavage, blastula and gastrula (Amphioxus, Frog and Bird)
4	Study of ethological aspects: a) Warning colouration b) Animal instinct c) Imprinting
5.	Study of ethological aspects: d) Communication in animals: Chemical signals and Sound signals e) Displacement activities in animals: Courtship and mating behaviour in animals and Ritualization
6	Study of Endoparasites: a. <i>Leishmania</i> b. Liver fluke
7	Study of Ectoparasites: a. Leech b. Flea
8	Parasitic adaptations: Scolex and mature proglottid of Tapeworm
9	Preparation and staining of temporary slides

Note -The practical's may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should 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. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.

#There shall be at least one excursion/field trip.

SEMESTER -III

REFERENCE BOOKS AND ADDITIONAL READING

COURSE-V (USZO301)

1. Principles of Genetics. Gardner, E.J., Simmons, M.J and Snustad, D.P. John Wiley and Sons
2. Concepts of Genetics. Klug, W.S., Cummings M.R., Spencer, C.A. Benjamin Cummings.
3. Genetics- A Molecular Approach. Russell, P. J Benjamin Cummings.
4. Genetics: Analysis of Genes and Genomes. Daniel L., Hartl, Elizabeth W. Jones Jones & Bartlett Publishers
5. Introduction to Genetic Analysis. Griffiths, A.J.F., Wessler. S.R., Lewontin, R.C. and Carroll, S.B. W. H. Freeman and Co.
6. Cell Biology, Genetics, Molecular Biology Evolution and Ecology. Verma P.S. and Agrawal P.K., 9th edition, S. Chand Publication, New Delhi.
7. Principles of Genetics – Eight edition- Eldon John Gardner, Michael J. Simmons, D. Peter Snustad
8. Genetics- Weaver, Hedrick, third edition, Mc Graw Hill Education
9. Genetics A Mendelian approach Peter Russel, Pearson Benjamin Cummings
10. Genetics A conceptual approach, Benjamin A. Pierce, Southwestern University, W.H. Freeman and company, New York
11. Genetics, Third Edition, M o n r o e W. Strickberger
12. Genetics from gene to genome, third edition, Leeland H. Hartwell, Leeroy Hood, Michael 7. L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education

SEMESTER -III

REFERENCE BOOKS AND ADDITIONAL READING

COURSE-VI (USZO302)

1. Vertebrate Zoology Volume I- Jordan and Verma, S. Chand and Co.
2. Invertebrate Zoology Volume II- Jordan and Verma, S. Chand and Co.
3. Invertebrate Zoology- Majupuria T. C., Nagin S.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.

SEMESTER -III
REFERENCE BOOKS AND ADDITIONAL READING

COURSE-VII (USZ0303)

1. Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
2. Animal Behavior: Mechanisms, Ecology and Evolution Stephen Vessey, Elizabeth Jacob, S. H. Vessey and L. C. Drickamer, McGraw-Hill.
3. Animal Behaviour- David McFarland
4. Animal Behaviour- Mohan Arora
5. Animal Behaviour- Reena Mathur
6. An introduction to Animal Behaviour- Manning and Dawkins
7. Animal Behaviour-Agarwal
8. Principles of Animal Communication. Bradbury, J.W. and S.L. Vehrencamp. Sinauer Assoc. Sunderland, Massachsets, USA.
9. The biology of Behaviour. Eibl-Eibesfeldt, I. Ethology. Holt, Rineheart & Winston, New York.
10. The Book of Indian Dogs- S. Theodore Baskaran (2017) Aleph Book Company
11. Newsletters- Animal Welfare Board of India- awbi.org
12. 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.
13. Park, Y. W., & Haenlein, G. F. (Eds.). (2013). Milk and dairy products in human nutrition: production, composition and health. John Wiley & Sons.
14. Venkatasubramanian, V., Singh, A. K., & Rao, S. V. N. (2003). Dairy development in India: An appraisal of challenges and achievements. Concept Publishing Company
15. Shrivastava, J. S. M. (2008). Dairy Development in The New Millennium (The Second White Revolution). Deep and Deep Publications.
16. Developmental Biology- 5th Edition, Scot F. Gilbert, Sinauer Associates Inc.
17. Developmental Biology- Subramoniam T., Narosa Publishers.
18. Developmental Biology-BerrilN.J., Tata McGraw –Hill Publication.
19. Essential Reproduction-Martin H. Johnson, Wiley-Blackwell Publication.
20. Chick Embryology- Bradley M. Pattern.
21. Embryology-Mohan P. Arora.
22. Chordate Embryology-Dalela, Verma and Tyagi

SCHEME OF EXAMINATION

- (a) One Theory examination of seventy-five (75) marks per course per semester should be conducted as per the following skeleton question paper pattern.
- (b) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.
- (c) Internal assessment and overall performance twenty-five (25) marks.

SKELETON PAPER PATTERN FOR THEORY EXAMINATION

NOTE: All Questions are compulsory.

Figures to the right indicate full marks.

Draw neat labelled diagrams wherever necessary.

Question number 1, 2 and 3 will be 20 Marks each and Question 4 for 15 Marks

Time: 2.5 hours

Total marks: 75

- Q.1. Unit I may have questions carrying 12 and 8 marks OR of 10 marks each with 100% internal options
- Q.2. Unit II may have questions carrying 12 and 8 marks OR of 10 marks each with 100% internal options
- Q.3. Unit III may have questions carrying 12 and 8 marks OR of 10 marks each with 100% internal options
- Q.4. Unit I, II and III (Any3 out of 6)
For Q.1, 2, 3 and 4 there shall be 100% internal option.

PRACTICAL
USZOP-I (COURSE V)
Skeleton-Practical Examination Question Paper Pattern

Time: 3 hrs

Marks: 50

Major Question

15 marks

Q1. Extraction and detection of DNA

OR

Q1. Extraction and detection of RNA

Minor Question

07 marks

Q2. Mounting of Barr bodies

OR

Q2. Study of mitosis-Temporary squash preparation of Onion root
tip OR

Q2. Detection of blood groups and Rh factor

Q3. Problems on Genetics and Molecular biology (Transcription /Genetic code) (01
problem each)

10 marks

Q4. Identification

08 marks

a. Chromosome morphology

b. Pedigree analysis

Q5. Viva and Journal

10 marks

**PRACTICAL
USZOP-2 (COURSE VI)**

Skeleton-Practical Examination Question Paper Pattern

Time: 3 hrs

Marks: 50

Major Question

15 marks

Q1. Urine analysis—Normal and abnormal constituents

Minor Question

10 marks

Q2. Detection of ammonia in water excreted by fish

OR

Q2. Detection of uric acid from excreta of Birds

Q3. Identification

15 marks

- a. Nutritional apparatus
- b. Respiratory structures
- c. Locomotory organs
- d. Study of hearts
- e. Permanent slides on reproduction

Q4. Viva

05 marks

Q5. Journal

05 marks

**PRACTICAL
USZOP-3 (COURSE VII)**

Skeleton -Practical Examination Question Paper Pattern

Time: 3 hrs

Marks: 50

Major Question

15 marks

Q1. Preparation and staining of temporary slides

Q2. Identify and describe as per instructions (3 marks each)

15 marks

- a. Any one permanent slide **classification** of Egg– fish, frog and hen
- b. Any one permanent slide Cleavage, blastula and gastrula (Amphioxus, Frog and Bird)
- c. Any one from Animal behavior
- d. Any one from Ectoparasites
- e. Any one from Endoparasites

Q3. Visit to IVF center report.

10 marks

Q4. Viva and Journal

10 marks

**SEMESTER IV
USZO401 COURSE-8**

Origin and Evolution of Life, Population Genetics, Scientific Attitude, Methodology, Scientific Writing and Ethics in Scientific Research

SEMESTER IV			
USZO401 COURSE-8			
	Origin and Evolution of Life, Population and Evolutionary Genetics, Scientific Attitude, Methodology, Scientific Writing and Ethics in Scientific Research.		
	Unit 1: Origin and Evolution of Life	15L	30hrs
	Objectives: ➤ <i>To impart scientific knowledge about how life originated and evolved on our planet.</i>		
	Desired outcomes: ➤ <i>Learner will gain insight about origin of life.</i> ➤ <i>Learner will ponder and critically view the different theories of evolution.</i>		
1.1	Introduction ● Origin of Universe ● Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory ● Origin of Life ● Origin of Eukaryotic cell	05L	10hrs
1.2	Evidences in favour of Organic evolution ● Evidences from: Geographical distribution, Palaeontology, Anatomy, Embryology, Physiology and Genetics	04L	08hrs

1.3	<p>Theories of organic evolution</p> <ul style="list-style-type: none"> ● Theory of Lamarck ● Theory of Darwin and Neo Darwinism ● Mutation Theory ● Modern Synthetic theory ● Weismann's Germplasm theory ● Neutral theory of Molecular evolution 	06L	12hrs
	Unit: 2: Population Genetics and Evolution	15L	28hrs
	<p>Objectives:</p> <p>➤ <i>To develop knowledge and understanding of genetic variability within a population and how the change in the gene pool leads to evolution of species</i></p>		
	<p>Desired outcomes:</p> <p>➤ <i>Learner would understand the forces that cause evolutionary changes in natural populations</i></p> <p>➤ <i>Learner would comprehend the mechanisms of speciation</i></p> <p>➤ <i>Learner will be able to distinguish between microevolution, macroevolution and megaevolution</i></p>		
2.1	<p>Introduction to Population genetics</p> <ul style="list-style-type: none"> ● Definition ● Brief explanation of the following terms: ● Population, Gene pool, Allele frequency, Genotype frequency, Phenotype frequency, Microevolution 	01L	03hrs

<p>2.2</p>	<p>Population genetics</p> <ul style="list-style-type: none"> ● Hardy- Weinberg Law ● Factors that disrupt Hardy Weinberg equilibrium: Mutation, Migration (Gene flow), Non-random mating (Inbreeding, inbreeding depression, Assortative Mating-Positive and Negative, Dis- assortative mating), Genetic drift (Sampling error, Fixation, Bottleneck effect and Founder effect) ● Natural Selection ● Patterns of Natural Selection ● Stabilizing selection ● Directional selection (Examples: Peppered moth, Antibiotic resistance in bacteria, Pesticide resistance) ● Disruptive selection 	<p>06L</p>	<p>10hrs</p>
<p>2.3</p>	<p>Evolutionary genetics</p> <ul style="list-style-type: none"> ● 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) ● Nature of genetic variations: Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced Polymorphism- Heterozygote advantage and frequency dependent selection, ● Neutral variations ● Geographic variation (Cline) 	<p>08L</p>	<p>15hrs</p>

	<ul style="list-style-type: none"> ● 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) 		
	<ul style="list-style-type: none"> ● Macroevolution and Megaevolution: Concept and Patterns of macroevolution (Stasis, Preadaptation /Exaptation, Mass extinctions, Adaptive radiation and Coevolution), Megaevolution 		
	Unit 3: Scientific Aptitude, Methodology, Writing and Ethics	15L	32hrs
	<p>Objective:</p> <ul style="list-style-type: none"> ➤ To inculcate scientific temperament in the learner. 		
	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ The learner will develop qualities such as critical thinking and analysis. ➤ The learner will develop the skills of scientific communication. ➤ Learner will understand the ethical aspects of research 		
3.1	<p>Process of science:</p> <ul style="list-style-type: none"> ● 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 	4L	10hrs

	<p>between method and methodology, characteristics, types</p> <p>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> <ul style="list-style-type: none"> ● Dissemination of data: Reporting results to scientific community (publication in peer-reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation) ● Application of knowledge: Basic research, Applied research and Translational research 		
3.2	<p>Scientific writing:</p> <ul style="list-style-type: none"> ● 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 	7L	15hrs
3.3	<p>Writing a review paper</p> <ul style="list-style-type: none"> ● Structure and components of review ● Report writing and types of report ● Computer application: Plotting of graphs, 	03L	05hrs

	Statistical analysis of data. Internet and its application in research-Literature survey, online submission of manuscript for publication		
3.4	Ethics <ul style="list-style-type: none">● Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Dissection Monitoring Committee (DMC)● Ethics in clinical research: Approval from clinical research ethics committee or/and informed consent	03L	05hrs
3.5	Plagiarism	1L	2hrs

SEMESTER IV
USZO402 COURSE-9
Cell Biology, Endo membrane System and Biomolecules

USZO402 COURSE-9			
Cell Biology, Endo membrane System and Biomolecules			
Unit 1: Cell Biology		15L	24hrs
	<p>Objective:</p> <p>➤ <i>To study the structural and functional organization of cell with an emphasis on nucleus, plasma membrane and cytoskeleton.</i></p>		
	<p>Desired outcome:</p> <p>➤ <i>Learner would acquire insight into the composition of the transport mechanisms adopted by the cell and its organelles for its maintenance and composition of cell</i></p>		
1.1	<p>Introduction to cell biology</p> <ul style="list-style-type: none"> ● Definition and scope ● Cell theory ● Generalized prokaryotic, eukaryotic cell: size, shape and structure 	02L	04hrs
1.2	<p>Nucleus</p> <ul style="list-style-type: none"> ● Size, shape, number and position ● Structure and functions of interphase nucleus ● Ultrastructure of nuclear membrane and pore complex ● Nucleolus: general organization, chemical composition & functions ● Nuclear sap/ nuclear matrix 	05L	06hrs

	<ul style="list-style-type: none"> ● Nucleocytoplasmic interactions 		
1.3	<p>Plasma membrane</p> <ul style="list-style-type: none"> ● Fluid Mosaic Model ● Junctional complexes ● Membrane receptors ● Modifications: Microvilli and Desmosomes 	04L	08hrs
1.4	<p>Transport across membrane</p> <ul style="list-style-type: none"> ● Diffusion and Osmosis ● Transport: Passive and Active ● Endocytosis and Exocytosis 	02L	04hrs
1.5	<p>Cytoskeletal structures</p> <ul style="list-style-type: none"> ● Microtubules: Composition and functions ● Microfilaments: Composition and functions 		
	Unit: 2: Endomembrane System	15L	28hrs
	<p>Objective:</p> <ul style="list-style-type: none"> ➤ <i>To acquaint the learner with ultrastructure of cell organelles and their functions</i> 		
	<p>Desired outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner would appreciate the intricacy of endomembrane system.</i> ➤ <i>Learner would understand the interlinking of endomembrane system for functioning of cell</i> 		
2.1	<p>Endoplasmic reticulum (ER):</p> <ul style="list-style-type: none"> ● General morphology of endomembrane system, ultrastructure, types of ER and biogenesis of ER ● Functions of Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER) 	01L	03hrs

2.2	Golgi complex: Ultrastructure of Golgi complex, functions of Golgi complex (protein glycosylation, lipid and polysaccharide metabolism, protein sorting and secretion, Golgi Anti-Apoptotic Protein -GAAP)	06L	10hrs
2.3	Lysosomes: Origin, occurrence, polymorphism and functions; Peroxisomes: Origin, morphology & functions	03L	5hrs
2.4	Mitochondria: Ultrastructure, chemical composition, functions of mitochondria and bioenergetics (Chemical energy & ATP, Krebs cycle, respiratory chain and oxidative phosphorylation)	05L	10hrs
Unit: 3 Biomolecules		15L	30hrs
	Objective: ➤ <i>To give learner insight into the structure of biomolecules and their role in sustenance of life.</i>		
	Desired outcome: ➤ <i>The learner will realize the importance of biomolecules and their clinical significance.</i>		
3.1	Biomolecules: ● Concept of micro molecules and macromolecules	02L	05hrs
3.2	Carbohydrates: ● Definition classification, properties and isomerism, glycosidic bond ● Structure of Monosaccharides (glucose and fructose); Oligosaccharides (lactose and sucrose); Polysaccharides (cellulose, starch, glycogen and chitin) ● Biological role and clinical significance	04L	08hrs

<p>3.3</p>	<p>Amino Acids and Proteins:</p> <ul style="list-style-type: none"> ● Basic structure, classification of amino acids, ● Essential and Non-essential amino acids, Peptide bond, ● Protein conformation: Primary, Secondary, Tertiary, Quaternary ● Types of proteins – Structural (collagen) and functional proteins (haemoglobin) ● Biological role and clinical significance 	<p>05L</p>	<p>08hrs</p>
<p>3.4</p>	<p>Lipids:</p> <ul style="list-style-type: none"> ● Definition, classification of lipids with examples, ester linkage ● Physical and chemical properties of lipids ● Saturated and unsaturated fatty acids ● Essential fatty acids; Triacylglycerols; Phospholipids (lecithin and cephalin); Steroids (cholesterol) ● Biological role and clinical significance 	<p>04L</p>	<p>05hrs</p>
<p>3.5</p>	<p>Vitamins:</p> <ul style="list-style-type: none"> ● Water soluble vitamins (e.g. Vit C, Vit B₁₂) ● Lipid soluble vitamins (e.g. Vit A, Vit D) ● Biological role and clinical significance 	<p>02L</p>	<p>04hrs</p>

SEMESTER IV
USZO403 COURSE -10
ECONOMIC ZOOLOGY

	USZO403 COURSE 10		
	ECONOMIC ZOOLOGY		
	UNIT 1: Sericulture	15L	30 hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To comprehend the functioning of sericulture industry and its scope in India.</i> ➤ <i>To study the varieties of silk-worms and host plants.</i> ➤ <i>To critically study the life history and rearing of <i>Bombyx mori</i>, harvesting, processing of cocoon, production of silk and diseases afflicting silk-worms.</i> 		
	<p>Desired Outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner would understand the basics of the functioning of sericulture industry and its scope in India.</i> ➤ <i>Learner shall gain knowledge on the varieties of silk-worms, host-plants and aspects on silk extraction and the diseases afflicting silk-worms.</i> 		
1.1	Introduction and scope of sericulture	02L	4hrs
1.2	Varieties of silk worm, host plants	02L	4hrs
1.3	Life history and rearing of <i>Bombyx mori</i>	03L	8hrs
1.4	Harvesting and processing of cocoon	02L	4hrs
1.5	Reeling and extraction of silk	03L	4hrs
1.6	Diseases and control measures	03L	4hrs

	UNIT2: APICULTURE AND DAIRY SCIENCE	07L	08hrs
2.1.	<p>2.1.1 Methods of bee keeping and management</p> <ul style="list-style-type: none"> ● 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>2.1.2 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. 		
2.2	DAIRY SCIENCE	08L	08hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To study the role of dairy development in rural India</i> ➤ <i>To study various techniques employed in dairy science.</i> 		
	<p>Desired Outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner shall understand the dairy animal's management and role of dairy development in rural Indian economy.</i> ➤ <i>Learner would gain knowledge of various Dairy processing techniques along with knowledge of milk and milk products.</i> 		
	<p>2.2.1 Dairy development in India Role of dairy development in rural economy, employment opportunities</p>		
	<p>2.2.2 Dairy Processing</p> <ul style="list-style-type: none"> ● Filtration, cooling, chilling, clarification, pasteurization, 		

	freezing		
	<p>2.2.3 Milk and milk products</p> <ul style="list-style-type: none"> ● Composition of milk ● Types of milk: <ul style="list-style-type: none"> a) Buffalo milk b) Cow milk (A1 &A2) ● Whole milk and toned milk ● Milk products 		
	UNIT 3: AQUACULTURE	15L	24hrs
	<p>Objectives</p> <ul style="list-style-type: none"> ➤ <i>To study the commercial and industrial significance/value of animals.</i> ➤ <i>To discuss the techniques/ methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.</i> 		
	<p>Desired outcomes</p> <ul style="list-style-type: none"> ➤ <i>Understand the culture techniques of prawn, pearl and fish.</i> ➤ <i>Understand silkworms rearing and their products.</i> ➤ <i>Understand the Bee keeping equipment's and apiary management.</i> ➤ <i>Understand dairy animals' management, the breeds and diseases of goats and learn the testing of egg and milk quality.</i> ➤ <i>Learn various concepts of lac cultivation.</i> ➤ <i>Be aware of a broad array of career options and activities in human medicine, biomedical research and allied health professions.</i> 		

3.1	Pisciculture: <ul style="list-style-type: none"> ● Definition and scope of fishery resources in India ● Finfish culture – monoculture and polyculture ● Cage culture ● Fish seed transport ● Fish diseases -- symptoms and control 	04L	8rs
3.2	Prawn/shrimp culture: Sources, seed, culture methods – <ul style="list-style-type: none"> ● Giant fresh water prawn (<i>Macrobrachium rosenbergii</i>) ● White shrimp (<i>Penaeus vannamei</i>) 	04L	8hrs
3.3	Pearl culture: <ul style="list-style-type: none"> ● Pearl producing species and their distribution ● Pearl culture methods ● Composition of pearl 	04L	8hrs
3.4	Culture of seaweeds: <ul style="list-style-type: none"> ● Seaweed species of commercial importance ● Culture methods ● Products of commercial importance from seaweeds – Emerging trends in farming in open seas. 	03L	

Note -The practical's may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should 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. No new specimens, however, shall be procured for the purpose of conducting practical's mentioned here-in-above.

There shall be at least one excursion/field trip

SEMESTER IV	
Practical USZOP 1 (Course - VIII)	
1	Study of population density by Line transect method & Quadrant method and calculate different diversity indices. <ul style="list-style-type: none">● Index of Dominance● Index of frequency● Rarity Index● Shannon Index
2	Study of prokaryotic cells (bacteria) by Crystal violet staining technique
3	Study of eukaryotic cells (WBCs) from blood smear by Leishman stain
4	Identification and study of fossils: <ul style="list-style-type: none">● Arthropods: Trilobite● Mollusca: Ammonite
5	Identification of: <ul style="list-style-type: none">● Allopatric speciation (Cyprinodont species)● Sympatric speciation (Hawthorn fly and Apple maggot fly)
6	Preparation of Review/ Bibliography / Abstract writing
7	Preparation of Power Point Presentation based on research paper.
8	Review writing based on programmes telecast by Doordarshan, Gyandarshan, UGC programmes or other media sources

SEMESTER IV	
Practical USZOP 2 (Course - IX)	
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	Qualitative tests for carbohydrates (Molisch 's test, Benedicts test, Barfoed's test, Anthrone test)
4	Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)
5	Qualitative test for lipids (Solubility test, Sudan III test)
6	Study of rancidity of lipids by titrimetric method
7	Ultrastructure of cell organelles (Electron micrographs) of: <ul style="list-style-type: none">● Nucleus● Endoplasmic reticulum (Smooth and Rough)● Mitochondria.● Golgi apparatus● Lysosomes
8.	Study of clinical disorders due to carbohydrates, proteins and lipid imbalance (Photograph to be provided / symptoms to be given and disorder to be identified)

SEMESTER IV	
Practical USZO P3 (Course - X)	
1.	Study of life cycle of <i>Bombyx mori</i>
2.	Study of Honey Bee: a) Life Cycle of Honey Bee and Bee Hive b) Mouthparts of Honey Bee c) Legs of Honey Bee
3.	Estimation and comparison of protein content in Cow and Buffalo milk sample
4.	Estimation and comparison of fat content in Cow and Buffalo milk sample
5.	Study of commercially important fishery. (Catla, Rohu, Catfish, Mackerel, Pomfret, Bombay duck, Prawn/Shrimp, Crab, Lobster, Edible oyster)
6.	Visit to dairy farm /aquaculture/ fish landing center/fishery institute and submit report of the same
7.	Estimation of dissolved oxygen from the given water sample.
8.	Estimation of salinity by refractometer from the given water sample.
9.	Estimation of conductivity by conductometer from the given water sample.
10.	A project on aquarium setting in laboratory
11.	Visit to Sericulture, Apiculture and Aquaculture Center

Semester IV
REFERENCES AND ADDITIONAL READING
COURSE-VIII (USZO401)

1. Darwin, C. 1859. On the Origin of Species. London: John Murray (always seek out the first edition, facsimile version, and avoid later editions).
2. Dobzhansky, T. 1937. Genetics and the Origin of Species. New York: Columbia Univ. Press (there are several later editions, and the title changed in the last).
3. Fisher, R. A. 1930. The Genetical Theory of Natural Selection. Oxford: Oxford Univ. Press (there is a later edition).
4. Hennig, W. 1966. Phylogenetic Systematics. Urbana: Univ. Illinois Press (an English translation of a book published earlier in German).
5. Mayr, E. 1942. Systematics and the Origin of Species. New York: Columbia Univ. Press (there is a later edition, with a different title).
6. Schmalhausen, I. I. 1949. Factors of Evolution. Philadelphia: Blakiston (publication of this book, written in the early 1940's, was delayed because of war, and then the translation from Russian to English was also delayed; it has been reprinted by Univ. Chicago Press).
7. Bonner, J. T. 1988. The Evolution of Complexity. Princeton: Princeton Univ. Press.
8. Hall, B. J. (ed.). 1994. Homology, the Hierarchical Basis of Comparative Biology. San Diego: Academic Press (a collection of essays by many authors).
9. Keller, E. F. and E. A. Lloyd. 1992. Keywords in Evolutionary Biology. Cambridge, MA: Harvard Univ. Press.
10. Mayr, E. 1982. The Growth of Biological Thought: Diversity, Evolution and Inheritance. Cambridge, MA: Harvard Univ. Press.
11. Rieppel, O. 1988. Fundamentals of Comparative Biology. Basel: Birkhäuser
12. Dawkins, R. 1982. The Extended Phenotype. New York: W. H. Freeman.
13. Williams, G. C. 1992. Natural Selection: Domains, Levels and Challenges. New York: Oxford Univ. Press.
14. Crow, J. F. 1991. Basic Concepts in Population, Quantitative, and Evolutionary Genetics. New York: W. H. Freeman.

15. Falconer, D. S. 1981. Introduction to Quantitative Genetics, second ed. London: Longman.
16. Hartl, D. L. And A. G. Clark. 1989. Principles of Population Genetics, second, ed. Sunderland, MA: Sinauer.
17. Real, L. A. (ed.). 1994. Ecological Genetics. Princeton: Princeton Univ. Press (a collection of essays by many authors).
18. Research Methodology, Methods and Techniques- by C.R. Kothari, Wiley Eastern Ltd. Mumbai
19. Practical research planning and design 2nd edition- Paul D Leedy, Macmilan Publication

Semester IV
REFERENCES AND ADDITIONAL READING
COURSE-IX (USZO402)

1. Harpers Illustrated Biochemistry 30th Edition / Edition 30 by Victor Rodwell 2015, Publisher:McGraw-Hill Professional Publishing
2. Biochemistry, 5th editionJeremy M Berg, John L Tymoczko, and Lubert Stryer 2002, publisher W. H. Freeman and Company.
3. Text Book of Biochemistry – West, Todd, Mason, Bruggen – Amerind Publishing Co. Pvt., Ltd
4. Harper’s Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice Hall International Inc.
5. Text Book of Biochemistry – West, Todd, Mason, Bruggen – Amerind Publishing Co. Pvt., Ltd.
6. Principles & Techniques of Practical Biochemistry – Wilson, Walker- Cambridge Univ. Press.
7. Principles of Biochemistry – White, Handler, Smith – McGrew Hill Publ.
8. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology – Verma, Agarwal – S. Chand & Co.
9. Molecular & Cell Biology – Bhamrah – Anmol Publ. Pvt. Ltd., New Delhi.
10. Molecular Biology of the Cell – Alberts, Bray, Lewis, Raff, Roberts, Watson – Garland Publishers, New York.

11. Molecular Biology of the gene – J. D. Watson, NH Hopkins, Roberts, Stertz, Weiner-Freeman.
12. Concepts in Biotechnology – Editors- Balasubramanian, Bryee, Dharmalingam, Green, Jayraman – Sangam Books.
13. Molecular Biology of the Gene – Watson, Hopkins, Roberts, Steitz, Weiner – Benjamin Cummings Publishing Co.
14. Molecular Cell Biology – Baltimore, Zipursky, Matsudaria, Darnel – W. H. Freeman & Co., New York.
15. Principles of Biochemistry – White, Handler, Smith – McGraw Hill Publ. 18) Cell & Molecular Biology – Phillip Sheller – Wiley Publ.
16. Lehninger Principles of Biochemistry -David L. Nelson, Michael M. Cox, Macmillan Worth Publishers.
17. Harper's Biochemistry-Rober K. Murray, Daryl K. Grammer, McGraw Hill, LangeMedical Books. 25thedition.
18. Fundamentals of Biochemistry-J.L. Jain, Sunjay Jain, Nitin Jain, S. Chand & Company.
19. Biochemistry-Dr. Amit Krishna De, S. Chand & Co., Ltd.
20. Biochemistry-Dr. Ambika Shanmugam, Published by Author. 6) Biomolecules-C.Kannan , MJP Publishers,Chennai.

Semester IV
REFERENCES AND ADDITIONAL READING

COURSE-X (USZO403)

1. **Mulberry pests current status and management practices:** Sakthivel, Narendra Kumar Dhahira Beev . Devamani R.S. Teotia Published by Central Silk Board, Ministry of Textiles, Government of India Srirampura, Mysuru - 570 008. July - 2019
2. **Sericulture technologies developed by csrti mysore** Central Sericultural Research & Training Institute (ISO 9001: 2008 Certified) Central Silk Board – Ministry of Textiles – Govt. of India, CSRTI Mysore
3. **Text Book of Tropical Sericulture.** Publ., Japan Overseas Corporation volunteers – 1975.

4. **Silkworm Rearing Techniques in the Tropics**, Dr. S. Omura, Japan International Cooperation Agency, 1980.
5. **Muga Silk Industry** by S. N. Choudhary, Directorate of Sericulture and weaving, Govt. of Assam, 1982. The natures and property of soils (9th edition) N. C. Brady (Mac Millan pub. Co. Inc., New York.
6. **Handbook of Practical Sericulture**: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore 1987.
7. **Handbook of Silkworm Rearing**: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.
8. **Manual of Silkworm Egg Production**: M. N. Narasimhanna, CSB, Bangalore 1988.
9. **Economics of Sericulture under Irrigated Conditions**: M.S. Jolly, CSR & TI, Mysore, 1982.
10. **Mulberry cultivation** (Vol. I) written by Zheng Ting-xing, Tan Yun-fang, Huang Guangxian and Ma ben. Published by: Oxford and IBH publishing Co. Pvt.Ltd., New Delhi, Bombay, Calcutta.
11. **Silk egg productions** (Vol. III) written by Wang Sang-ming Published by: Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta.
12. **Principles of Sericulture**: Hisao Aruga, Mohan Primlani for Oxford and IBH Publishing Co. Pvt. Ltd., 66, Janpath, New Delhi-110001.
13. **Silkworm Rearing and Disease of Silkworm**, 1956, Ptd. By Director of Ptg., Stn. & Pub.Govt.Press Bangalore
14. **Guide to Bees and Honey**: Ted Hooper, 2010. The World's Best-Selling Guide to Beekeeping. Northern Bee Books. Oxford. 8 David Cramp, 2012.
15. **The Complete Step-by-step Book of Beekeeping**: A Practical Guide to Beekeeping, from Setting Up a Colony to Hive Management and Harvesting the Honey. Oxford. 8 David Cramp, 2012. Lorenz Books. London.
16. **Apiculture**: Prost, P. J. (1962). e. Oxford and IBH, New Delhi.
17. **Beekeeping in India**, Singh, S. (1971) , Indian council of Agricultural Research, New Delhi
18. **Living in the Environment-Concepts, Connections and Solutions**. G. Tyler Miller and

Scott E. Spoolman, Brooks/Cole, Cengage learning.

19.An introduction to conservation biology. Richard B. Primack and Anna A. Sher,
Sinauer Associates

20.FishLore.Com – Fresh water Aquarium Book- Free eBook

21.In Association with practical fish keeping magazine www.practicalfishkeeping.co.uk

22.Handbook on Aquafarming-Ornamental Fishes. Published by MPEDA

23.Diseases of ornamental fishes and their control- By A. P. Lipton (2006)
eprints.cmfri.org.in

SCHEME OF EXAMINATION

- (d) One Theory examination of seventy-five (75) marks per course per semester should be conducted as per the following skeleton question paper pattern.
- (e) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.
- (f) Internal assessment and overall performance twenty-five (25) marks.

SKELETON PAPER PATTERN FOR THEORY EXAMINATION

NOTE: All Questions are compulsory.

Figures to the right indicate full marks.

Draw neat labelled diagrams wherever necessary.

Question number 1, 2 and 3 will be 20 Marks each and Question 4 for 15 Marks

Time: 2.5 hours

Total marks: 75

- Q.1. Unit I may have questions carrying 12 and 8 marks OR of 10 marks each with 100% internal options
- Q.2. Unit II may have questions carrying 12 and 8 marks OR of 10 marks each with 100% internal options
- Q.3. Unit III may have questions carrying 12 and 8 marks OR of 10 marks each with 100% internal options
- Q.4. Unit I, II and III (Any3 out of 6) 15 marks

For Q.1, 2, 3 and 4 there shall be 100% internal option.

PRACTICAL USZOP1
(Course VIII)
Skeleton -Practical Examination Question Paper
Pattern

Time: 3 hrs

Marks: 50

Major Question

12 Marks

Q1. Study Population density by Line transect or Quadrant method and calculate biodiversity indices (any 2)

Minor Question

08 Marks

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 Marks

a. Fossils

b. Speciation

Q4. From the given article prepare the bibliography/ abstract

06 Marks

Q5. Project presentation

06 Marks

Q6. Viva and Journal

10 Marks

PRACTICAL
USZOP2 (Course IX)

Skeleton -Practical Examination Question Paper Pattern

Time: 3 hrs

Marks: 50

Major Question

12 marks

Q1. Study of permeability of cell through plasma membrane (Osmosis in blood cells)

OR

Q2. Study of rancidity of lipids by titrimetric method.

Minor Question

08 marks

Q2. Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test, Anthrone test)

OR

Q2. Qualitative tests for proteins (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)

OR

Q2. Qualitative test for lipids (Solubility test, Sudan III test)

OR

Q2. Measurement of cell diameter by ocurometer (by using permanent slide)

Q3. Identify and describe as per instructions

15 marks

- i. Ultra-structure of cell organelles (a, b, c)
- ii. Clinical disorders (d, e)

Q4. Field Report and Viva based on it.

10 marks

Q5. Journal

05 marks

**PRACTICAL
USZOP3 (Course X)**

Skeleton -Practical Examination Question Paper Pattern

Time: 3 hrs

Marks: 50

Major Question

12 marks

Q1. Estimation and comparison of protein content in Cow and Buffalo milk sample

OR

Q1. Estimation and comparison of fat content in Cow and Buffalo milk sample

Minor Question

08 marks

Q2. . Estimation of Dissolved oxygen from the given water sample.

OR

Q. 2 Estimation of Salinity by refractometer from the given water sample

OR

Q.2 Estimation of conductivity by conductometer from the given water sample

Q3. Describe any two type of commercially important fishery.

Catla, Rohu, Catfish, Mackerel, Pomfret

06 marks

Q4. Identify and describe as per instructions: (Any 3)

09 marks

i. Life Cycle of Honey Bee and Bee Hive

ii. Mouthparts of Honey Bee

iii. Legs of Honey Bee

iv. Sting Apparatus of Honey Bee

v. Life cycle of silk worm

Q5. Report based on field visit to Dairy farm /Aquaculture/ Sericulture/ Apiculture center.

10 marks

Q6. Journal and viva

05 marks