AC – 24/5/2024
Item No. – 6.7

As Per NEP 2020

University of Mumbai

Title of the program

A- U.G. Certificate in Zoology
B- U.G. Diploma in Zoology
C- B.Sc. (Zoology)
D- B.Sc. (Hons.) in Zoology
E- B.Sc. (Hons. with Research) in Zoology

Syllabus for

Semester – Sem I & II (Scheme III)

Ref: GR dated 20th April, 2023 for Credit Structure of UG

(With effect from the academic year 2024-25 Progressively)

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars	
1	**Title of program** **O: _____A**	**A**	**U.G. Certificate in Zoology**
	O: _____B	**B**	**U.G. Diploma in Zoology**
	O: _____C	**C**	**B.Sc. (Zoology)**
	O: _____D	**D**	**B.Sc. (Hons.) in Zoology**
	O: _____E	**E**	**B.Sc. (Hons. with Research) in Zoology**
2	**Eligibility** **O: _____A**	**A**	HSC(Science) **OR** Passed Equivalent Academic Level 4.0
	O: _____B	**B**	Under Graduate Certificate in Zoology **OR** Passed Equivalent Academic Level 4.5
	O: _____C	**C**	Under Graduate Diploma in Zoology **OR** Passed Equivalent Academic Level 5.0
	O: _____D	**D**	Bachelors of Zoology with minimum CGPA of 7.5 **OR** Passed Equivalent Academic Level 5.5
	O: _____E	**E**	Bachelors of Zoology with minimum CGPA of 7.5 **OR** Passed Equivalent Academic Level 5.5
3	**Duration of program** **R: _____**	**A**	One Year
		B	Two Years
		C	Three Years
		D	Four Years
		E	Four Years
4	**Intake Capacity** **R: _____**	**120**	

5	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination	
6	**R: _____ Standards of Passing**	40%	
7	**Credit Structure** **Sem. I - R: _____A** **Sem. II - R: _____B**	Attached herewith	
	Credit Structure **Sem. III - R: _____C** **Sem. IV - R: _____D**		
	Credit Structure **Sem. V - R: _____E** **Sem. VI - R: _____F**		
8	**Semesters**	A	Sem I & II
		B	Sem III & IV
		C	Sem V & VI
		D	Sem VII & VIII
		E	Sem VII & VIII
9	**Program Academic Level**	A	4.5
		B	5.0
		C	5.5
		D	6.0
		E	6.0
10	**Pattern**	Semester	
11	**Status**	New	
12	**To be implemented from Academic Year Progressively**	From Academic Year: 2024-25	

Sign of the BOS Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

Preamble

1) Introduction

The FYBSc Zoology syllabus (Under Graduate Certificate in Zoology) is designed as per the objectives and guidelines of National Education Policy 2020. This programme is designed to provide a basic understanding of the principles of life processes, evolution of life, animal behaviour, ecology and laboratory techniques through an academic curriculum of theory and practical courses. We aim to provide not only subject knowledge but also make the learners understand the core values of the Zoology. This syllabus is framed to equip learners with a basic theoretical and practical knowledge for developing analytical abilities for problem solving, exploring opportunities, and also to develop entrepreneurship skills. There will be continuous evaluation of learners based on both practical skills and theoretical / mental abilities through class tests, group engagement and assignments.

2) Aims and Objectives

The aims and objectives of the FYBSc Zoology (Under Graduate Certificate in Zoology) curriculum is to provide learners with a basic understanding of the principles of life processes, evolution of life, animal behaviour, ecology and laboratory techniques, developing applications of knowledge Zoology for academic and entrepreneurial pursuits. The aims and objectives align with broader educational goals, focusing on academic and professional goals. The syllabus aims in imparting knowledge related to animal sciences, current trends and advancements in the field to develop entrepreneurial aptitude and skills.

3) Learning Outcomes

The learners will develop an understanding of fundamental principles of life processes, evolution of life, ecological interactions, and animal behaviour and acquire laboratory skills for applications in allied industries, research, and academia. The learners will develop an aptitude for exploring the opportunities for self-employment and entrepreneurship activities.

4) Any other point (if any)

The skills and knowledge acquired through this programme will make the learners well-equipped for exploring the diverse fields of Zoology and applying them to entrepreneurial activities or higher academic pursuits.

5) Credit Structure of the Program (Sem I, II, III, IV, V & VI)

Under Graduate Certificate in Zoology

Credit Structure (Sem. I & II)

	R: _____A								
Level	**Semester**	**Mandatory**		**Major 3**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC,IKS**	**OJT, FP, CEP, CC, RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Major1	**Major 2**							
4.5	I	**MJ1:** Life Processes (2) **MJP1:** Practical based on MJ1 (2)	04	04	-	**VSC1a:** Ornamental fish Breeding and maintenance (2) OR **VSC1b:** Pet rearing and care. (2) **SEC1:** Aquarium Management (2)	AEC:2, VEC:2, IKS:2	-	22	**UG Certificate 44**
	R:_____B									
	II	**MJ2:** Ecology and Biodiversity (2) **MJP2**: Practical based on MJ2 (2)	04	04	**2**	**VSC2a:** Apiculture (2) OR **VSC2b:** Poultry Science (2) **SEC2:** Fish value added products (2)	AEC:2,	CC:2	22	
	Cum Cr.	08	08	08	2	4+4	6+2	2	44	
Exit option: Award of UG Certificate in Major with 40-44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Majorand Minor										

Under Graduate Diploma in Zoology

Credit Structure (Sem. III & IV)

	R:_____C									
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC,IKS**	**OJT, FP, CEP, CC,RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.0	III	**MJ5:** Cell Biology (2) **MJ6:** Biochemistry (2) **MJP3:** Practical based on MJ5 (2) **MJP4**: Practical based on MJ6 (2)		4	2	**VSC3a:** Pest control (2) OR **VSC3b:** Dairy Science (2)	AEC:2	FP: 2 CC:2	22	**UG Diploma 88**
	R:_____D									
	IV	**MJ7:** Genetics (2) **MJ8**: Molecular Biology (2) **MJP5:** Practical based on MJ7 (2) **MJP6:** Practical based on MJ8 (2)		4	2	**SEC3a:** Intellectual Property Rights (2) OR **SEC3b:** Nature educator (2)	AEC:2	CEP: 2 CC:2	22	
	Cum Cr.	28		10	12	6+6	8+4+2	8+4	88	
Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continuewith Major and Minor										

B.Sc. (Zoology)

Credit Structure (Sem. V & VI)

Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC,IKS	OJT, FP, CEP, CC, RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
	R:_____E									
5.5	V	**MJ9:** Non-Chordates Taxonomy (2) **MJ10:** Haematology and Immunology (2) **MJP7:** Practical based on MJ9 (2) **MJP8:** Practical based on MJ10 (2) **MJ11**: ZIKS (2)	4	4		**VSC4a:** Aquaculture (2) OR **VSC4b:** Sericulture (2) OR **VSC4c:** Environmental Audit (2)		FP/CEP :2	22	**UG Degree 132**
	R:_____F									
	VI	**MJ12:** Chordates Taxonomy (2) **MJ13**: Animal Physiology (2) **MJP9:** Practical based on MJ12 (2) **MJP10:** Practical based on MJ13 (2) **MJ14:** Histology and endocrinology (2)	4	4				OJT :4	22	
	Cum. Cr.	48	8	18	12	8+6	8+4+2	8+6+4	132	
Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor										

[Abbreviation: OE– Open Electives, VSEC-Vocational and Skill Enhancement Course, VSC– Vocation Skill Course, SEC– Skill Enhancement Course, AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – On Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project, ZIKS- Zoological Indian Knowledge System, NSQF- National Skills Qualification Framework]

F.Y.B.Sc. Zoology (USZO) Course Structure

Mandatory courses
Semester I

Ladder	Course Type	Title	Credits	Hours	Marks
Major 1 (MJ1)	Theory	Life Processes	2	30	50
Major P1 (MJP1)	Practical	Practical based on MJ1	2	60	50
VSC1a	Practical	Ornamental fish Breeding and maintenance	2	60	50
VSC1b	Practical	Pet rearing and care	2	60	50
SEC-1	Practical	Aquarium Management	2	60	50

Semester II

Ladder	Course Type	Title	Credits	Hours	Marks
Major 2 (MJ2)	Theory	Ecology and Biodiversity	2	30	50
Major P2 (MJP2)	Practical	Practical based on MJ2	2	60	50
VSC2a	Practical	Apiculture	2	60	50
VSC2b	Practical	Poultry Science	2	60	50
SEC-2	Practical	Fish value added products	2	60	50

Sem. - I

Mandatory course

Syllabus

B.Sc. (Zoology)

(Sem.- I)

Name of the course: MJ1: Life processes

Course Objectives (CO):

CO1. To develop the understanding of learners about the basic of life processes including locomotion, respiration, reproduction, excretion, circulation, and nutrition.

CO2. To develop understanding of learners about coordination in life processes of the living organism.

Course Outcomes (OC):

Upon completion of the course, the learners should be able to:

OC1. Describe the co-ordination of physiological processes in organisms, including transport systems and responses to stimuli

OC2. Apply detailed knowledge to explain the processes by which organisms develop, move, breath and excrete.

Paper-1
MJ1: Life Processes

Module 1: Life Processes-I	15hr
1.1 Movement and locomotion 1.1.1: Amoeboid movement, tube feet, flagellum 1.1.2: Ultra-structure of cilia and ciliary movements 1.1.3: Action of muscles (Role of muscles in movement)	**03hr**
1.2 Nutrition 1.2.1 Types of nutrition: Autotrophic and Heterotrophic. 1.2.2. **Apparatus for nutrition**: 1.2.2.1 Animals without alimentary canal, ex. Amoeba 1.2.2.2. Animals with incomplete alimentary canal, ex. Hydra, 1.2.2.3. Animals with complete alimentary canal, ex. ruminants and non-ruminants 1.2.3 Brief account of physiology of digestion in vertebrates and symbiotic digestion in Ruminants.	**05hr**
1.3 Respiration 1.3.1 Aerobic and anaerobic respiration **1.3.2 Types of respiratory surfaces**: 1.3.2.1 General body surface: Cell membrane - ex. Amoeba, 1.3.2.2 Skin - ex. Earthworm and Frog 1.3.2.3 Trachea and spiracles, 1.3.2.4 Gills of fish, 1.3.2.5 Accessory respiratory organ in Fish, 1.3.2.6 Lungs of Human.	**04hr**
1.4 Circulation 1.4.1 Types of circulating fluids: 1.4.1.1 Water, 1.4.1.2 Coelomic fluid, 1.4.1.3 Lymph and 1.4.1.4 Blood 1.4.2 **Types of circulation** 1.4.2.1 Protoplasmic streaming, 1.4.2.2 open and closed circulation, 1.4.2.3 single and double circulation. 1.4.3 **Hearts Types**, 1.4.3.1 Heart in Daphnia, 1.4.3.2 Heart of Cockroach 1.4.3.3 Heart in chordates (2, 3 and 4 chambered heart)	**03hr**

Module 2: Life Processes-II	15 hr
2.1 Excretion and osmoregulation 2.1.1 Concepts of osmoregulation and excretion. 2.1.2 Categorization of animals on the basis of principle nitrogenous excretory products.	**4hr**
2.2 Control and Coordination 2.2.1 Irritability in Paramoecium 2.2.2 Structure of neuron, 2.2.3 Conduction of nerve impulse 2.2.3.1 Resting potential, 2.2.3.2 Action potential 2.2.3.3 Refractory period. 2.2.4 Endocrine regulation: 2.2.4.1 Hormones as chemical messengers, 2.2.4.2 Feedback mechanisms.	**5 hr**
2.3 Reproduction **2.3.1 Asexual Reproduction**: 2.3.1.1 Binary fission in Paramoecium, 2.3.1.2. Gemmule in Sponges, 2.3.1.3. Budding in Hydra, 2.3.1.4. Regeneration in planaria, **2.3.2 Sexual mode of reproduction** 2.3.2.1 Gametogenesis, 2.3.2.2 structures of Mammalian Ovum 2.3.2.3 Structure of Mammalian Spermatozoa	**3hr**
2.4 Fertilization: 2.4.1 External and internal fertilization 2.4.2 Oviparity, 2.4.3. Viviparity 2.4.4 Ovo-viviparity	**3hr**

Reference Books

1. Campbell Biology, 11th Ed. (2017) Lisa Urry et al. Pearson Publication. ISBN. 978-0134093413
2. Biology (1994) by John W. Kimball, 6th Ed. ISBN. 978-0697142573
3. Invertebrate Zoology: A functional and evolutionary approach. 7th Ed. (2006) Robert D Barns. ISBN: 978-8131501047.
4. Modern Textbook of Zoology Vertebrates. (2020) 4th Ed. R L Kotpal. Rastogi Publication. ISBN: 978-9350780954
5. Modern Textbook of Zoology Invertebrates (2020) 12th Ed. R L Kotpal. Rastogi Publication. ISBN: 978-8193887554.
6. Embryology (2017) Mohan P Arora. Himalaya Publishing House. ISBN: 978-9352730964.

Major Practical-1

Name of the Course: MJP1: Practical based on MJ1

Course Objectives (CO):

CO1. To upgrade the skill in handling of basic laboratory instruments.

CO2. To enhance learners' skills in calibration of instruments and calculation techniques.

CO3. To upgrade the skill of learners in minimization of Error minimization in the laboratory.

CO4. To upgrade the skill good laboratory practices.

Course Outcomes (OC):

Upon completion of the course, the learners should be able to:

OC1. Safely practice, basic laboratory procedures and protocols inside a laboratory

OC2. Acquire the skills of basic calibration and handling of instrumentation in laboratory.

OC3. Appreciate the basics of life process in animals and their coordination in animal body.

OC4. Acquire skills for preparation of various solutions required in experimental research.

Major Practical-1

Name of the Course: MJP1: Practical based on MJ1

1. Study of *Paramoecium* culture to observe food vacuole, contractile vacuole and ciliary movement.
2. Study of nutritional apparatus: Amoeba, L.S. of Hydra, Digestive system of Cockroach, Fish, Bird, and Mammals (ruminant and non-ruminant).
3. Study of effect of pH and temperature on amylase/ trypsin activity.
4. Study of heart of Cockroach, Fish, Frog, *Calotes*, Crocodile and Mammal.
5. Excretory apparatus in Amoeba, Planaria, Earthworm, Cockroach and Fish, Mammal.
6. Study of Reproductive system in Ameoba, Hydra, Planaria, Cockroach, Mammals (T.S Testes and T.S ovary).
7. Study of respiratory apparatus in Amoeba, Cockroach, Spider, Fish and Frog, Mammal.
8. Introduction to basic laboratory safety practices, precautions and safety rules and symbols.
9. Use of Fire extinguisher,
10. Precaution and first aid for acid burn,
11. Precaution and first aid of chemical inhalation and the accident
12. Study of compound microscope, care and functions of its components,
13. Handling of common laboratory equipment (instrument and glassware): burner, autoclave, burette, and pipette (analytical and serological.
14. Handling of weighing Balance and preparation of solution of different concentration (Percentage, ppm, molarity, normality).
15. Packaging and autoclaving of test tubes, pipettes, Petri plates, and conical flask.
16. Measurement of pH of Milk, aerated drinks, Lemon juice, etc. using pH paper and pH meter.
17. Demonstration of aseptic transfer of liquids between burners.
18. Visit to clinical lab/ pathology lab, OR Central Instrumentation facility OR R & D center, and submission of report OR Participation in an Instrumentation workshop.

(Additional activity which the center may consider: Fractionation of tissue extract / cellular extract by centrifugation.)

Reference Books

1. A course in electronic measurements and instrumentation. (2015) A K Sawhney Dhanpat Rai and Co. Pvt Ltd. ISBN: 978-8177001006
2. Wilson And Walker's Principles And Techniques Of Biochemistry And Molecular Biology. 8th Ed. ISBN: 978-1316614761.
3. An Introduction to Practical Biochemistry. (2017) David Plummer. 3rd Ed. McGraw HillEducation. ISBN: 978-0070994874.
4. Bioinstrumentation. (2019) Bhawana Pandey and MH Fulekar. Dreamtech Press ISBN: 978-9389520286.
5. Guidelines for good laboratory practices-Indian council of medical research, New Delhi (2008).
7. Invertebrate Zoology: A functional and evolutionary approach. 7th Ed. (2006) Robert D Barns. ISBN: 978-8131501047.
8. Modern Textbook of Zoology Vertebrates. (2020) 4th Ed. R L Kotpal. Rastogi Publication. ISBN: 978-9350780954
9. Modern Textbook of Zoology Invertebrates (2020) 12th Ed. R L Kotpal. Rastogi Publication. ISBN: 978-8193887554.
10. Embryology (2017) Mohan P Arora. Himalaya Publishing House. ISBN: 978-9352730964.
11. Comparative anatomy of vertebrates (2008) R. K. Saxena, Sumitra Saxena. ISBN: 978-1905740994.

Vocational Skill Course

Name of the Course: VSC1a: Ornamental fish Breeding and maintenance

Course Objectives (CO):

CO1. To introduce learners to the fundamental concepts of ornamental fish species identification and classification.

CO2. To provide knowledge of breeding methodologies and the factors influencing successful reproduction in ornamental fish.

CO3. To impart skills in designing and managing suitable habitats for various ornamental fish species.

Course Outcomes (OC):

Upon completion of the course, the learners should be able to:

OC1. Understand the diverse species of ornamental fish and their specific care requirements.

OC2. Apply various breeding techniques to successfully propagate ornamental fish.

OC3. Demonstrate proficiency in maintaining optimal aquatic environments for ornamental fish.

Module-1: Ornamental fish Breeding and maintenance

1. Identification of ornamental fishes (freshwater and marine).
2. Breeding set up for live bearers (Guppy, swordtail, molly)
3. Breeding set up for egg bearers (Egg scatters goldfish, zebra fish, Egg depositors -Discus, Egg barriers- Killi fish, Mouth breeders-Arowana, Nest builders- Gourami, Siamese fighter)
4. Setting of rearing and breeding tank.
5. Estimation of water parameters-pH, DO, CO_2 and Salinity
6. Experiment: Study of separation of fries from parents
    1. Selecting the Right Time
    2. Using a Breeding Trap
    3. Separate Tank or Nursery Tank
    4. Using a Siphon
    5. Providing Hiding Places in the Nursery Tank
    6. Monitoring and Feeding
    7. Gradual Introduction to Larger Tank
7. Record behaviours (swimming patterns, schooling behaviour, changes in coloration, and interactions with other fish) in ornamental Fish.
8. Study of diseases and its prevention during fish breeding.
9. Assignment on breeding of an ornamental fish species (e.g. Siamese fighter, guppy, etc.).
10. Visit to a fish breeding centre / facility / aquarium shop.
11. Feasibility report for setting up an ornamental fish breeding facility.
12. Case study - Hatchery and nursery management of ornamental fishes.
13. Additional practical as per the center's requirement / facility available.

Reference Books

1. Emmens, C. W. (2013). Keeping and breeding aquarium fishes. Academic Press.
2. Dholakia, A. D. (2009). Ornamental fish culture and Aquarium management. Daya Publishing House.
3. Sinha, A., & Pandey, P. K. (2023). Breeding and Culture of Freshwater Ornamental Fish. CRC Press.
4. Dey, V.K., 1993. Ornamental fishes. Marine Products Export Development Authority, Kochi. pp.7-10.
5. Dey, V.K., 2008. Global Trade in Ornamental Fish: Trends, Prospects and Issues. Abstract, International seminar on Ornamental fish breeding, farming and trade, Cochin, India. pp.2.
6. Petrovicky, I., 1993. Tropical Aquarium Fishes. Chancellor press, London. p.258.
7. Beaven C.R., Hand Book of Fresh Water Fishes of India. Narendra Pub. House.
8. C.B.C. Srivastava. Fish Biology. Narendra Pub. House

Vocational Skill Course

Name of the Course: VSC1b: Pet Rearing and Care

Course Objectives (CO):

CO1. To familiarize learners with the characteristics and distinguishing features of exotic and indigenous dog and cat breeds commonly found in India and to provide learners with tools for understanding pet behaviour through the study of body language charts.

CO2. To teach learners practical grooming techniques for dogs and cats and to provide learners with essential first aid tips for common pet emergencies.

CO3. To enable learners to formulate balanced and nutrient-rich dry food suitable for the dietary needs of dogs and cats.

CO4. To emphasize the importance of preventative healthcare in maintaining the health of pets and to foster responsible pet ownership practices.

Course Outcomes (OC):

OC1. Learners will acquire skills to identify and differentiate between various exotic and indigenous dog, cat breeds and learners will be able to interpret and analyse the body language of dogs and cats through the use of body language charts, enabling them to understand the behaviour of pets.

OC2. Learners will comprehend the stages of the oestrus cycle in female cats and dogs and will develop practical skills in grooming and providing first aid.

OC3. Learners will demonstrate understanding of common parasites affecting dogs and cats.

OC4. Learners will be equipped with the knowledge and skills to administer confidently and effectively immediate first aid to pets in various emergency situations.

Module: Pet Rearing and Care

1. Identification of exotic breeds of dogs in India- German shepherd, Beagle, Bull dog, Great dane, Indian spitz, Pug, Labrador, Golden retriever, Shih Tzu, Siberian Husky.
2. Identification of Indian breeds of dogs- Indian Pariah dog, Rajapalayam, Gaddi, Rampur hound, Mudhol hound, Chippiparai, Kanni dog, Himalayan sheepdog (Bhutia), Kaikadi, Jonangi.
3. Identification of common breeds of cats- Persian cats, Bombay cats, maine coons, Turkish van, Siamese cat, Ragdoll.
4. Identification of behaviour of a pet animal from its body language- Dog and Cats (Body language charts).
5. Study of the stages of the oestrus cycle in female cats and dogs through behavioural changes, vocalization, and physical signs.
6. Study of grooming techniques- brushing, bathing, nail trimming, and ear cleaning, teeth brushing, hair trimming.
7. Pet First Aid tips- wound care, seizures, choking and poison.
8. Study of Body Condition Scoring (BCS) techniques for Weight assessment and overall Well-being in Dogs and Cats.
9. Estimation of moisture content in dry pet food.
10. Formulation of Nutrient-Rich Dry Food for Dogs and Cats.
11. Study of common parasites in pets: Understanding, Treating, and Preventing in Dogs and Cats – Fleas, Ticks, Mites (Ear mites and Sarcoptic mites), Tapeworm and Giardia.
12. Study of deworming, vaccination schedules, and other preventive healthcare measures for cats and dogs.
13. Study of Zoonotic and reverse zoonotic diseases.
14. Study and preparation of reports on rights and responsibilities of pet owners in India.
15. Assignment on rearing and care of lesser-known pet animals.
16. Visit to an animal rescue centre/ animal care centre and prepare a report based on it.
17. Visit to animal training centre/ veterinary hospital/ pet grooming centre and prepare a report based on it.
18. Additional practical as per the center’s requirement / facility available.

Reference Books

1. Yeates, J. (Ed.). (2019). Companion animal care and welfare: The UFAW companion animal handbook. John Wiley & Sons. ISBN:9781118688793
2. Alderton, D., Edwards, A., Edwards, A., Larkin, P., Stockman, M. The Complete Book of Pets & Petcare: The Essential Family Reference Guide to Pet Breeds and Petcare T Hong Kong: Anness Publishing. 2018. ISBN:9781844779338.
3. Companion Animals: Their Biology, Care, Health, and Management. Campbell, Karen L., and Campbell, John R.. United Kingdom, Pearson Prentice Hall, 2009. ISBN:9780135047675
4. The Book of Indian Dogs. Baskaran, S. Theodore. Aleph. 2017. ISBN:9789384067571.
5. Encyclopedia of Dogs: A Comprehensive Guide to Dog Breeds. United Kingdom, NPP Books, 2014. ISBN:9780755494958

Skill Enhancement Course (SEC)

Name of the Course: SEC1: Aquarium Management

Course Objectives (CO):

CO 1. Develop entrepreneurial skill in aquarium management.

CO 2. Enhance professional skill with proper scientific knowledge.

CO 3. Acquaint learners to practical skills of aquarium management .

Course Outcomes (OC):

Upon completion of the course, the learners should be able to:

OC 1. Work as aquarium maintenance professional.

OC 2. Generate source of employment.

OC 3. Construct and set aquarium for ornamental fishes.

OC 4. Disease management of ornamental fish.

Module: Aquarium Management

1. Types of aquariums: Freshwater (warm water, cold water), nano, marine, reef tank.
2. Accessories/equipment used in aquarium: Filters (mechanical, biological, chemical), Aerator, Heater, Thermometer, Lights, protein skimmer.
3. Identification of freshwater ornamental fishes: Guppy, Molly (*Poecilia* sps.), Goldfish (*Carassius auratus auratus*), Oscars (*Astronotus ocellatus*), Asian arowana (*Scleropages formosus*), Siamese fighting fish (*Betta splendens*), Zebra fish (*Danio rerio*), Reticulated loach (*Botia lohachata*), Dwarf gourami (*Trichogaster lalius*), Denison barb (*Sahyadria denisonii*), and Rosy Barb (*Puntius conchonius*)
4. Identification of marine ornamental fishes: Yellowtail damselfish (*Chrysiptera parasema*), Royal Gramma (*Gramma loreto*), Powder Blue Tang (*Acanthurus leucosternon*), Ocellaris Clown Fish (*Amphiprion ocellaris*), Blue Devil (*Paraplesiops meleagris*), and Butterfly fish (*Chaetodon* sps).
5. Types of plants: Vallisneria, Hydrilla, Azolla, Pistia, Sagittaria, Amazon Sword, *Limnophila*, *Limnophila aquatica*, *Ceratophyllum*, *Chara*,
6. Live fish feed: Infusoria, Rotifers, Artemia, Cladocerans, Tubifex worms, Chironomid Larvae (Blood worm),
7. Preparation of formulated fish feed.
8. Symptoms and treatment of fish diseases: Parasitic/Protozoa: Whit spot diseases, costiasis, whirling disease, Trichodiniasis; Bacterial: Bacterial gill rot, Dropsy, Ulcer disease, Furunculosis, Vibriosis, Columnaris, and Fish T.B.; Fungal- Saprolegniasis, Brachiomycosis, Ichthyophonosis.
9. Estimation of ammonia and pH of aquarium water.
10. Determination of hardness of water.
11. Determination of dissolved oxygen of water.
12. Determination of salinity.
13. Assignment on setting of freshwater and / or marine aquarium.
14. Report Submission: Visit to aquarium fish keeping entrepreneur.
15. Submission of feasibility report or budget for setting up an aquarium fish farm.

Reference Books

1. Amita Saxena (2009). Aquarium Management-Daya Publishing House, New Delhi
2. Nandita Singh, Surekha Gupta and Geeta Joshi (2023). Aquarium and its Management-AkiNik Publication, New Delhi
3. Dholakia A.D. (2016). Ornamental Fish Culture and Aquarium Management, Daya Publishing House, New Delhi
4. Taylor J.E. (2018). The Aquarium: Its Inhabitants, Structure, and Management- Unikum Verlag.
5. Mundy Obilor Jim (2015). Aquarium Making, JimArts Publishing, Norway
6. Tappan Frank (2016). Aquaria Fish, Createspace Independent Publishing Platform
7. Untergasser Dieter (1992). Handbook of fish disease, T.F.H. Publication.
8. Arumugam N. (2014). Aquaculture and Fisheries, Saras Publication, New Delhi.
9. Alderton David (2003). Freshwater Aquarium, Fox Chapel Publishing.
10. Dawes John (2001). Complete Encyclopaedia of the Freshwater Aquarium, Firefly Books.
11. Pawar Prabhakar (2013). A Complete Guide to Setting Up and Maintenance of an Aquarium, Lap Lambert Academic Publishing GmbH KG

Sem. – II

Mandatory course
Syllabus
B.Sc. (Zoology)
(Sem.- II)

Paper-1
MJ2: Ecology and Biodiversity

Module 1: Ecology	**15hr**
1.1 Concepts of Ecology: Study of Environment, Hydrosphere, lithosphere and Biosphere, Community, Population, **Types of Ecology** Autecology and synecology.	**03hr**
1.2 Types of ecosystems: Aquatic (Freshwater, estuarine, Marine and terrestrial (Forest, Grassland and Desert) 1.2.1 Food chain: Detritus and grazing food chains, Food web, Energy flow through the ecosystem, Ecological pyramids: Number, Biomass, and Energy.	**05hr**
1.3 Population dynamics: Density, Natality, Mortality, Fecundity, sex ratio, survivorship curves, age pyramid, dispersal and dispersion. 1.3.1 Exponential and logistic growth,	**04hr**
1.4 Study of Animal interactions 1.4.1 Competition: Interspecific and intraspecific (any two example); 1.4.2 Commensalism (remora fish on shark, Cattle egrets on livestock), 1.4.3. Mutualism (Termite and *Trichonympha*, bees and flowers, cleaning symbiosis in fish by prawns. 1.4.4 Parasitism (*Ascaris* and man, lice and humans), 1.4.5 Prey predation (Lion and deer).	**03hr**
Module 2: Biodiversity	**15hr**
2.1 Introduction to Biodiversity: Definition, Concepts, types, scope and Significance.	**01hr**
2.2 Value of Biodiversity: 2.2.1 Consumptive value, 2.2.2 Productive value, 2.2.3 Social value, 2.2.4. Ethical value, 2.2.5 Aesthetic value, 2.2.6 Option value. **2.3**. **Patterns of Biodiversity**:	**06hr**

2.3.1 Latitudinal gradients, 2.3.2 Species area relationship	
2.4. Threats to Biodiversity 2.4.1 Habitat loss and Man-Wildlife conflict	**03hr**
2.4.2 **Biodiversity Conservation**: 2.4.2.1 Species Conservation: *In-situ* and *Ex-situ* conservation 2.4.2.2 Habitat Conservation	**05hr**

Reference Books

1. Fundamentals of Ecology, 5th Ed. (2004). Odum, E.P. and Barrett G. W. Publisher: Brooks/Cole.ISBN: 978-0534420666
2. Elements of Ecology. 9th International Edition (2014). Smith T. M. and Smith R. L. Benjamin Cummings publication
3. Wildlife Biology, An Indian Perspective (2017). Saha G.K. and Mazumdar S. PHI Learning Private Limited. ISBN: 978-8120353138
4. Ecology – Principle and application (1999) Chapman J. L. and Reiss M. J., Cambridge University press, Low priced edition. ISBN: 0521588022
5. Essentials of Ecology, 3rd edition (2011) G. Tyler and Miller Jr. Thompson Books. ISBN: 978-0538735377
6. Essentials of ecology and environmental sciences. 5th Ed. (2013) S. V. S. Rana. PHI publisher. ISBN: 978-8120347861
7. Biodiversity- (2000) K.C.Agarwal- Agro Botanica Publications
8. Zoology, 5th Ed. (1999). S. A. Miller and J. B. Harley, Tata McGraw hill. ISBN: 978-0071158107

Major Practical-2

Name of the Course: MJP2: Practical based on MJ2

Course Objectives (CO):

CO1. To equip learners in basic practical knowledge of population dynamics.

CO2. To train learners in basic understanding of animal behaviour and its role in animal development.

CO3. It will help learners to understand rich biodiversity of India, its significance, and its role in human welfare.

Course Outcomes (OC):

Upon completion of the course, the learners should be able to:

OC1. Apply the concept the origin of life and the causes behind organic evolution

OC2. Correlate the animal behaviour and its cognitive aspects.

OC3. Identify the threats to biodiversity and its possible solution

OC4. Apply the understanding of the dynamics of population density to discover the impact of population on ecology and biodiversity.

Major Practical-2

Name of the Course: MJP2: Practical based on MJ2

1 Identification of mammalian fauna, avian fauna, and herpeto-fauna of India.

2 To study the various animal tracking system: Global Positioning System, Remote Sensing and Biotelemetry

3 Effect of climate change on biodiversity: Case study

4 Population estimation through Capture recapture method.

5 Study of r/k selection in *Catla catla*, *Hoplobatrachus tigrinus*, *Panthera leo*, *Canis lupus*, Oliev Ridley and *Gyps indicus*.

6 Determination of hardness of water sample.

7 Determination of dissolved oxygen.

8 Determination of salinity of the water sample by Refractometer / argentometric method.

9 Study of population dynamics, food chain food web: (Grassland, Forest, Desert and Aquatic).

10 Study of animal interaction: Ectopatasite (Head Louse) and Endoparasite (Tape worm), Exo parasite (Bed Bug), mutualism (Clownfish and anemones/ hermit crab and anemone), commensalism (Sharks and Remora).

11 Estimation of water holding capacity of given soil sample.

12 Study of animal community structure by quadrate method (Field or Simulation).

13 Study of aquatic fauna and their ecological role; fresh water (Cladocera), Intertidal (Sea Star, Sea Anemone, Barnacles), deep sea (Coral, Squids, Sperm Whale) (pictures / diagrams only).

14 Using photographs / paintings / coloured drawings identify and study ecological role of characteristic animal species (Desert- Camel, Himalayan- Marmots, Himalayan thar, Grassland- One horned Rhinoceros, Gaur) of terrestrial environment.

15 Identification, biology & ecological role of the following using suitable diagram / picture; Pangolin, blind cave fish, Ganges Dolphin.

16 Paper chromatography for separation of amino acids

17 Separation of lipids by thin layer chromatography.

18 Separation of pigments by chalk chromatography.

19 Measurement of optical density using colorimeter.

(Additional activity which the center may consider: Study of IUCN red data book status of brand animals (India only))

Reference Books

1. Biological Science, 3rd Ed. (2005) D.J. Taylor, N. P. O. Green, G. W. Stout. Cambridge University press, Low priced edition. ISBN: 978-0521684170
2. Animal Behaviour: Psychobiology, Ethology and Evolution (1999). David McFarland. Pearson Publication. ISBN: 978-0582327320
3. An introduction to animal behaviour, 6th edition – (2012) Aubrey Manning and M. S. Dawkins. Cambridge University press, ISBN: 978-0521165143.
4. National Geographic Vol. 193 (3) March 1998: Rise of life on Earth p. 54-81
5. Scientific American Oct. 1994: Origin of life on Earth p. 53-61.
6. Essentials of human genetics. 5th Ed. (2009) –M.L. Kothari, L.A. Mehta and S.S. Roychoudhary, University Press. SBN: 978-8173716478.
7. Essentials of Ecology, 3rd edition (2011) G. Tyler and Miller Jr. Thompson Books. ISBN: 978-0538735377
8. Biodiversity: An Introduction.(2004) 2nd Ed. Kevin J. Gaston & John I. Spicer . Blackwell Publishing. ISBN: 1-4051-1857-1.
9. Essentials of ecology and environmental sciences. 5th Ed. (2013) S. V. S. Rana. PHI publisher. ISBN: 978-8120347861
10. Strickberger's Evolution (2007) Monroe W. Strickberger, J. & B. Publication. ISBN: 978-0763700669.
11. National Parks of India. (2016) R.S. Bisht. Publication Division, Ministry of I & B Govt. India. eBook.
12. Indian National Parks. R. Pathak. ISBN: 978-8184200355.
13. Indian Wild life Sanctuaries and National parks (2013). By Prakash Chandra. Cyber Tech Publications. ISBN: 978-9350531914.

Vocational Skill Course

Name of the Course: VSC2a: Apiculture

Course Objectives (CO):

CO1. To acquaint the learners about entrepreneurship opportunities in Apiculture.

CO2. To acquaint learners about the rearing and management of apiculture.

CO3. To acquaint learners to different techniques and products of bee keeping.

Course Outcomes (OC):

OC1. The learners will be equipped with skill to demonstrate the rearing and management processes of honey bees.

OC2. The learners will be able to explore the entrepreneurial opportunities in apiculture.

Module: Apiculture

1. Study of morphology of Honeybees.
2. Study of different species of Indian honey bees (*Apis dorsata*, *A. florea*, *A. cerana indica*, *A. trigona* and *A. mellifera*).
3. Study of enemies of honey bees.
4. Study of diseases in honey bees.
5. Identification of different casts of honey bees.
6. Study of nesting behavior of bee species.
7. Study of different stages of the life cycle of the honey bee.
8. Study of different equipment required for bee keeping.
9. Study of different types and parts of the bee box.
10. Study of extraction of honey using honey extractor.
11. Study of moisture reduction of honey.
12. Study of packing materials and labeling.
13. Study of different techniques of rearing of honey bees.
14. Study of methods of extraction of bee-wax, royal jelly, propolis and bee venom.
15. Study of behavior and communication in bees.
16. Analysis of moisture content in honey using refractometer or a moisture analyzer.
17. Analysis of adulteration of honey.
18. Survey and report on commercial products available in the market.
19. Visit to Apiary center nearby your institution.
20. Submission/Presentation of Feasibility Report.
21. Assignment for preparation of bee box.

Reference Books

1. Graham, J M (1992) The hive and the honey bee. Dadant and Sons, Hamilton, IIIinois.
2. Mishra R.C. (1995) Honey bees and their management in India. ICAR Publication, New Delhi. 3. Singh, S. (1971) Beekeeping in India, ICAR publication.
3. The Biology of the Honey Bee: Mark L. Winston First Harvard Univ. Press 281 pages. ISBN: 0-674-07409 1987
4. The Anatomy of the Honey Bee: R.E. Snodgrass Forgotten Books 214 plus pages. ISBN: 1000193433 1910
5. The Hive and The Honey Bee version Editor: Joe Graham Dadant 943 plus pages. ISBN: 978-0-915698-16-5 2015
6. Honey Bee Biology & Beekeeping Authors: Dewey M Caron & Lawrence John Connor 2013 Wicwas Press 364 pages ISBN: 978-1-878075-29-1
7. Practical hand book of apiculture. A. G. Jaiswal. (2019). ISBN:9780359836161
8. Beekeeping: A Compressive Guide to Bees and Beekeeping. D. P. Abrol (2013). Scientific Publishers (India). ISBN:9789386237620
9. Apiary. Yogendra Kumar Payasi (2022). OrangeBooks Publication. ISBN:9789392878183

Vocational Skill Course

Name of the Course: VSC2b: Poultry

Course Objectives (CO):

CO1. To acquaint the learners about entrepreneurship opportunities in poultry science.

CO2. To acquaint learners to different breeds of poultry.

CO3. To acquaint learners about the rearing and management of poultry.

Course Outcomes (OC):

Upon completion of the course, the learner should be able to:

OC1. Understand the operation of poultry.

OC2. Comprehend the different breeds of poultry.

OC3. Demonstrate basic skills of rearing and management of poultry.

Module: Poultry

1. Study of Chicken Breeds – Leghorn, Gavran (Domestic), Kadaknath, Brahma Australorp, Plymouth rock.
2. Study of other poultry birds – Duck, Goose, Turkey, Quail
3. Study of poultry nutrition- Preparation of poultry feed.
4. Study of equipment required for poultry farming - (Cages and coops, Laying nest, Egg tray, Incubator, Waterer, Drinker, Feeder, Debeaker Ventilation fan, Heater, Fly trap and Egg washer).
5. Study of Structure of Hen's egg.
6. Mechanism of egg formation in hen (Fertilized and Parthenogenetic / Unfertilized).
7. Study of breeding techniques in poultry.
8. Estimation of protein content of hen's egg.
9. Estimation of fat / lipid content of hen's egg.
10. Study of various Types, Prevention and Treatment of Poultry diseases – Viral, bacterial, fungal and protozoan diseases of poultry birds.
11. Study of packaging of poultry products
12. Submission / Presentation of Feasibility Report on poultry.
13. Preparation of poultry manure from poultry waste. (Project)
14. Visit to poultry farm and to make a report. (Field Report)

Reference Books

1. Poultry Science: Fifth Edition/ Colin G. Scanes, Karen D. Christensen (2019). ISBN:9781478640370
2. Poultry: Production and Management. Egor P. Popov and Jagdish Prasad Jagdish (2010).
3. Management of farm poultry with a view to profit. Herbert Howes (2018). Agri Horti Press. ISBN:9789386595089
4. The Complete Guide of Poultry Farming: Eggs Production, Raising Chickens. Virender Singh. (2021). ISBN:9798741291801
5. Poultry Diseases, Diagnosis and Treatment. H V S Chauhan and Dr. Sushovan Roy. (1996). New Age International. ISBN:9788122410235.
6. Handbook of Poultry Science and Technology, Primary Processing. Alma Delia Alarcón-Rojo, Amarinder S. Bawa, Casey M. Owens, et al., (2010). Wiley. ISBN:9780470504444
7. Management in Small Poultry Farms. D. P. Mathur, V. K. Gupta (1979). Abhinav Publications. ISBN:9788170170921
8. Poultry Diseases. Mark Pattison. (2008). Elsevier/Butterworth-Heinemann. ISBN:9780702028625.
9. Hand Book of Poultry Farming and Feed Formulations. Engineers India Research Institute (EIRI) Board. (2007). Engineers India Research Institute. ISBN:9788186732830.
10. Business plan for poultry farm in India. Molly Rose (2020). Amazon Digital Services LLC - KDP Print US. ISBN:9798633755817

Skill Enhancement Course (SEC)

Name of the Course: SEC2: Fish Value Added Products

Course Objectives (CO):

CO 1. To acquaint learners to various fish value added products.

CO 2. To acquaint learner with the methods of seafood processing and entrepreneurial opportunities

Course Outcomes (OC):

Upon completion of the course, the learners should be able to:

OC 1. Prepare a few fish value added products.

OC 2. Conduct a feasibility study for starting a new venture on fish value added products.

Module: Fish Value Added Products

1. Basic methods of fish preservation techniques: salting, sun-drying, smoking and deep-freezing.
2. *Preparation of prawn or prawn pickle / chutney.
3. *Preparation of fish soup / sauce.
4. *Preparation of fish or prawn or squid or cuttlefish cutlets.
5. Identification of Packaging materials - Modified atmosphere packaging (MAP) rigid trays with lidding films, expanded polystyrene (EPS) trays, micro perforated EPS trays, Low density polyethylene (LPDE) bags, High density polyethylene (HPDE) containers, Fiberglass cans / trays, Aluminium / steel trays, Paperboard cartons.
6. Selecting a fish and fish cleaning methodology:

    a. Selecting a fresh fish

    Basic cleaning and storing procedure of fish:

    a. Scaling and requisites for scaling a fish.
    b. Cleaning a fish
    c. Gutting techniques
    d. Methods of head removal
    e. Filleting a fish
    f. Refrigerating a fish
    g. Waste disposal
7. Storing an ungutted fish
8. Study of fish value added marketing strategy:

    a. **Elements of marketing:** assemblage, storing, sorting, grading, packaging, labelling, storage before transport, transportation, advertisement, selling and buying.

    b. **Packaging of fish products:** principle, forms of packaging and skill

    c. **Labelling methodology**

    d. **Marketing Agents:** Producer, auctioneer, fishermen co-operative societies, wholesaler, retailors, exporter, vendors.

    e. **Marketing channels:** local market, commodity exchange market, commission brokers and agents.

9. Project / Survey on packaged fish food products available in the market.
10. Survey of challenges to commercial market of fish products.
11. Survey of market driving factors of fish products.
12. Visit to fish processing centre/cold-storage facilities/ fish landing centres/ fishery institutes and preparation of report with photographs.
13. Preparation of Feasibility report on starting a small-scale fish value added processing unit.

*Preparation of any recipe from available fish or crabs or mollusc can be done from home and its recipe along with nutritional vales can be submitted as additional activity.

Reference Books

1. K K Balachandran (2002) - Post Harvest Technology of Fish and Fish Products, Daya Publications.

2. G M Hall - Text Book of Fish Processing Technology. ICAR. (Ed). 1992.

3. K Gopakumar - Textbook of fish processing technology

4. Ninawe and Rathnakumar (2008) - Fish Processing Technology and Product Development, Narendra Publishing House.

5. Wheaton and Lawson (1985) Processing Aquatic Food Products, John Wiley & Sons.

6. Prasanna Chandra (2020). Fundamentals of Financial Management, 7th Edition, McGraw Hill.

7. Aitken A (1982). Fish handling & Processing: 2nd edition, Ministry of Agriculture, Fisheries & Food, Torry Research Station; Edinburgh.

Web Resources:

1 Hassoun et al., (2022) Seafood Processing, Preservation, and Analytical Techniques in the Age of Industry 4.0 https://doi.org/10.3390 /app12031703

2 Quality Assurance in seafood processing (2005) - CIFT Publication Seafood quality assurance https://krishi.icar.gov.in/jspui/bitstream/ 123456789/24957/1/15_Seafood%20quality%20assurance.pdf

3 Value addition: https://egyankosh.ac.in/bitstream/123456789/9798/ 1/Unit-12.pdf

4 Value Added Fish Products: https://www.researchgate.net/publication/ 259345025_Value_Added_Fish_Products

5 Value added fish products: https://krishi.icar.gov.in/jspui/bitstream/ 123456789/25126/1/12_Value%20added%20fish%20products.pdf

6 Prospects of Value added Fish Products & it's future in Indian Market: https://www.researchgate.net/publication/280876943_Prospects_of_Val ue_added_Fish_Products_it%27s_future_in_Indian_Market

7 Asogwa VC and Asogwa (2019). Marketing of fish products. Journal of Aquaculture & Marine Biology. 8(2):55–61. https://doi.org/10.15406/jamb.2019.08.00243

QUESTION PAPER PATTERN
(External and Internal)

FYBSc Zoology Evaluation pattern and Question paper pattern for Semester End Theory Examination of Major Course

Internal Continuous Assessment: 40% (20 Marks)	**Semester End Examination: 60% (30 Marks)**	**Duration for End semester examination**
Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.	As per paper pattern	01.00 hour

Format of Theory Question Paper: Semester end examination	
Time 1.0 Hr **Attempt any two out of four**	**Max. Marks 30**
Attempt any two out of four	
Q. 1. Write short note on the following a. Module I b. Module I c. Module II	 **05** **05** **05**
Q. 2. Write short note on the a. Module II b. Module II c. Module I	 **05** **05** **05**
Q. 3. Answer the following a. Module I b. Module II	 **08** **07**
Q. 4. Answer the following a. Module II b. Module I	 **08** **07**

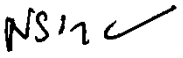
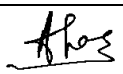
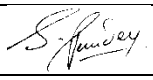
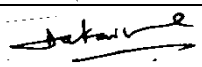
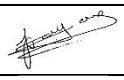
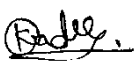
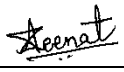
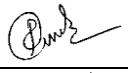
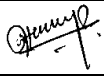
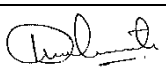
FYBSc Zoology Evaluation pattern and Question paper pattern for Semester End Practical Examination of Major Course

Internal Continuous Assessment: 40% (20 Marks)	**Semester End Examination: 60% (30 Marks)**	**Duration for End semester examination**
Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks) = 20 Marks	As per paper pattern	1 h 30 minutes
Format of Question Paper:		
Time 1 hr 30 min		**Max. Marks 30**
Q.1 One Major experiment		**10**
Q.2 One Minor experiment		**7**
Q. 3. Identification (any four)		**8**
Q.4. Journal and Viva (practical)		**5**

FYBSc Zoology Evaluation pattern and Question paper pattern for Semester End Practical Examination of Vocational Skill Courses and Skill Enhancement Courses

Internal Continuous Assessment: 40% (20 Marks)	**Semester End Examination: 60% (30 Marks)**	**Duration for End semester examination**
Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks) = 20 Marks	As per paper pattern	1 h 30 minutes
Format of Question Paper:		
Time 1 hr 30 min		**Max. Marks 30**
Q.1 Major experiment		**08**
Q.2 Minor experiment / ID based questions		**06**
Q.3 Minor experiment / ID based questions		**04**
Q.4. Project / Assignment and Viva (based on project / assignment)		**10**
Q5. Journal		**02**

Signatures of Team Members

Sr. No.	Name of committee member	Name of College	Signature
1	Dr. Anita Jadhav (Convenor)	ICLES Motilal Jhunjhunwala College, Vashi.	
2	Dr. Nandita Singh (Co-convenor)	G. M. Momin College, Bhiwandi.	
3	Dr. Aamod N. Thakkar (Co-convenor)	Veer Wajekar Arts, Science & Commerce College, Phunde.	
4	Dr. Shashibhal M. Pandey (Co-convenor)	C. H. M. College, Ulhasnagar.	
5	Dr. Dilip Kakavipure (Member, BoS)	B. N. N. College, Bhiwandi.	
6	Dr. Kantilal Nagare (Member, BoS)	B. K. Birla College, Kalyan.	
7	Dr. Kiran Pariya (Member, BoS)	B. N. Bandhodkar College, Thane.	
8	Dr. Rishikesh S. Dalvi (Member, BoS)	Maharshi Dayanand College, Parel, Mumbai-400012.	
9	Dr. Minakshi Gurav (Member, BoS)	D. G. Ruparel College, Mahim, Mumbai-400016.	
10	Dr. Ambadas Rodge (Member, BoS)	Gogate Jogalekar College, Ratnagiri-415612.	
11	Dr. Vishal Kadu (Member)	Sathaye College (Autonomous), Vile Parle (E), Mumbai 400057.	
12	Dr. Conrad Cabral (Member)	Xavier's College, Mumbai	
13	Dr. Zeenat Surve (Member)	Maharashtra College, Mumbai.	
14	Dr. Vishal Nangare (Member)	Siddharth College, Mumbai.	
15	Dr Swapnil Shewale (Member)	Hazarimal Somani College, Chowpatti, Mumbai.	
16	Mr. Kuldeep Mhatre (Member)	Seva Sadan's R K Talreja College, Ulhasnagar.	
17	Dr. Mahesh Mudgal (Member)	ACS College, Jawhar.	
18	Dr. Rahul Patil (Member)	Veer Wajekar Arts, Science & Commerce College, Phunde	
19	Dr. Nanda Jagtap (Member)	Dapoli Urban Bank Senior Science College, Dapoli, 415712	
20	Dr. Digvijay Lawate (Member)	ACS College, Lanja.	
21	Dr. Budharatna G. Bhaware (Member)	G. M. Vedak College of Science, Tala-Raigad.	
22	Dr. Gayathri N. (Member)	D. G. Ruparel College, Mahim, Mumbai 400016.	
23	Dr. Smita Subramanian (Member)	Viva College, Virar.	
24	Mr. Manoj D. Kadam (Member)	RD National College, Bandra	

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

This syllabus is applicable to IDOL learners as well, w.e.f. 2025-26.

Appendix B

Justification for B.Sc. (Zoology)

1.	Necessity for starting the course:	The B.Sc. (Zoology) course is necessary because it serves as a fundamental, multidisciplinary, and practical programme that prepares students for pursing higher education, allows them to explore numerous career options, and actively participate in tackling scientific and societal challenges.
2.	Whether the UGC has recommended the course:	**Yes**
3.	Whether all the courses have commenced from the academic year 2023-24.	The course has already commenced in the university and in the academic year 2024-25 it is restructured under NEP 2020
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	This course is aided / self-financed based on the sanction given by University of Mumbai to affiliated colleges time to time.
5.	To give details regarding the duration of the Course and is it possible to compress the course?:	The duration of the program is three years (6 semesters). It is not possible to compress the course.
6.	The intake capacity of each course and no. of admissions given in the current academic year:	120 per division
7.	Opportunities of Employability / Employment available after undertaking these courses:	Graduation in Zoology provides students with a greater awareness of the intricate relationships within the animal kingdom and the environment, as well as the ability to think critically and practically, allowing them to enhance their career prospects and open up novel opportunities.

Sign of the BOS Coordinator
Dr. Vaishali Somani
BOS in Zoology

Sign of the Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology

S.Y.B.Sc Zoology

Draft Syllabus (2018-2019) for Public Criticisms and Suggestion

Suggestion to be mailed on the Email-ID given below on or before 7th Dec 2017

1. *drgbraje@rediffmail.com*
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UNIVERSITY OF MUMBAI

Program: S.Y.B. Sc.

Course: Zoology Proposed Syllabus

(Credit Based Semester and Grading System with effect from the academic year 2018-2019) .

Syllabus for S.Y.B.Sc.
Course – ZOOLOGY

To be implemented from Academic year 2018-19
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	Study of Nutrition and Excretion	2	1
	II	Study Respiration and circulation		1
	III	Control and coordination, Locomotion and Reproduction		1
USZOE303A	I	Ethology	2	1
ELECTIVE 1	II	Parasitology		1
	III	Economic Zoology		1
USZOE303B	1	Aquarium maintenance	**2**	1
ELECTIVE 2	II	Agricultural pests and their control		1
	III	Amazing animals		1
USZOP3	Practical based on all three courses		**03**	**9**

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 Attitude methodology , writing and ethics		1
USZO402	I	Cell Biology,	2	1
	II	Endo membrane system		1
	III	Biomolecules		1
USZOE403A	I	Comparative Embryology,	2	1
ELECTIVE 1	II	Aspects of Human Reproduction,		1
	III	Pollution and its effect on organisms		1
USZOE403B	I	Dairy industry	**2**	
ELECTIVE 2	II	Sericulture		
	III	Aquaculture		
USZOP4	Practical based on all three courses		**03**	**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)
4. Model Question bank

	S.Y.B.Sc. ZOOLOGY UNIT WISE DISTRIBUTION						
Semester III				Semester IV			
Course 5	Course 6	Course 7	Course 7	Course 8	Course 9	Course 10	Course 10

		A	B			A	B
Unit 1 Fundamentals of Genetics	**Unit 1** Study of Nutrition & Excretion	**Unit 1** Ethology	**Unit 1** Aquarium maintenance	**Unit 1** Origin & evolution of life	**Unit 1** Cell Biology	**Unit 1** Comparative Embryology	**Unit 1** Dairy industry
Unit 2 Chromosomes & Heredity	**Unit 2** Study of Respiration & circulation	**Unit 2** Parasitology	**Unit 2** Agricultural pests & control	**Unit 2** Population Genetics & Evolution	**Unit 2** Endomembrane System	**Unit 2** Aspects of Human Reproduction	**Unit 2** **sericulture**
Unit 3 Nucleic Acids	**Unit 3** Control and Coordination Locomotion & Reproduction	**Unit 3** Economic zoology	**Unit 3** Amazing animals	**Unit 3** Scientific Attitude, Methodology, Writing & Ethics	**Unit 3** Biomolecules	**Unit 3** Pollution & Effects on Animals	**Unit 3** Aquaculture
Practical (USZO P3)	**Practical (USZO P3)**	**Practical (USZO P3)**	**Practical (USZO P3)**	**Practical (USZO P4)**	**Practical (USZO P4)**	**Practical (USZO P4)**	**Practical (USZO P4)**

S.Y.B.Sc. SYLLABUS DRAFT

SEMESTER III

Sr.	USZO301 COURSE-5	No. of lect	Learning

No		allotted	pleasure
	Fundamentals of Genetics, Chromosomes and Heredity, Nucleic acids		
	Unit 1: Fundamentals of Genetics	**15L**	**25hrs**
	Objectives: • To introduce basic terms of genetics. • To study Mendelian principles of inheritance and other forms and pattern of inheritance		
	Desired outcomes: • Learner shall comprehend and apply the principles of inheritance to study heredity. • Learner will understand the concept of multiple alleles, linkage and crossing over.		
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.	**02L**	**02hrs**
1.2	**Mendelian Genetics** • Mendelian Genetics: Monohybrid cross, Dihybrid cross, Test cross, Back cross, Mendel's laws of Inheritance, Mendelian traits in man. • Exceptions to Mendelian inheritance: Incomplete dominance, Co-dominance, Lethal alleles, Epistasis - Recessive, Double recessive, Dominant and Double dominant. • Chromosome theory of inheritance. • Pedigree Analysis-Autosomal dominant and Autosomal recessive, X-linked dominant, and X-linked recessive.	**08L**	**12hrs**
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 man. • Concept of Pleiotropy.	**03L**	**06hrs**
1.4	**Linkage and Crossing Over** • Linkage and crossing over, Types of crossing over, Cytological basis of crossing over.	**02L**	**05hrs**
	Unit: 2: Chromosomes and Heredity	**15L**	**26hrs**
	Objectives: • To familiarize the learners with the structure, types and classification of chromosomes. • To introduce the concept of sex determination and its types, sex influenced and sex limited genes.		
	Desired outcomes: • Learner will comprehend the structure of chromosomes and its types. • Learner shall understand the mechanisms of sex determination. • Learner would be able to correlate the disorders linked to a particular		

	sex chromosome.		
2.1	**Chromosomes** • Types of chromosomes–Autosomes and Sex chromosomes • Chromosome structure - Heterochromatin, Euchromatin • Classification based on the position of centromere • Endomitosis, Giant chromosomes- Polyteneand Lamp brush chromosomes and Significance of Balbiani rings	**04L**	**08hrs**
2.2	**Sex- determination** • Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW • Sex determination in Honey bees- Haplodiploidy • Sex determination in *Drosophila*-Genic balance theory, Intersex, Gynandromorphs • Parthenogenesis • Hormonal influence on sex determination-Freemartin and Sex reversal. • Role of environmental factors- Bonelia and Crocodile • Barr bodies and Lyon hypothesis	**07L**	**10hrs**
2.3	**Sex linked, sex influenced and sex limited inheritance.** • X-Linked: Colour-blindness, Haemophilia • Y-linked: Hypertrichosis • Sex-influenced genes • Sex limited genes	**04L**	**08hrs**
	Unit: 3 Nucleic acids	**15L**	**30hrs**
	Objectives: • To introduce the learner to the classical experiments proving DNA as the genetic material. • To make the learner understand the structure of nucleic acids and the concept of central dogma of molecular biology. • To familiarize the learner with the concept of gene expression and regulation.		
	Desired outcomes: • Learner will understand the importance of nucleic acids as genetic material. • The learner shall comprehend and appreciate the regulation of gene expressions.		
3.1	**Genetic material** • Griffith's transformation experiments, Avery-Macleod and McCarty, 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 viruses • Types of RNA: Structure and function	**07L**	**14hrs**
3.2	**Flow of genetic information in a Eukaryotic cell** • DNA Replication • Transcription of mRNA • Translation • Genetic code	**05L**	**08hrs**

3.3	**Gene Expressions and regulation** • One gene-one enzyme hypothesis /one polypeptide hypothesis • Concept of Operon • Lac Operon	**03L**	**08hrs**
	SEMESTER III		
	Practical USZOP3 (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 a. Monohybrid/ Dihybrid cross b. X- linked inheritance c. Multiple alleles		
8	Chromosome morphology: Metaphase spreadsheet (photograph to be provided)		
9	Pedigree analysis		
10	Problems on molecular biology		

Sr. No	USZO302 COURSE-6	No. of lect allotted	Learning pleasure
	Study of Nutrition and Excretion , Respiration and circulation, Control and coordination, Locomotion and Reproduction		
	Unit: 1 Study of Nutrition and Excretion	**15L**	**23hrs**
	Objectives: • To introduce the concepts of physiology of nutrition, excretion and osmoregulation. • To expose the learners to various nutritional apparatus, excretory¬ and osmoregulatory structures in different classes of organisms.		
	Desired outcomes: • Learner would understand the increasing complexity of¬ nutritional, excretory and osmoregulatory physiology in evolutionary hierarchy. • Learner would be able to correlate the habit and habitat with¬ nutritional, excretory and osmoregulatory structures. Comparative study of Nutritional Apparatus (structure and function)		
1.1	Amoeba, Hydra, Cockroach, Amphioxus, Pigeon, Ruminants. 5L 06hrs Physiology of digestion in man	**05L**	**06hrs**
1.2	• Physiology of digestion in man	**02L**	**04hrs**
1.3	• Comparative study of Excretory and Osmoregulatory structures and function. • a) Amoeba -contractile vacuoles • b) Planaria -Flame cells • c) Cockroach-Malphigian tubules and green gland	**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: Study of Respiration and Circulation	**15L**	**27hrs**
	Objectives: • To introduce the concepts of physiology of respiration and¬ circulation • To expose the learner to various respiratory and circulatory¬ structures in different classes of organisms		
	Desired outcomes: • Learner would understand the increasing complexity of respiratory¬ and circulatory physiology in evolutionary hierarchy. • Learner would be able to correlate the habit and habitat with¬ respiratory and circulatory structures. Comparative study of Respiratory organs (structure and function).		
2.1	• Earthworm, Spider, Rohu/Anabus/Clarius, Frog and Pigeon. 3L 06hrs Accessory respiratory structures: Anabas /Clarius	**03L**	**06hrs**
2.2	• Structure of lungs and physiology of respiration in man	**02L**	**03hrs**
2.3	• Comparative study of circulation: Open and closed - single and double	**02L**	**04hrs**

2.4	• Types of circulating fluids- Water, coelomic fluid, haemolymph,¬ lymph and 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 Control and coordination, Locomotion and Reproduction	**15L**	**25hrs**
	Objectives: • To introduce the concepts of physiology of control and coordination¬ and locomotion and reproduction • To expose the learner to various locomotory and reproductive¬ structures in different classes of organisms		
	Desired outcomes: • Learner would understand the process of control and coordination¬ by nervous and endocrine regulation. • Learner would be fascinated by various locomotory structures¬ found in the animal kingdom. • Learner would be acquainted with various reproductive strategies¬ present in animals.		
3.1	**Control and coordination** • **Irritability**-Paramoecium, Nerve net in Hydra, Nerve ring and¬ nerve cord in earthworm • Types of neurons on the basis of structure and function¬ • Conduction of nerve impulse: Resting potential, action potential and¬ refractory period • Synaptic transmission	**05L**	**08hrs**
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	**04L**	**08hrs**
3.3	Structure of Striated muscle fibre in human and Sliding filament theory	**02L**	**02hrs**
	Reproduction a. Asexual Reproduction- Fission, fragmentation, gemmule formation, budding b. Sexual reproduction i. Gametogenesis ii. Structure of male and female gametes in human iii. Types of fertilization iv. Oviparity, viviparity, ovo-viviparity	**04L**	**07hrs**
	SEMESTER III		
	Practical USZOP3 (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 non-striated muscle fibre		
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		

	USZOE1303 COURSE-7A		
	Ethology , Parasitology, Economic Zoology	**15L**	**26hrs**
	Unit: 1 Ethology		
	Objective: ➢ *To equip learners with a sound knowledge of how animals interact with one another and their environment.* ➢ *To enable the learners to understand different behavioural patterns.*		
	Desired Outcome: ➢ *Learners would gain an insight into different types of animal behaviour and their role in biological adaptations.* ➢ *Learners would be sensitized to the feelings instrumental in social behavior.*		
1.1	**Introduction to Ethology** ➢ 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.	**4L**	**06hrs**

1.2	**Aspects of animal behaviour** ➢ Communication in Bees and Ants ➢ Mimicry and colouration ➢ Role of hormones and pheromones in sexual behaviour ➢ Displacement activities, Ritualization ➢ Migration in fish, schooling behaviour ➢ Habitat selection, territorial behaviour, food selection and foraging behaviour in African ungulates	**7L**	**12hrs**
1.3	**Social behaviour** ➢ Social behaviour in primates-Hanuman langur ➢ Elements of Socio-biology: Selfishness, cooperation, altruism, kinship and inclusive fitness	**4L**	**08hrs**
	Unit: 2 Parasitology	**15L**	**27hrs**
	Objective: ➢ *To acquaint learners with the concepts of parasitism, their relationship with environment.* ➢ *To make learners aware about the modes of transmission of parasites.*		
	Desired Outcome: ➢ *Learners would understand the general epidemiological aspects of parasites that affect humans and apply simple preventive measures for the same.* ➢ *Learners would comprehend the life cycle of specific parasites, the symptoms of the disease and its treatment.*		
2.1	**Introduction to Parasitology and types of parasites** ➢ Definitions: parasitism, host, parasite, vector-biological and mechanical ➢ **Types of parasites-** Ectoparasites, Endoparasite and their subtypes ➢ Parasitic adaptations in Ectoparasites and Endoparasites ➢ Types of hosts: intermediate and definitive, reservoir	**3L**	**06hrs**
2.2	**Host-parasite relationship-Host specificity** ➢ Definition, structural specificity, physiological specificity and ecological specificity.	**2L**	**06hrs**
2.3	**Life cycle, pathogenicity, control measures and treatment** ➢ *Entamoeba histolytica, Fasciola hepatica, Taenia solium, Wuchereria bancrofti*	**4L**	**06hrs**
2.4	**Morphology, life cycle, pathogenicity, control measures and treatment** ➢ Head louse(*Pediculushumanus capitis*), Mite (*Sarcoptesscabei),* Bed bug (*Cimexlectularis)*	**2L**	**06hrs**
2.5	**Parasitological significance** ➢ Zoonosis- Bird flu, Anthrax, Rabies and Toxoplasmosis	**4L**	**03hrs**
	Unit 3 Economic Zoology	**15L**	**24hrs**
	Objective: ➢ *To disseminate information on economic aspects of zoology like apiculture, vermiculture, dairy science.* ➢ *To encourage young learners for selfemployment.*		
	Desired Outcome:		

	➢ *Learners wouldgain knowledge on animals useful to mankind and the means to make the most of it.* ➢ *Learners would learn the modern techniques in animal husbandry.* ➢ *Learners would be pursuing entrepreneurship as careers*		
3.1	**APICULTURE**	**6L**	**08hrs**
3.1.1	**Methods of bee keeping and management** ➢ 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		
3.1.2	**Economic importance** ➢ Honey- Production, Chemical composition and economic importance ➢ Bees wax- Economic importance. ➢ Role of honey bees in pollination.		
3.2	**VERMICULTURE**	**4L**	**08hrs**
3.2.1	**Rearing methods, management and economic importance** ➢ An introduction to different species of earthworms used in vermiculture. ➢ Methods of vermiculture. ➢ Maintenance and harvesting ➢ Economic importance: advantages of vermiculture, demands for worms; market for vermin-compost and entrepreneurship.		
3.3	**DAIRY SCIENCE**	**5L**	**08hrs**
3.3.1	**Dairy development in India** ➢ Role of dairy development in rural economy, employment opportunities	**1L**	
3.3.2	**Dairy Processing** ➢ Filtration, cooling, chilling, clarification, pasteurization, freezing		
3.3.3	**Milk and milk products** ➢ Composition of milk ➢ Types of milk: A. Buffalo milk and B. Cow milk (a1 and a2) Whole milk and toned milk ➢ Milk products		

	SEMESTER III		
	Practical USZOE1P3 (Course VIIA)		
1	Extraction of Casein from Milk and its qualitative estimation		
2	Preparation of paneer from given milk sample		
3	Measurement of density of milk using different samples by Lactometer		
4	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		
5	Study of ethological aspects: a) Warning Colouration b) Instincts c) Imprinting d) Communication in animals: Chemical signals and sound signals e) Displacement activities in animals: Courtship and mating behavior in animals and ritualization		
6	Study of Protozoan parasites: a. *Trypanosoma gambiense* *b. Giardia intestinanalis*		
7	Study of Helminth parasites: *a) Ancylostomaduodenale* *b) Dracunculusmedenensis*		
8	Parasitic adaptations: Scolex and mature proglottid of Tapeworm		
9	Study of Ectoparasites: a. Leech b. Tick c. Mite		
10	Project- Suggested topics on economic zoology (eg Apiculture, sericulture/ lac culture / vermicompost Technique / Construction of artificial beehives /Animal husbandry/ aquaculture etc)		
	USZOE2303 COURSE-7B		
	Aquarium maintenance,Agricultural pests and their control,Amazing animals	**15L**	**26hrs**
	Objective: ➢ *To develop the skill of aquarium maintenance and budget allocation for setting up an aquarium fish farm.* ➢ *To study the biology of aquarium fishes, food, feeding and transportation of fishes.*		
	Desired Outcome: ➢ *Learner will develop the skill of aquarium maintenance and become familiar with the budgeting aspects for setting aquarium fish farm.* ➢ *Learner will derive knowledge about the biology of aquarium fishes as also food, feeding and transportation of fishes.*		

	Unit 1 Aquarium maintenance		
1.1	Introduction and scope	**2L**	**04hrs**
1.2	Exotic and Endemic species	**2L**	**06hrs**
1.3	Biology of Aquarium Fishes-	**2L**	**08hrs**
1.3.1	➢ Guppy ➢ Molly ➢ Gold fish		
1.3.2	Common characters and sexual dimorphism Marine fishes - ➢ Anemone fish ➢ Butterfly fish	**2L**	**6L**
1.3.3 .	Common characters and sexual dimorphism Marine fishes – ➢ Anemone fish ➢ Butterfly fish	**2L**	**4L**
1.4	Food and feeding- ➢ Live fish feed ➢ Formulated fish feed	**2L**	**4L**
1.5	Fish transportation – i)Transport ii) handling iii) packing	**3L**	**5L**
1.6	General Aquarium maintenance- budget for setting up an aquarium Fish Farm.	**2L**	**4L**
	Unit: 2 Agricultural pests and their control	**15L**	**27hrs**
	Objective: ➢ *To study different types of pests.* ➢ *To comprehend various aspects of agricultural pests and their economic implications.* ➢ *To learn about the differing pest control practices and plant protection appliances.*		
	Desired Outcome: ➢ Learner will gain information on the different types of pests and comprehend various aspects of agricultural pests and its economic implications. ➢ Learner shall derive knowledge of pest control practices and appliances used for plant protection against pests.		
2.1	Introduction and concept of Pest	**2L**	**06hrs**
2.1.1 **.**	Types of pests ➢ Agricultural ➢ Household ➢ Stored grains ➢ Structural ➢ Veterinary	**3L**	**06hrs**

	➢ Forestry		
2.2	Major insect pests of agricultural importance (Life cycle, nature of damage and control measures). a) Jowar stem borer b) Brinjal fruit borer c) Aphids d) Mango stem borer e) Pulse beetle f) Rice weevil.	**3L**	**06hrs**
2.3	Non insect pests: Rats and Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels.	**2L**	**06hrs**
2.4	Pest control practices: i) Cultural control ii) Physical control iii) Mechanical control iv) Chemical control v) Biological control, vi) concept of IPM.	**3L**	**03hrs**
2.5	Plant protection appliances: Rotary duster, knapsack sprayer and cynogas pump, hazards of pesticides and antidotes.	**2L**	**03hrs**
	Unit 3 Amazing animals	**15L**	**24hrs**
	Objective: ➢ To comprehend the concept of life timeline, and the natural history of some amazing animals. ➢ To kindle interest and yearning to study amazing animals.		
	Desired Outcome: ➢ *Learner shall understand the concept of life time-line.* ➢ *Learner will gain knowledge of and develop various skills while studying amazing animals.*		
3.1	Natural History a) Introduction and life timeline b) Butterflies the flying jewels- Blue Mormon, Striped tiger c) Herpetofauna of India- Flying frog, Fan Throated lizard and Gharial d) Feathered Bipeds: Kingfisher, Drongo e) Mammals of India: Malabar giant squirrel	**4L**	**08hrs**

3.2	The world's most amazing animals a) Octopus b) Spider c) Mudskipper d) Flying fish e) Pebble toad f) Strawberry poison frog g) Komodo dragon h) Lesser flamingo i) Great white pelican j) Spatule -tailed hummingbird k) Cheetah	**5L**	**10hrs**
3.3	Five most incredible animals discovered within the last decade a) The purple (Joker) Crab, b) The African dwarf sawshark (Stabbing Shark), c) The Psychedelic (Crime Fighting) Gecko, d) The Matilda Viper e) The Michael Jackson Monkey	**3L**	**5hrs**
3.4	Marvels of Animals a) Mantis shrimp: Fastest punch b) Homing in Pacific Salmon c) Sperm whale: Mechanism of deep sea diving.	**3L**	**08hrs**

	Practical USZOE2P3 (Course VIIB)
1	Aquarium maintenance –equipments required to set up –Types of filter, type of gravel, air pump, type of bulb, net, verities of aquarium plants, verities of fishes.
2	Types of pests –Agricultural-Aphids,Household-cockroaches,ants,structural-termites, stored grains-grain borer, Veterinary- fleas, Forestry- caterpillar.
3	Non insect pests- a) Invertebrates -nematodes, mites, snails, slugs. b) Vertebrates- rats, birds
4	Types of pest control –a) Physical b) Biological c) Electronic d) Insecticides, Rodenticides and Special Treatments
5	Amazing animals- a) Spider b) Pebble toad c) Komodo dragon d) Flamingo
6	Most incredible animals in last decades – a) Joker crab b) Michel Jackson monkey c)Matilda viper
7	Most endangered animals of India – a) One horned rhino b) Asiatic Lion c) Bengal tiger d) Snow leopard
8	A project of aquarium setting in lab.
9	A field visit to study the natural flora and fauna.

Note -The practicals 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 asenvisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall beprocured for the purpose of conducting practicals mentioned here-in-above.
#There shall be at least one excursion/field trip.

SEMESTER IV

Sr. No	USZO401 COURSE-8	No. of lect allotted	Learning pleasure
	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: ➢ *To impart scientific knowledge about how life originated and evolved on our planet.*		
	Desired outcomes: ➢ *Learner will gain insight about origin of life.* ➢ *Learner will ponder and critically view the different theories of evolution.*		
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	**Theories of organic evolution** • 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**
	Objectives: • To develop knowledge and understanding of genetic variability within a population and how the change in the gene pool leads to evolution of species		
	Desired outcomes: • Learner would understand the forces that cause evolutionary changes in natural populations • Learner would comprehend the mechanisms of speciation • Learner will be able to distinguish between microevolution, macroevolution and megaevolution		
2.1	**Introduction to Population genetics** • Definition • Brief explanation of the following terms: Population, Gene pool, Allele frequency, Genotype frequency, Phenotype frequency, Microevolution	**01L**	**03hrs**

2.2	**Population genetics**	**06L**	**10hrs**
	• 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-assortativemating),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		
2.3	**Evolutionary genetics** • 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) • 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)	**08L**	**15hrs**
	• Macroevolution and Megaevolution: Concept and Patterns of macroevolution (Stasis, Preadaptation /Exaptation, Mass extinctions, Adaptive radiation and Coevolution), Megaevolution		
	Unit: 3 Scientific Attitude Methodology, Scientific Writing and Ethics in Scientific Research	**15L**	**32hrs**
	Objectives: • To inculcate scientific temperament in the learner		
	Desired outcomes: • The learner shall develop qualities such as critical thinking and analysis • The learner will imbibe the skills of scientific communication and he/she will understand the ethical aspects of research		
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 • 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	**04L**	**10hrs**

	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) • Application of knowledge: Basic research, Applied research, Translational research, Patent		
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	**04L**	**10hrs**
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	**03L**	**05hrs**
3.4	**Ethics** • Ethics in animal research:The ethical and sensitive care and use of animals in research, teaching and testing, Approval from Institutional animal ethics Committee • Ethics in clinical research:Approval from Clinical Research Ethics Committee Informed consent • Approval from concerned/ appropriate authorities: National Biodiversity Authority, State Biodiversity Board, Forest Department • Conflict of interest	**03L**	**05hrs**
3.5	**Plagiarism**	**01L**	**02hrs**

	SEMESTER IV		

Sr. No	USZO401 COURSE-8	No. of lect allotted	Learning pleasure
	Practical USZOP4 (Course VIII)		
1	Study of population density by Line transect method & Quadrant method and calculate different diversity indices. A. Index of Dominance B. Index of frequency C. Rarity Index D. Shannon Index E. Index of species diversity		
2	Study of Prokaryotic cells (bacteria) by Crystal violet staining technique		
3	Study of Eukaryotic cells (WBCs) from blood smear by Leishman's stain		
4	Identification and study of fossils a. Arthropods: Trilobite b. Mollusca: Ammonite c. Aves: Archaeopteryx		
5	Identification of a) Allopatric speciation (Cyprinodont species) b) Sympatric speciation (Hawthorn fly and Apple maggot fly) c) Parapatric speciation (Snail)		
6	Bibliography/ Abstract writing		
7	Preparation of Power Point Presentation		

Sr.No.	USZO402 Course IX	No.of lects allotted	Learning pleasure
	Unit 1: Cell Biology	**15L**	**24hrs**
	Objectives: ➢ *To study the structural and functional organization of cell with an emphasis on nucleus, plasma membrane and cytoskeleton.*		
	Desired outcomes: ➢ *Learner would acquire insight of transport mechanisms for the maintenance and composition of cell*		
1.1	**Introduction to cell biology** • Definition and scope • Cell theory • Generalized prokaryotic , eukaryotic cell: size, shape and structure	**02L**	**04hrs**
1.2	**Nucleus** • 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¬ • Nucleocytoplasmic interactions	**05L**	**06hrs**
1.3	**Plasma membrane** a. Fluid Mosaic Model b. Junctional complexes c. Membrane receptors d. Modifications: Microvilli and Desmosomes	**04L**	**08hrs**
1.4	**Transport across membrane** a. Diffusion and Osmosis b. Transport: Passive and Active c. Endocytosis and Exocytosis	**02L**	**04hrs**
1.5	Cytoskeletal structures Microtubules: Composition and functions Microfilaments: Composition and functions		
	Unit: 2: Endomembrane System	**15L**	**28hrs**
	Objectives: • To acquaint the learner with ultrastructure of cell organelles and their functions		
	Desired outcomes: • Learner would appreciate the intricacy of endomembrane system. • Learner would understand the interlinking of endomembrane system for functioning of cell		
2.1	**Endoplasmic reticulum:** General morphology of endomembrane system • Morphology and Types of ER • Biogenesis of ER • Functions of RER and SER	**01L**	**03hrs**
2.2	**Golgi complex:** Morphology of Golgi complex, Cytochemistry . • Functions of Golgi complex	**06L**	**10hrs**

	• Protein Glycosylation, • Lipid and Polysaccharide Metabolism • Protein Sorting and Secretion • Golgi anti-apoptotic protein (GAAP)		
2.3	**Lysosomes:** Origin, occurrence and polymorphism Functions of lysosomes: Peroxisomes: Origin, morphology & functions	**08L**	**15hrs**
2.4	**Mitochondria:** Morphology and chemical composition of mitochondria, Bioenergetics, • Chemical energy & ATP • Glycolysis • Krebs cycle • Respiratory chain and Oxidative phosphorylation		
	Unit: 3 Biomolecules	**15L**	**30hrs**
	Objectives: To give learner insight into the structure of biomolecules,¬ and their role in sustenance of life		
	Desired outcomes: The learner will realize the importance of biomolecules and¬ their clinical significance		
3.1	**Biomolecules** : Concept of Micromolecules and Macromolecules	**02L**	**05hrs**
3.2	**Carbohydrates:** Definition Classification, Properties and Isomerism,¬ Glycosidic bond Structure of¬ a. Monosaccharides- Glucose and Fructose b. Oligo-saccharides - Lactose and Sucrose c. Polysaccharides - Cellulose, Starch, Glycogen and Chitin Biological role and their Clinical significance	**04L**	**08hrs**
3.3	• **Amino Acids and Proteins:** Basic structure of amino acid, 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 (Hemoglobin) role and their Clinical significance	**05L**	**08hrs**
3.4	**Lipids**: 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) and Steroids (Cholesterol). • Biological role and their Clinical significance	**04L**	**05hrs**
3.5	**Vitamins**: Water soluble vitamins(e.g. Vit C, Vit B12) • Lipid soluble vitamins (e.g. Vit A, Vit D) • Biological role and their Clinical significance	**02L**	**04hrs**

	SEMESTER IV		
	Practical USZOP4 (Course VIII)		
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	Ultra structure of cell organelles (Electron micrographs) a. Nucleus b. Endoplasmic reticulum (Smooth and Rough) c. Mitochondria. d. Golgi apparatus e. Lysosomes		
8.	Study of clinical disorders due to carbohydrates, proteins and lipid imbalance (Photograph to be provided / significance to given and disorder to be identified) a. Hyperglycemia, Hypoglycemia. b. Thalassemia, Kwashiorkar c. Obesity, Atherosclerosis		

	USZOE1403 COURSE-10A		
	Comparative Embryology, Aspects of Human Reproduction, Pollution and its effect on organisms		
	UNIT 1: Comparative Embryology	**15L**	**25hrs**
	Objective: ➢ *To acquaint the learner with key concepts of embryology.*		
	Desired Outcomes: ➢ *Learner will be able to understand and compare the different pre- embryonic stages* ➢ *Learner will be able to appreciate the functional aspects of extra embryonic membranes andclassify the different types of placentae.*		
1.1	➢ Types of Eggs- Based on amount and distribution of yolk	2L	4hrs
1.2	➢ Structure and Types of Sperms	2L	4hr
1.3	➢ Types of Cleavages.- Holoblastic and Meroblastic	2L	4hrs
1.4	➢ Types	1L	4hrs
1.5	➢ Gastrulation	2L	4hrs
1.6	➢ Coelom -Formation and types	4L	6hrs

	UNIT 2: Aspects of Human Reproduction	15L	30 hrs
	Objectives: ➢ *To acquaint the learners with different aspects of human reproduction.* ➢ *To make them aware of the causes of infertility, techniques to overcome infertility and the concept of birthcontrol*		
	Desired Outcome: ➢ *Learners will able to understand human reproductive physiology* ➢ *Learners will become familiar with advances in ART and related ethical issues.*		
2.1	**Human Reproductive system and Hormonal regulation** ➢ Anatomy of human male and female reproductive system ➢ Hormonalregulationof Reproduction and Impact of age on reproduction-Menopause and Andropause	2L	4hrs
2.2	**Contraception & birth control** ➢ Difference between contraception and birth control ➢ Natural Methods: Abstinence , Rhythm method, Temperature method, cervical mucus or Billings method, Coitus interruptus, Lactation amenorrhea ➢ Artificial methods **:** Barrier methods, Hormonal methods, Intrauterine contraceptives, Sterilization, Termination , Abortion	2L	4hrs
2.3	**Infertility** **Female infertility** ➢ **Causes -** Failure to ovulate; production of infertile eggs ; damage to oviducts (oviduct scarring and PID or Pelvic inflammatory disease, TB of oviduct), Uterus (T. B. of uterus and cervix) ➢ **Infertility associated disorders (**Endometriosis, Polycystic Ovarian syndrome (PCOS), POF (Primary ovarian failure) STDs (Gonorrhea, Chlamydia, Syphilis and Genital Herpes); Antibodies to sperm; Genetic causes-Recurrent abortions; Role of endocrine disruptors	4L	8hrs
	Male infertility **Causes :** Testicular failure, infections of epididymis, seminal vesicles or prostate, hypogonadism, cryptorchidism , congenital abnormalities,Varicocele, Blockage, Azoospermia, Oligospermia, abnormal sperms, autoimmunity, ejaculatory disorders andIdiopathic infertility.		

2.5	**Treatment of Infertility** ➢ Removal /reduction of causative environmental factors ➢ Surgical treatment ➢ Hormonal treatment- Fertility drugs ➢ Assisted Reproductive Technology ➢ In vitro fertilization, Embryo transfer (ET), Intra-fallopian transfer (IFT), Intrauterine transfer (IUT), Gamete intra-fallopian transfer (GIFT), intra-zygote transfer (ZIFT), Intracytoplasmic sperm injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsies – Testicular sperm extraction (TESE), Pronuclear stage transfer (PROST). ➢ Sperm banks, cryopreservation of gametes and embryos ➢ Surrogacy	7L	8hrs
	UNIT3: Pollution and its effect on organisms	**15L**	**27hrs**
	***Objective*:** ➢ *To provide a panoramic view of impact of human activities leading to pollution and its implications.*		
	Desired Outcome: ➢ *The learners will be sensitized about the adverse effects of pollution and measures to control it.*		
3.1	**Air Pollution** ➢ **Types and sources of air pollutants** ➢ Effects and control measures	3L	6hrs
3.2	**Water Pollution** ➢ Types and sources of water pollutants ➢ Effects and control measures	3L	6hrs
3.3	**Soil Pollution** ➢ Types and sources of soil pollutants ➢ Effects and control measures	**3L**	**4hrs**
3.4	**Noise pollution** ➢ Different sources of sound pollution ➢ Effects and control measures	1L	3hrs
3.5	**Pollution by radioactive substances**	1L	2hrs
3.6	**Pollution by solid wastes** ➢ Types and sources, ➢ Effects and control	2L	4hrs
3.7	**Pollution –** Climate Change and Global Warming	2L	2hrs

	Practical USZOE1P4 (Course XA)
1	Estimation of Dissolved oxygen from the given water sample .
2	Estimation of Salinity by refractometer from the given water sample.
3	Estimation of conductivity by conductometer from the given water sample .
4	Determination of blood pressure by spyghmomanometer.
5	Detection of Creatinine in urine.
6	Determination of blood sugar by GOD and POD method
7	Study of bleeding time and clotting time.
8	Study of the following permanent slides, museum specimens and materials. a. Mammalian sperm and ovum. b. Egg types –Fish eggs, Frog eggs , Hen's egg. c. Cleavage , blastula and gastrula (Amphioxus, Frog and Bird).
9	Study of commercially important fishery (Catla, Rohu, Catfish, Mackerel, Pomfret, Bombay duck, Prawn/ Shrimp, Crab, Lobster, Edible oyster)
10	Review writing based on programmes telecast by Doordarshan, Discovery channel, Gyandarshan, UGC programmes, Animal planet
11	Study of natural ecosystem and field report of the visit

	USZOE2403 COURSE-10B		
	Dairy Industry,sericulture,Aquaculture		
	UNIT 1: Dairy Industry	**15L**	**25hrs**
	Objective: ➢ *To comprehend the functioning of various aspects of dairy industry.* ➢ *To study different indigenous and exotic cattle breeds and buffalo breeds in India.* ➢ *To develop an understanding of the different systems of breeding and various aspects dealing with housing of dairy animals.*		
	Desired Outcomes: ➢ *Learner shall gain knowledge on the functioning of various aspects of dairy industry,indigenous, exotic cattle and buffalo breeds in India.* ➢ *Learner shall study different systems of breeding and gain information regarding various aspects pertaining to housing of dairy animals.*		
1.1	Definition Indian Cattle breeds ➢ Malvi ➢ Hariyana ➢ Deoni ➢ Red sindhi ➢ Khillari	2L	8hrs
1.2	Exotic breeds ➢ Jersy ➢ Holstein	2L	4hr
1.3	Indian buffalo breeds ➢ Nagpuri ➢ Bhadawari ➢ Murrah ➢ Jafrabadi	2L	4hrs
1.4	Systems of inbreeding and crossbreeding	1L	4hrs
1.6	Cleaning and sanitation	2L	6hrs
1.7	Weaning of calf,castration and dehorning	2L	4hrs
1.8	Diseases and control	2L	4hrs
	UNIT 2: Sericulture	**15L**	**30 hrs**
	Objectives: ➢ *To comprehend the functioning of sericulture industry and its scope in India.* ➢ *To study the varieties of silk-worms and host plants.* ➢ *To critically study the life history and rearing of Bombyxmori, harvesting, processing of cocoon, production*		

	of silk and diseases afflicting silk-worms.		
	Desired Outcome: ➢ Learner shall understand the basics of the functioning of sericulture industry and its scope in India. ➢ Learner shall gain knowledge on the varieties of silk-worms, host-plants and aspects on silk extraction and the diseases afflicting silk-worms.		
2.1	Introduction and its scope	2L	4hrs
2.2	Verities of silk worm, host plants	2L	4hrs
2.3	Life history and rearing of *Bombyxmori*	2L	8hrs
2.4	Harvesting and processing of cocoon	2L	4hrs
2.5	Reeling and extraction of silk	3L	4hrs
2.6	Diseases and control measures	3L	4hrs
	UNIT3: Aquaculture	**15L**	**27hrs**
	Objective: ➢ *To comprehend various kinds of aquaculture practices and its scope as fishery resource in India.* ➢ *To study various techniques employed in aquaculture practices*		
	Desired Outcome: ➢ *Learner shall understand the aquaculture practices and the scope of fishery in India.* ➢ *Learner will gain knowledge of various techniques employed in aquaculture practices.*		
3.1	Pisiculture a) Definition and scope of fishery resources in India b) Finfish culture ➢ Monoculture ➢ Polyculture c) Role of exotic fishes in polyculture d) Cage culture e) Induced breeding f) Fish seed transport, fish diseases, their symptoms and control	5L	6hrs
3.2	Prawn/shrimp culture a) Giant fresh water prawn (*Macrobrachiumrosenbergii*) b) white shrimp(*Penaeusvannamei*) c) Sources, seed, culture methods	5L	6hrs
3.3	Pearl culture a) Pearl producing species and their distribution b) Pearl culture methods	**5L**	**4hrs**

	c) Composition of pearl		

	Practical USZOE2P4 (Course XB)
1	Comparison of protein content from cow's milk and buffalo's milk.
2	Comparison of fat content from cow's milk and buffalo's milk.
3	Preparation of falooda
4	Preparation of caramel custard.
5	Restraining devices used in cattle farming- Halters, gags, bull-rings, muzzeles, cradle, crush, ropes
6	Life cycle of *Bombyx morri*
7	Crustacean fishery – common characters and sexual dimorphism in Lobster ,prawn, shrimp ,crab
8	Visit to dairy farm /aquaculture and submit report of the same.

Note -The practicals 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 byusing photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and asenvisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall beprocured for the purpose of conducting practicals mentioned here-in-above.
#There shall be at least one excursion/field trip.

N.B :
I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II)Apart from the institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority/Body from time to time, every college should constitute the following Committees :

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
2) A Dissection Monitoring Committee (DMC)

Composition of DMC shall be as follows :

i) Head of the Concerned Department (Convener/Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of related department from the same College

One or two members of related department from neighboring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT/DISSECTIONS/MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES,CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

SCHEME OF EXAMINATION (THEORY)

(a) External assessment of one hundred (100) marks per course per semester should be conducted as per the following skeleton question paper pattern.
(c) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

All Questions are compulsory
Figures to the right indicate full marks

Time: 3 hours **Total marks: 100**

Q1	Objective*	20 marks
Q.2.	UNIT 1 Answer any four out of eight (5 marks each)	20 marks
Q.3.	UNIT 2 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.4.	UNIT 3 Answer any two out of four (10 marks each)	20 marks
Q.5.	a. Unit 1 - (One note of five marks OR objective type questions) b. Unit 2 - (One note of five marks OR objective type questions) c. Unit 3- (One note of five marks OR objective type questions)	20 marks

Note:
1) *For Question No. 01 it is recommended to have objective questions on all units, such as –
(a) Match the column (b) MCQ
(c) Give one word for (d) True and False
(e) Define the term (f) Answer in one sentence etc
2) Under Question No. 05 there should be one note of five marks with internal or of five objective questions each of 01 mark. This pattern is applicable to all three sub-questions.

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, McGraw Hill Education
9. Genetics A Mendelian approach Peter J.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, Monroe W. Strickberger
12. Genetics from gene to genome, third edition, LeelandH.Hartwell, Leeroy Hood, Michael 7. L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education

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.,Cambridg University Press.

COURSE-VII (USZOE1303A)

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. Biology of Insects- 1992 SaxenaS. C. Oxford and IBH Publishing CoNew Delhi. Bombay. Calcutta
8. A Text Book of Entomology- 1974Mathur V. K. and Upadhayay KGoel Printing press, Barani.
9. Bee and Bee Keeping- Roger A. Morse, Conell University PressLondon
10. Vermiculture Technology - Clive A. Edwards, Norman Q. Arancon and Rhonda Sherman
11. Parasitology- ChatterjeeK.D., Chatterjee Medical Publishers.

12. Medical Parasitology- Arora
13. Textbook of Medical Parasitology-.C.K JayaramPaniker, Jaypee Brothers.
14. A text book of Parasitology- KochharS.K. Dominant Pub. & Dis, New Delhi.
15. Essentials of Parasitology- Gerald and Schmidt: Universal Bookstall, New Delhi.
16. Parasitology- Sharma P.N.andRatnuL.N., Chand S &Co.Pvt.Ltd.
17. Introduction to Parasitology- Chandler and Read John Wiley & Sons
18.Economic Zoology- Biostatistics and Animal behaviour – S.Mathur, Rastogi Publicatons.
19. Economic Zoology- Shukla G.S. & Upadhyay V.B., Rastogi Publications.
20. A handbook on Economic Zoology, S.Chand& Co.

COURSE-VII (USZOE2303B)

1. A General textbook of entomology -- A D Imms. Asia Publication.
2. Agricultural insect pests and their control. V.B. Awasthi. Scientific Publication.
3. A manual of practical entomology. – M MTrigunayat. Scientific Publication.
4. Applied Entomology – AlakaPrakash and Fennemore. New Age Publishers.
5. Applied Entomology – Awasthi. Scientific Publication.
6. A Text book of insect morphology, physiology and endocrinology – Tembhare D. B.– Chand Publication
7. Entomology and Pest Management –Larry P. Pedigo. Pearson Education.
8. Forensic Entomology-The utility of Arthropods in legal investigations. –Jason H. Byrd and James L. Castner. CRC Press.
9. General and applied Entomology – David and Ananthakrishnan. Tata McGraw Hill
10. Insect endocrinology and physiology – Tembhare D B – S Chand publication.
11. Insect Jewelry by Roger D. Akre., Laurel D. Hansen, and Richards S. Zack: in Summer (1991). (Online available as research article).
12. Insect Year Book of Agriculture- American Agriculture Department Publication.
13. .
14. Economic Zoology- Shukla G.S. & Upadhyay V.B., Rastogi Publications.
15. A handbook on Economic Zoology, S. Chand & Co.
16. 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.
17. Park, Y. W., & Haenlein, G. F. (Eds.). (2013). Milk and dairy products in human nutrition: production, composition and health. John Wiley & Sons.
18. Venkatasubramanian, V., Singh, A. K., & Rao, S. V. N. (2003). Dairy development in India: An appraisal of challenges and achievements. Concept Publishing Company.
19. Shrivastava, J. S. M. (2008). Dairy Development In The New Millennium (The Second White Revolution). Deep and Deep Publications.
20. http://listverse.com/2012/12/03/10-amazing-animal-abilities/
21. www.toptenz.net/top-10-amazing-animals-discovered-within-the-last-decade.php
22. dailynewsdig.com/top-10-amazing-animal-hybrids.
23. https://www.pinterest.com/pin/16044142395584735/
24. www.naturalhistorymag.com/
25. https://naturalhistory.si.edu/.

MODEL QUESTION BANK SEMESTER III
USZO301(COURSE V)

Question bank is suggestive. The paper setters are free to modify the questions or

include new questions to the best of their perception

Unit:1 (10 Marks)

1. Define genetics and explain its scope and importance.
2. Explain Mendel's laws of inheritance
3. Describe in detail the monohybrid cross and state the Mendelian principle of inheritance derived from it. Add a note on Co-dominance
4. Describe in detail dihybrid cross and state the Mendelian principles of inheritance derived from it
5. Discuss in brief inheritance of Mendelian phenotypic traits in humans.
6. Describe incomplete dominance with a suitable example
7. Describe Co-dominance with a suitable example
8. What is epistasis? Give a detailed account of double dominant epistasis
9. What is epistasis? Give a detailed account of recessive epistasis
10. What is epistasis? Give a detailed account of dominant epistasis
11. What is epistasis? Give a detailed account of double recessive epistasis
12. Explain the pattern of inheritance of recessive and dominant lethal alleles
13. Explain the inheritance of multiple alleles with the help of a suitable example
14. Describe polygenic inheritance with reference to skin colour and eye colour in man
15. Compare pleiotropy and polygenic inheritance
16. Explain the phenomenon of linkage with respect to Morgan's Experiment. Add a note on the differences between complete and incomplete linkage
17. Describe the pattern of inheritance of blood group and Rh factor in man
18. Explain the cytological basis and molecular mechanisms of crossing over
19. Explain pedigree analysis of X-linked recessive traits

Unit:1 (5 Marks)

1. Describe the classical concept of gene
2. Explain the modern concept of gene
3. Differentiate between (Any two):
   (a) Genotype and phenotype of an organism
   (b) Dominant and recessive traits
   (c) Gene and genome
   (d) Homozygous and heterozygous
   (e) Monohybrid and Dihybrid cross
   (f) Incomplete Dominance and Co-dominance
   (g) Multiple alleles and Polygenes
   (h) Test cross and Backcross
4. Explain how probability is used to predict the results of genetic crosses
5. Write a note on the chromosome theory of inheritance
6. Describe co-dominance with a suitable example
7. Give an account of the symbols used in human Pedigree analysis
8. Characteristics of autosomal dominant traits
9. Characteristics of X-linked recessive traits
10. Characteristics of autosomal recessive traits
11. Characteristics of X-linked dominant traits
12. Intermediate lethal alleles

13. Phenylketonuria
14. Albinism
15. Explain the inheritance of skin colour in humans
16. Write a note on pleiotropy.

Unit: 2 (10 Marks).

1. Explain the structure of eukaryotic Chromosome
2. Classify chromosomes on the basis of position of centromere
3.Explain any two mechanisms of chromosomal basis of sex determination
4. Explain the inheritance of colour blindness in man
5. Explain sex determination in man/ Honey bee/ Birds/ Drosophila

Unit: 2 (05 Marks)

1. Describe the terms euchromatin and heterochromatin
2. Write a note on polytene chromosomes
3. Write a note on Lampbrush chromosomes
4. Write a note on salivary gland chromosome of Drosophila
5. Write a note on Balbiani rings
6. Explain endomitosis
7. Write a note on Gyanandromorphs
8. Explain the role of environment on sex determination
9. Explain the role of hormones in sex determination
10. Explain hypertrichosis
11. Differentiate between sex linked and sex influenced genes
12. Differentiate between human X and Y chromosome
13. Differentiate between autosomes and sex chromosomes
14. Write a note on Lyons hypothesis
15. What are Barr bodies? Give a scientific reason that Barr bodies are present only in women and not in men
16. Give a scientific reason that Y chromosome is a sex determining chromosome in man
17. Explain parthenogenesis
18. Give scientific reason that the X linked genes affect males more than females in human beings
19. What is centromere? Explain its role during cell division

Unit: 3 (10 marks)

1. Describe Griffith transformation experiment
2. Explain Avery, Macleod, McCarty's experiment
3. Give an account of Hershey Chase experiment of bacteriophage infection
4. Write a note on types of DNA
5. Explain RNA as a genetic material
6. Describe the process of DNA replication
7. Write in detail the process of transcription
8. Discuss the process of translation
9. What is gene expression? Describe the regulation of genes with Lac operon
10.

Unit 3: Write short notes on – (5 Marks)

1. Chemical composition of nucleic acid
2. A and B DNA
3. Plasmid
4. Function of mRNA
5. Function of tRNA
6. Genetic code
7. One gene one enzyme hypothesis
8. Concept of operon
9. ZDNA
10. H DNA
11. Chromosomal DNA in prokaryotes
12. Mitochondrial DNA
13. DNA in chloroplast

USZO302 (COURSE VI)

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

Unit 1: (10 Marks)

1. Explain in detail the digestive system of earthworm.
2. Explain in detail the digestive system of cockroach.
3. Describe the digestive system in bivalve.
4. Describe the digestive system of pigeon.
5. With the help of a labeled diagram describe the structure and functions of ruminant stomach.
6. Explain the physiology of digestion in cockroach.
7. Give an account of the enzymes involved in the process of digestion in cockroach.
8. With the help of a labeled diagram describe the structure of mammalian kidney.
9. Give a detailed account of process of urine formation in man.
10. With the help of a labeled diagram describe the structure of septal nephridium of earthworm.

Unit 1: (05 Marks)

1. Write a note on nutrition apparatus in amoeba.
2. Describe briefly gastro-vascular cavity in hydra.
3. Write a note on Wheel organ of Amphioxus.
4. Write a note on ruminant stomach.
5. Write short note on digestion of proteins with respect to man.
6. Write short note on digestion of carbohydrates with respect to man
7. Write short note on digestion lipids with respect to man
8. Write short note contractile vacuoles as excretory and osmoregulatory structures in protozoa.
9. Write a note on flame cells.
10. Write a note on nephridia as excretory organs in earthworm.
11. Describe briefly excretory and osmoregulatory structures in arthropods.
12. Write a note on structure of kidney in fish.
13. Write a note on structure of amphibian kidney.
14. Write a note on structure of kidney in bird.
15. Write a note on structure of mammalian kidney.
16. Write a note on Ammonotelic organisms.
17. Write a note on Ureotelic organisms.

18. Write a note on Uricotelic organisms.
19. Write a note on ultrafiltration.

Unit 2: (10 Marks)

1. Describe briefly air sacs in pigeon.
2. Describe briefly the process of internal respiration with respect to man
3. Describe briefly the process of external respiration with respect to man
4. Give a brief account of types of circulating fluids present in animals.
5. Describe briefly mechanism of working of heart.
6. Describe briefly two chambered heart in shark.
7. Describe briefly structure of heart of frog.
8. Describe briefly heart of crocodile.
9. Give a brief account of heart of man.

Unit 2: (5 Marks)

1. Write short note on cutaneous respiration.
2. Write a note on Spiracle in cockroach.
3. Write a note on book lungs in spider.
4. Explain the structure of gills of bony fish
5. Explain the structure of gills of cartilaginous fish.
6. Describe briefly lungs as respiratory organs in frog.
7. Describe briefly lungs as respiratory organs in man.
8. Explain briefly accessory respiratory structure in *Anabas*.
9. Write short note on open circulation.
10. Write short note on closed circulation.
11. Write a note on heart of cockroach
12. Write a note on heart of earthworm.

Unit 3:(10 Marks)

1. Describe different types of neurons on the basis of structure and function.
2. Explain conduction of nerve impulse.
3. Briefly describe synaptic transmission.
4. Describe briefly hormones as chemical messenger.
5. Explain briefly feedback mechanism of hormone regulation.
6. Explain sol-gel theory of amoeboid movement.
7. Describe ciliary movement in *Paramecium*.
8. Give an account on types of wings in insects.
9. Explain types of fins in Pisces.
10. Describe sliding filament theory.
11. Describe briefly asexual reproduction in animals.
12. Describe the structure and function of tube feet.
13. Describe spermatogenesis.
14. Describe oogenesis.
15. Describe briefly the structure of mammalian gametes.
16. Give an account on types of fertilization.

Unit 3: (5 Marks)

1. Write a note on irritability in *Paramecium*.
2. Write a note on resting potential of nerve membrane.
3. Write a note on action potential of nerve membrane.
4. Describe different types of neurons on the basis of structure.
5. Describe briefly different types of neurons on the basis of functions.
6. Describe the structure of synapse.
7. Write a note on striated muscle fibre.
8. Describe the structure of cilia.

9. Give an account on types of legs in insects.
10. Write a note on ovo-vivipariry.
11. Write a note on viviparity.
12. Write a note on oviparity.
13. Describe the structure of mammalian egg.
14. Describe the structure of mammalian sperm.
15. Describe the formation of gemmule in sponges.
16. Write a note on budding as asexual reproduction in mammals

USZOE1303 (COURSE VIIA)

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

Unit 1: (5 Marks)

1. How do honey bees communicate for foraging?
2. What is classical conditioning? Explain with an example.
3. What is imprinting? Explain different types of imprinting.
4. What do you mean by learning? Describe any two types of learning.
5. Describe the various ways in which ants communicate.
6. What is the significance of mimicry and warning coloration?
7. What is mimicry? Explain different types of mimicry with examples.
8. What is displacement activity? In what situations do displacement activities occur? Explain with examples.
9. Write notes on:
   i. Migration in Fish
   ii. Territorial behavior
   iii. Schooling behavior in fish
   iv. Altruism and kinship
10. Which are the different types of social groups seen in non human primates?
11. Comment on any two aspects of non human primate social behavior.

Unit 2: (10 Marks)

1. Give an account of the life history and pathogencity of the parasite causing amoebic dysentery.
2. Describe in detail part of life cycle of *P.vivax* in mosquito.
3. Give an account of asexual cycle of *P.vivax* in man.
4. Describe the life history of *Taeniasolium.*
5. Give an account of parasitic adaptive features of *Taeniasolium.*
6. Give an account of the life history of *Fasciola hepatica.*
7. Give an account of the life history of filarial worm and discuss its pathogenic effects.
8. Describe the life history of bedbug and suggest some control measures.
9. Give an account of the life history of *Sarcoptesscabiei.*
10. Give an account of the life history of head louse *Pediculus.*
11. What is bird flu? How is it spread and what are its symptoms?
12. How would you control the transmission of anthrax among humans?
13. How is anthrax transmitted to man?

Unit 2: (5 Marks)

1. Describe the structure of *E. histolytica.*
2. Where is *E. histolytica* found and what disease does it cause?
3. Write a short note on pathogenecity of *E. histolytica*.
4. Briefly describe the life cycle of *E. histolytica.*
5. What are the symptoms of malaria? Write its control measures.

6. Give an account of symptoms and pathogenecity of *Plasmodium vivax.*
7. Illustrate the complete life history of *T. solium* with the help of diagram only.
8. What is the effect of *Fasciola* on the hosts?
9. What are the primary and secondary hosts of *Wuchereriabancrofti*? Which stage of *Wuchereria* is infective for man?
10. What is host specificity?
11. What are the signs and symptoms of bird flu?
12. How is rabies transmitted?
13. What are the preventive measures to be taken to prevent infection of rabies virus?
14. What is toxoplasmosis and what are its causes?
15. Write notes on:
    i. Parasitic adaptations in endoparasites
    ii. Cysticercus or bladder worm.
    iii. Pathogenecity of *Wuchereria*
    iv. Control measures of bedbug.
    v. Types of hosts

Unit 3: (10 Marks)

1. What does the modern method of apiculture include? Explain in brief.
2. How is an artificial bee hive constructed?
3. How do you select the flora and bee species for apiculture?
4. What are the benefits of vermiculture?
5. Describe any two methods of vermiculture.
6. How is raw milk processed?
7. What are the common adulterants of milk in India

Unit 3: (5 Marks)

1. State the economic importance of honey and beeswax.
2. What are the disadvantages of the indigenous method of apiculture?
3. How does the wax moth cause damage to the honey comb?
4. Name any two bee enemies and explain how they harm the bees.
5. Give an account of the commonly found species of honey bee in India.
6. What are the advantages of the modern method of apiculture?
7. Which type of flora is beneficial for apiculture?
8. Which type of bee is suitable for apiculture?
9. What is the chemical composition of honey?
10. What is the suitable material for culturing earthworms?
11. What are the advantages of processing dairy products?
12. What is skimmed milk and toned milk? How are they prepared?
13. How is recombined milk prepared?

USZOE2303 (COURSE VIIB)

Unit 1 10 mark each

1. Give a brief account on exotic species used in aquarium.
2. Give a brief account on endemic species used in aquarium.
3. Give sexual dimorphism in fresh water fishes along with examples.
4. Give sexual dimorphism in marine water fishes along with examples.
5. Give a brief account on food and feeding used in aquarium.
6. Give a brief account on fish transportation in aquarium.

Unit 2 (10 mark each)

1. Explain agricultural pests along with suitable example.
2. Explain household pests along with suitable example.
3. Explain stored grains pests along with suitable example.
4. Explain structural pests along with suitable example.
5. Explain veterinary pests along with suitable example.
6. Explain forestry pests along with suitable example.

Unit 3. (10 mark questions):

1. Give a brief account on Blue mormon butterfly and Striped Tiger butterfly
2. Describe the behavior of Octopus and spider as most dedicated mothers in the world.
3. Describe marvelous characters of fan throated lizard and flying frog.
4. Describe marvelous characters of Mantis shrimp.
5. Give a brief account on Malabar giant squirrel
6. Describe marvelous characters of the Purple (Joker) crab and lesser flamingo.
7. Describe marvelous characters of the Stabbing Shark and Crime Fighting gecko.
8. Describe marvelous characters of the Gharial and the Matilda Viper
9. Describe marvelous characters of the MichealJackjon Monkey and micro chameleon.

Unit 1: 5 Mark questions:

Write short note on :-

1. Budget for setting up an aquarium
2. Fish packing
3. Formulated fish feed
4. Gold fish
5. Molly
6. Guppy.

Unit 2: (5 Mark questions):

Write short note on :-

1. Jowar stem borer
2. Brinjal fruit borer
3. Aphids
4. Mango stem borer
5. Pulse beetle
6. Rice weevil.
7. Non insect pests
8. Cultural control
9. Physical control
10. Mechanical control
11. Chemical control
12. Biological control,
13. concept of IPM.

Unit 3: (5 Mark questions):

Write short note on the amazing characters in following amazing animals.

1. Blue mormon butterfly
2. Striped Tiger butterfly
3. Mudskipper,
4. Komodo dragon,
5. Pebble toad,
6. Lesser flamingo,
7. Great white pelican,
8. Drongo
9. Malabar giant squirel
10. Cheetah,
11. Octopus

Unit 3: (5 Marks)

1. **Write notes on:**
   i. Defensive behavior in Octopus
   ii. Territorial behavior in tiger

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

Time: 2 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
USZOP3 (Course VI)
Skeleton-Practical Examination Question Paper Pattern

Time: 2 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

USZOE1P3 (Course VIIA)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Major Question 12 marks

Q1. Extraction of Casein from Milk and its qualitative estimation

OR

Q1. Preparation of paneer from the given milk sample.

OR

Q1. Measurement of density of milk using different samples by lactometer

Minor Question 08 marks

Q2. Life Cycle of Honey Bee and Bee Hive

OR

Q2. Mouthparts of Honey Bee

OR

Q2. Legs of Honey Bee

OR

Q2. Sting Apparatus of Honey Bee

Q3. Identifiy and describe as per instructions15 marks

a. Ethology
b. Protozoan parasites
c. Helminth parasites
d. Ectoparasites
e. Parasitic adaptations

Q4. Project submission and Viva based on project 10 marks

Q5. Journal 05 marks

PRACTICAL

USZOE2P3 (Course VIIB)

Skeleton-Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Major Question 15 marks

Q1. Identification (5 Mark each)

a) Aquarium equipment.
b) Type of pest (Any insect)
c) Non insect pest

Q.2 Identification (3 Mark each) 15 marks

a) Type of pest control
b) Type of pest control
c) Amazing animal
d) Incredible animal
e) Endangered animal

Q.3 Submission of photographs of any 5 amazing animals. 05 marks

Q4. Project submission and Viva based on project 10 marks

Q5. Journal 05 marks

Semester IV
Reference and additional reading

COURSE-VIII (USZO401)

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. Research Methodology, Methods and Techniques- by C.R. Kothari, Wiley Eastern Ltd. Mumbai
8. Practical research planning and design 2nd edition- Paul D Leedy, MacmilanPublication

9. **COURSE-IX (USZO402)**

10. 1. Cell Biology. Singh and Tomar, Rastogi Publication.
11. 2. Cell and Molecular Biology E.D.P De Robertis and E.M.R Robertis ,CBS Publishers and Distributors.
12. 3. The cell A molecular Approach Goeffrey M.Coper ASM Press Washington D.C.
13. 4. A textbook of cytology Suruchi Tyagi Dominant Publishers and Distributors New Delhi.
14. 5. Cell and molecular biology Gupta P.K , Rastogi Publication, India.
15. 6. Cell Biology Pawar C.B. Himalaya publication
16. 7. Molecular Biology of the cell (6th ed) by the Insertus
17. 8. Campbell Biology (9th Ed.)
18. 9. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M ,
19. 10. Biochemistry, Dushyant Kumar Shrma, 2010, Narosa Publishing house PVT.Ltd.
20. 11. Fundamentals of Biochemistry, Dr AC Deb, 1983, New Central Book Agency Ltd.

21. 12. A Textbook of Biochemistry, 9th edition, Dr. Rama Rao A.V.S.S and Dr A Suryalakshmi.
22. 13. Biochemistry-G Zubay , Addison Wesley, 1983
23. 14. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989 , Freeman and Co. NY
24. 15. Harper's Biochemistry,1996, 26th edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA
25. 16. Outline of Biochemistry, 1976, E.E. Conn and P.K. Stumpf. John Wiley and Sons USA

COURSE-X(USZOE1403A)

1. Developmental Biology- 5th Edition, Scot F.Gilbert, Sinauer Associates Inc.
2. Developmental Biology- SubramoniamT.,Narosa Publishers.
3. Developmental Biology-BerrilN.J., Tata Mc Graw –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.
12. Air Pollution,KudesiaV.P. Pragati Prakasan,Meerut
13. Fundamentals of Air PollutionDaniel A.Vallero,Academic press 5th Edition
14.Principles and Practices of Air Pollution Control and Analysis J.R. MudakaniI K International Pub. House Pvt. Ltd.
15.Text Book of Air Pollution and its Control,S.C.Bhatia Atlantic
16.Water Pollution,KudesiaV.P.,Pragati Prakasan,Meerut
17. A text book of Environmental Chemistry and Pollution Control,S.S.Dogra,Swastic Pub,New Delhi
18.Practical Methods for water and Air Pollution Monitoring,S.K.Bhargava,New Age International
19. Hand Book of Water and waste water Analysis,Kanwaljit Kaur,Atlantic
20. Aquatic Pollution by Edward A.Laws
21. Environmental Science and Technology,StanelyE.Manahan
22. Environmental Chemistry,A.K.De, New Age International
23. A Text Book of Environmental Studies,GurdeepR.Chatwal,Harish Sharma,Madhu Arora,Himalaya

COURSE-X (USZOE2403B)

References of Elective 2

1.Principles of Dairy Chemistry R. Jenness, S. Patton John Wiley and Sons Inc.
2.Fundamentals of dairy chemistry B.H. Webb, A.H. Johnson, J.A. Alford Avi Pub. Co.
3. Food Chemistry Owen R. Fennema CRC Press
4. Food Chemistry John M. De Man Springer
5.Technology of Dairy Products Early, Ralph. Academic & Professional, 1998

6.Quality of milk production and processing technology D.K. Thompkinson and latha sabikhi New India Publishing agency, New delhi
7. Outlines of Dairy Technology Sukumar De Oxford UniversityPress, New delhi
8. Food Microbiology William C. Frazier, dennis C. Westoff Tata Mcgrew Hill publishing Company Ltd. New Delhi
9. Applied Dairy Microbiology Elmer H. Marth, James L. Steele CRC Press
12.Dairy plant engineering and management Tufail Ahmed Kitab Mahal
13. Heat and mass transfer R.K Rajput S.Chand
14. Fluid mechanics A.K Upadhyay S.K Kataria
15.LatestAquaculture, Principles and Practices by Pillay T.V.R. – Fishing New Books (1988).
16.Course Manual in Fishing Technology by LathaShenoy, CIFE, Versova, Mumbai.
17.Prawn and Prawn Fisheries by Kurian and Sebestian

Freshwater aquaculture	R.k. rathy	Scientific publication	
2	A text book of fish biology and fisheries	Khanna & singh	Narendra Publication
3	Handbook of fisheries and aquaculture	Yadav	ICAR
4	Fish processing technology	Gopakumar	ICAR
5	Ornamental fish farming	Saroj. K, swain	ICAR
6	Sport fisheries of india	K.l. sehgal	ICAR
7	Coldwater fisheries of india	V.g. jhingran	ICAR
8	Fish nutrition in aquaculture	Sena s. Desilva	ICAR
9	Practical course manual fishery and gear technology	Latha shenoy, y	CIFE, Mumbai
10	Breeding and seed production of finfish and shellfish	Thomas,rath	Daya pub.
11	Fundamental of fish taxonomy	Jayaram, KC	Narendra
12	Limnology	Welch	Narendra
13	Model question bank on ICAR J.R.F	Ratanankumar, K	Narendra
14	Manual of freshwater biota	Jayshree Datta Munshi	Narendra
15	Ornamental fish culture and aquarium management	Dholakia	Astral
16	Postharvest technology of fish and fish products	Balachandran	Astral
17	Handbook of freshwater fishes of India	Beaven R	Techno
18	Conservation and management of aquatic ecosystems	Unni, K Sankaran	Daya
19	Modern fishing gear technology	Hameed, M Shahul	Daya
20	Introduction to fish physiology	Smith, L.S	Narendra
21	Textbook of fish biology and fisheries	Khanna/Singh	Narendra
22	Textbook of fish diseases	Amalacher, E	Narendra

1. INDIAN SILK - MONTHLY JOURNAL
2. SERI BUSINESS MANUAL – A USER'S GUIDE (Eng)
3. Handbook of Sericulture Technologies 4th Edition (Tamil)
4. Handbook of Sericulture Technologies 5th Edition (English)
5. Handbook of Sericulture Technologies 4th Edition (Kannada)
6. Vanya Silk Directory (English)
7. COMPENDIUM OF STATISTICS OF SILK INDUSTRY – 1999 in English
8. SERICULTURE & SILK INDUSTRY STATISTICS – 2003 (with CDR version)
9. SERICULTURE & SILK INDUSTRY STATISTICS – 2007 (with CD version)
10. SERICULTURE & SILK INDUSTRY STATISTICS – 2012 (with CD version)
11. VANYA – WILD SILKS OF INDIA in English
    * VOL.I - AN INTRODUCTION TO VANYA SILKS
    * VOL.II - PROFILES OF FARM ACTIVITIES
    * VOL.III - MANAGEMENT MATRIX
    * VOL.IV- PROFILES OF NON-FARM ACTIVITIES
12. CAC TEXT BOOKS IN English
    * Silkworm Rearing Technology
    * Mulberry Cultivation & Physiology
    * Mulberry Crop Protection
    * Sericulture Extn. Management & Economics
    * Silkworm Crop Protection
    * Silkworm Breeding & Genetics
13. HANDBOOK OF PRACTICAL SERICULTURE (ENGLISH & HINDI)
14. HANDBOOK OF MUGA CULTURE IN ENGLISH
15. ERICULTURE IN INDIA IN ENGLISH
16. TIPS TO SUCCESSFUL SILKWORM COCOON CROPS :
17. GUIDELINES FOR BIVOLTINE REARING:
18. CSR & TI (MYSORE) BULLETINS ON IMPROVED PRACTICES OF SERICULTURE in Hindi & Telugu
19. Reports of Indian Delegations: Sericulture in Japan & South Korea Vol. I & II in English
20. Proceedings of the International Congress on Tropical Sericulture - 1988 in English
21. Satellite Remote Sensing Applications for Sericulture Development in English
22. Biodiversity of Muga Silkworm & its Utilization
23. F.A.O. MANUAL ON SERICULTURE

For Additional and Latest Information on the topics, various Web Sites can be visited.

MODEL QUESTION BANK SEMESTER IV

USZO401(COURSE VIII)

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

Unit 1: (10 Marks)

1. Write explanatory notes on:1. Lamarckism. 2. Darwinism and Neo Darwinism.3. Mutation Theory 4. Modern Synthetic theory.5. Weismann's germplasm theory
2. Neutral theory of molecular evolution. (Some of them can be asked as short notes as well)
3. Discuss evidences in favour of organic evolution by giving examples of geographical distribution
4. Discuss evidences in favour of organic evolution by giving examples of genetics, and molecular biology
5. Discuss evidences in favour of organic evolution by giving examples of physiology and biochemistry
6. Discuss brief account of Origin of eukaryotic cell

Unit 1: (5 Marks)

1. Describe chemical evolution with Miller-Urey experiment
2. Describe chemical evolution with Haldane and Oparin theory
3. Write short notes on: 1. Mutation Theory 2. Modern Synthetic theory

Unit 2: (10 Marks)

1. Define the term 'population genetics'. Describe in brief the various evolutionary forces that tend to disturb genetic equilibrium and introduce changes in the gene pool of a population
2. State Hardy Weinberg's law of equilibrium and discuss its salient features
3. Give an account of the different factors involved in speciation
4. Describe the different types of speciation
5. Explain the role of geographic isolation in the development of new species
6. Explain the role of reproductive isolation in the development of new species
7. Discuss the pre-zygotic barriers responsible for reproductive isolation
8. Discuss the post-zygotic barriers which lead to reproductive isolation
9. Describe the sources of genetic variation in natural populations
10. Explain the nature and extent of genetic variation within populations
11. Describe the mechanisms that preserve balanced polymorphisms
12. Describe the salient features of microevolution

13. Compare and contrast microevolution and macroevolution
14. Explain the salient features of macroevolution
15. Give an account of the different patterns of macroevolution
16. Elaborate on the role of adaptive radiation and extinction in macroevolution
17. What do you understand by the term natural selection? Describe the different types of natural selection with suitable examples
18. What is megaevolution? Explain the mechanism of megaevolution using a suitable example

Unit 2:(5 Marks)

1. Explain the term ‘gene pool’. How does evolution operate via the gene pools of populations?
2. Differentiate between:
    a. Allopatric and Sympatric speciation
    b. Biological and evolutionary species
    c. Microevolution and macroevolution
    d. Stabilizing selection and disruptive selection
    e. Convergent and divergent evolution
3. Explain stabilizing selection with the help of a suitable example
4. How does the example of sickle cell allele illustrate heterozygote advantage?
5. How does frequency-dependent selection affect genetic variation within a population over time?
6. Write short notes on:
    a. Role of mutations in evolution
    b. Role of migration in evolution
    c. Non-random mating
    d. Role of natural selection in evolution
    e. Genetic drift
    f. Bottleneck effect
    g. Founder effect
    h. Directional evolution in peppered moth
    i. Evolution of Antibiotic resistance in bacteria
    j. Geographic variation
    k. Genetic polymorphism
    l. Parapatric speciation
    m. Adaptive radiation
7. What is the biological species concept? What are its limitations? How does it differ from the evolutionary species concept?
8. Explain the concept of co evolution using suitable examples

Unit 3: (10 Marks)

1. Describe briefly, the steps towards preparing a research design
2. Describe literature survey, collection of data and its analysis
3. What is a patent and how is it obtained?
4. Write an account on application of statistics in research

Unit 3: (5 Marks)

1. Define research. State the difference between research method and research methodology
2. Write a note on computer application in research
3. Describe briefly identification of research problem and formulation of research hypothesis
4. What is abstract writing?
5. What is plagiarism?
6. What is bibliography?
7. Write a short note on ethics in animal research
8. Write a short note on ethics in clinical research

USZO402 (COURSE IX)
Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

Unit 1: (10 marks)
1. Explain prokaryotic cell.
2. Explain Eukaryotic cell.
3. Give an account of cell theory.
4. Describe the ultrastructure of nuclear membrane.
5. State the chemical composition and functions of nucleolus.
6. Describe nucleocytoplasmic reactions.
7. Explain rRNA processing.
8. Describe fluid mosaic model of plasma membrane.
9. Give an account of active and passive transport
10. Describe various modifications of plasma membrane
11. Explain pinacocytosis, phagocytosis and secretion
12. Give an account of cell permeability
13. Differentiate prokaryotic and eukaryotic cell

Unit 1: (5 Marks)
1. Virus
2. Nuclear matrix
3. Number ad position of nucleus
4. Molecular organization of chromatin

5. Unit membrane concept
6. Nucleolus
7. Membrane receptors
8. Sandwich model
9. Cell coat
10. Cell recognition

Unit 2: (10 Marks)
1. Write a note on structural organization & importance of endomembrane system.
2. Describe ultrastructure of Endoplasmic Reticulum
3. Describe the types and functions of ER.
4. Give an account of ultrastructure and functions of Golgi complex.
5. Write an essay on functions of Golgi complex.
6. Give an account of polymorphism in lysosomes.
7. Write an essay on peroxisomes.
8. Describe the structure and chemical composition of mitochondria.
9. Write a note on mitochondria as powerhouse of the cell.
10. Describe the major functions of mitochondria.

Unit 2: (5 Marks)
1. Importance of endomembrane system
2. Write a short note on biogenesis of endomembrane system
3. Functions of Rough Endoplasmic Reticulum
4. Functions of Smooth Endoplasmic Reticulum
5. Structure of Golgi complex
6. Chemical composition of Golgi complex
7. Lipid & polysaccharide metabolism in Golgi complex
8. Secretion and protein sorting by Golgi complex
9. Write a brief note on GAAP
10. Write a brief note on protein glycosylation by Golgi complex
11. Origin and functions of lysosomes
12. Write a short note on peroxisomes
13. Structure of mitochondria
14. Chemical composition of mitochondria
15. Write a short note on ATP
16. Write a short note oglycolysis
17. Write a short note on Kreb's cycle
18. Write a short note on oxidative phosphorylation

Unit 3: (10 Marks)
1. Discuss the chemical behavior of carbon and a note on variety of functional groups of biomolecules.
2. Explain the concept of micromolecules and macromolecules.
3. Describe the structure of water. Add a note on physic-chemical properties of water.
4. Define carbohydrate. Add a note on its classification.
5. What are carbohydrates? Explain the classification of carbohydrate with suitable examples.
6. Explain with suitable example monosaccharide and disaccharide.
7. Discuss the properties of carbohydrates.
8. What are disaccharides? Draw the structures of maltose and sucrose.

9. What are polysaccharides? How are they classified? Write the structures of glycogen and heparin/ chitin and heparin.
10. Discuss about chemical structure of the monosaccharides/ disaccharides.
11. What are amino acids? Discuss classification of amino acids based on R group.
12. Give an account of primary and secondary structure of proteins.
13. Write an account on tertiary and quarternary structure of proteins.
14. Describe the structure of saturated and unsaturated fatty acids.
15. Define essential fatty acids. Add a note on it.
16. Define lipids. Write a note on mono, di and triglycerides/ phospholipids.
17. What are fatty acids? Add a note on types of fatty acids.
18. Describe the structure and functions of water soluble vitamins.
19. Describe the structure and functions of lipid soluble vitamins.

Unit 3: (5 Marks)
1. Write a short note on monomers and polymers.
2. Write note on properties of carbohydrates.
3. Give an account of polysaccharides.
4. With suitable example explain glycosidic bond.
5. Explain the linkage in lactose and sucrose.
6. Give the biological importance of carbohydrates.
7. What are essential and nonessential amino acids?
8. Give an account of properties of amino acids.
9. Define and explain peptide bond with suitable example.
10Explain the different types of proteins with suitable examples.
11. Explain the biological role of proteins.
12. Peptide bond
13. Types of fatty acids.
14. Biological role of lipids
15. Properties of fatty acid
16. Sterol and waxes
17. Describe properties of fatty acid/lipids.
18. Discuss the clinical significance of protein / carbohydrate /lipids.
19. Write short note on clinical significance of lipids.
20. Write a note on isomerism in carbohydrates and amino acids?
21. Describe the structure and functions of vitamin A/ vitamin B/ vitamin C/ vitamin D.

USZOE1403(COURSE XA)

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

Unit-1: (10 Marks)

1) Classify the different types of eggs..
2) Briefly explain types and structure of sperms (any two animals).
3) Define cleavage Explain types of cleavages.
4) Give brief account on various types of blastulae.
5) What is gastrulation ? Explain gastrulation in frog.
6) Give an account of process of coelom formation and its types.

7) Give an account of extra embryonic membranes.
8) Describe briefly the types of eggs on the basis of amount and distribution of yolk.
9) Describe the early development of mammalian egg uptogastrulation.
10) Give a brief note on different types of sperms.
11) Write a note on blastula and explain its types.
12) Explain the comparative process of embryo formation**.**

Unit-1: (5-Marks)

1) Draw neat labeled diagram and explain any one of the following:
   (Microlecithal, ,Alecithal, Homolecithal, Heterolecithal, Isolecithal, Telolecithal, Centrolecithal, Discoidal).
2) Explain structure of sperms of frog/ reptiles/ birds/ mammals.
3) Short note on Holoblastic cleavage. Or Meroblastic cleavage.
4) Short note on equal or unequal cleavage.
5) Short note on Discoblastula or Coeloblastula.
6) Short note on centroblastula or amphiblastula or stereoblaastula,
7) Explain the process of coelom formation in process of gastrulation.
8) Short notes on : Amnion /Chorion/Allantois/Yolk sac.
9) Explain the function of Amnion /Chorion/Allantois/Yolk sac/.
10) Short note on Deciduous or non-deciduous placenta
11) Write the functions of placenta.

Unit 2: (10 Marks)

1. Describe male reproductive system and its hormonal regulation.
2. Describe female reproductive system and its hormonal regulation.
3. Define reproduction. Explain the hormonal regulation of reproduction.
4. What is contraception? Explain different methods of contraception.
5. How is contraception different from birth control?
6. Define infertility and explain the causes of female infertility.
7. What are the causes of male infertility?
8. Explain the hormonal treatment for infertility using drugs.
9. Describe the methods of treatment of infertility.
10. Give a brief account of infertility related disorders.
11. What are sperm banks? Add a note on cryopreservation of sperms.
12. What is testicular biopsy? Explain Testicular sperm extraction (TESE), Pronuclear stage transfer (PROST).
13. What are the steps involved in Embryo transfer (ET) and / Intra-fallopian transfer (IFT)?
14. What is ART technique? Add a note on IVF (steps, success and ethical considerations).

Unit 2: (5 Marks)

1. Write a note on impact of age on reproductive stage –
    a. Menopause
    b. Andropause
2. What is amenorrhea?
3. What are IUD's? How do they work as barriers for fertilization?
4. How does sterilization act as a method of contraception?
5. Write a note on birth control.
6. What is the difference between natural and artificial methods of contraception?
7. How is T.B. a cause of female infertility?
8. What are the genetic causes of infertility?
9. Write a note on STD's as infertility related disorders?
10. Explain briefly:
    a. Impotency
    b. Surrogacy
    c. Endometriosis
    d. Idiopathic infertility
11. What are the roles of endocrine disruptions in infertility?
12. Explain the role of the following in infertility:
    a. Gonorrhea
    b. Syphilis
    c. Genital Herpes
    d. Chlamydia
13. Write a note on treatment of infertility by removal of causative environmental factors.
14. Write a note on Ethical considerations of ART.

Unit 3: (10 Marks)

1. What are the causes, effects and control measures for air pollution?
2. What are the causes, effects and control measures for water pollution?
3. What are the causes, effects and control measures for soil pollution?
4. What are the causes, effects and control measures for noise pollution?
5. Define air pollution and give an account of hazardous air pollutants.
6. Explain the causes of nutrient pollution and its control measures.
7. What is ocean littering? Explain in details the causes and control measures for ocean littering?
8. Describe the alteration of metabolism of micro-organisms due to soil pollution.
9. Explain noise pollution along with its measurement and permissible limits.
10. Give a brief account of methods to control gaseous / particulate matters.
11. What is pollution? Add notes on:
    a. Effect of air pollution on vegetation.
    b. Effect of noise pollution on animals.

12. How can the people be made aware of pollution and its effects?

Unit 3: (5 Marks)

1. Explain the effects of air pollution on human beings.
2. What are different types of pollutants that cause air pollution?
3. Write short notes on:
    a. Ozone depletion
    b. Green house gases
    c. Global warming
    d. Acid rain
    e. Sonic boom
    f. Acoustic zoning
4. Explain the effect of thermal pollution on biodiversity.
5. Write a note on solar radiation.
6. Write a note on ionizing radiation
7. How are heavy metals responsible for nutrient pollution? Cite some examples of effects of heavy metal pollution on human health.
8. How is oil spills a cause of water pollution / ocean littering?
9. How do pesticides and fertilizers contaminate water?
10. How can oil be retracted back from sea / ocean?
11. What are the effects of soil pollution on food chain?
12. How are POP's and ordinary salts responsible for nutrient pollution?
13. What are the auditory / non – auditory effects of noise pollution.
14. Why is the necessity to save drinking water?

USZOE2403(COURSE XB)

Unit 1(10 Marks each)

1. Give in brief different indigenous breeds of cattle with a suitable example.
2. Give in brief different exotic breeds of cattle with a suitable example.
3. Give in brief different breeds of buffalo with a suitable example.
4. Give in brief different housing types in dairy farm.
5. Explain different types of diseases in cattle farming and add a note on control .

Unit 1(05 Marks each)

Write short note on

1. Malvi
2. Hariyana
3. Deoni
4. Red sindhi
5. Khillari
6. Jersy

7. Holstein
8. Nagpuri
9. Bhadawari
10. Murrah
11. Jafrabadi
12. Weaning of calf
13. Castration
14. Dehorning
15. Cleaning and sanitation.

Unit 2 (10 Marks each)

1. Give in brief life history of silkworm.
2. Give in brief reeling and extraction of silk.
3. Give in brief diseases and control measures in sericulture.
4. Give in brief harvesting and processing of cocoon.

Unit 2 (05 Marks each)

1. Varieties of silkworm
2. Rearing of silkworm
3. Silk extraction
4. Host plants.

Unit 3 (10 Marks each)

1. Give an account on pisiculture ,add anote on finfish culture
2. Explain monoculture with respect to aquaculture
3. Explain polyculture with respect to polyculture
4. Give an account on fresh water prawn culture
5. Give an account on pearl culture.

Unit 3 (05 Marks each)

Write short notes on :-

1. Composition of pearl
2. White shrimp culture
3. Cage culture
4. Induced breeding with respect to aquaculture
5. Fish diseases
6. Symptoms of diseases
7. Control of diseases.

PRACTICAL

USZOP4 (Course VIII)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Major Question

Q1. Study Population density by Line transect or Quadrant method

and calculate biodiversity indices (any 2) **12 marks**

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. Power point presentation **06 marks**

Q6. Viva and Journal **10 marks**

PRACTICAL
USZOP4 (Course IX)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Major Question 15 marks

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

OR

Q1. Measurement of cell diameter by occulometer (by using permanent slide)

Minor Question 10 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. Study of rancidity of lipids by titrimetric method

Q3. Identify and describe as per instructions 15 marks

1. Ultra structure of cell organelles (a, b & c)
2. Clinical disorders (d & e)

Q4. Viva 05 marks
Q5. Journal 05 marks

PRACTICAL
USZOE1P4 (Course XA)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Major Question 12 marks

Q1. Estimation of Dissolved oxygen from the given water sample

OR

Q1. Detection of Creatinine in urine

OR

Q1. Determination of blood sugar by GOD and POD method

Minor Question 08 marks

Q2. Estimation of Salinity by refractometer from the given water sample

OR

Q2. Estimation of conductivity by conductometer from the given water sample

OR

Q2. Determination of blood pressure by using sphygmomanometer

OR

Q2. Study of bleeding time and clotting time

Q3. Identify and describe as per instructions 15 marks

1. Permanent slides (a &b)
2. Fishery (c, d & e)

Q4. Field Report and viva based on it. 10 marks

Q5. Journal 05 marks

PRACTICAL
USZOE2P4 (Course XB)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Major Question 12 marks

Major Question 15 marks

Q1.Comparison of protein content from cow's milk and buffalo's milk.

OR

Q.1 Comparison of fat content from cow's milk and buffalo's milk

Minor Question 08 marks

Q.2 Preparation of falooda.

OR

Q.2 Preparation of caramel custard.

Q.3 Identification (3 marks each) 12 marks

a) Restraining device
b) Restraining device
c) Any stage of life cycle of *Bombyx morri*
d) Crustacean fishery

Q4. Report submission and Viva based on project 10 marks

Q5. Journal 05 marks

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UNIVERSITY OF MUMBAI
No. UG/17 of 2018-19

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/153 of 2017-18, dated 3rd August, 2017 relating to syllabus of the Bachelor of Science (B.Sc.) degree course.

They are hereby informed that the recommendations made by the Board of Studies in Zoology at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.32 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.Y.B.Sc. in Zoology (Sem -V & VI), has been brought into force with effect from the academic year 2018-19, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
14th June, 2018

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.32/05/05/2018

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No. UG/17 -A of 2018 MUMBAI-400 032 14th June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Zoology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

UNIVERSITY OF MUMBAI

Program: B.Sc.

Course: Zoology

Syllabus for Semester V & VI

(with effect from the academic year 2018-19)

Credit Based Semester and Grading System
- with a Choice for Additional Credits

Syllabus Framing Committee Members' List 2018-2019

Vinayak Dalvie (Convenor)
Capt. Dr. A. A. Dalvi (Co-Convenor)
Dr. Mrinalini Kagwade (Co-Convenor)
Dr. Vinod Ragade (Co-Convenor)
Dr. Sharad Mahajan (Co-Convenor)
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Ms. Nausheen Shaikh
Ms. Kranti Patil

CONTENTS

PREFACE

Revision of Syllabus, an integral part of educational institutions and one of the important functions of Board of Studies of any University, is an opportunity to revisit what is being taught and what ought to be taught to learners in the landscape of changing times.

A great initiative in the form of, prior to and during the process of curriculum design, involving various stakeholders has been a hallmark of the syllabus committee for Zoology in general and the committee for T. Y. B. Sc. Zoology, SEM V and SEM VI in particular. It is after a lot of hard work in a true team spirit that this syllabus has been prepared and presented for coming into force from the Academic Year 2018-2019.

Human beings are an intricate and unique entity of the 'Kingdom Animalia.' It is no wonder that students of yore and the present day are drawn to the subject of Zoology in all aspects of life and living, like iron to magnet. This poses a challenge while designing a curriculum since the young minds attracted to the subject, thought passionate about the subject may possess differential abilities to grasp the subject and may do so at their own pace.

The curriculum has thus to be designed not only to engage interest, to stimulate and inspire the learner but also to kindle the spirit of inquiry. The syllabus presented herewith for implementation with effect from the academic year 2018-19, in the subject of Zoology also is an instrument to inculcate in the learner the culture of critical thinking.

The scope of the curriculum therefore has to be wider incorporating elements of traditional as well as contemporary and even futuristic dimensions of the particular area of study. This aspect of curriculum design has been exemplarily met with by this syllabus in Zoology for SEM V and SEM VI at T. Y. B. Sc.

Another important consideration for the syllabus committee is to incorporate in the architectural design of the curriculum, the scope for teachers to use classical as well as contemporary technological tools of pedagogy with an aim to connect and cater to all types of learners including slow learners as well as the advanced ones. This syllabus with clearly stated objectives and outcomes, unit-wise, is one of the best examples of being an instrument of mixed pedagogy available to the teachers.

In spite of constraints in the form of having to teach curricula without including any dissection in the course of study, the syllabus committee has designed the syllabus keeping the classical flavour of the subject intact.

A unique feature of this syllabus is its unique blend of standardization and customization creating a vibrant ecosystem of teaching-learning for the teacher to function as a facilitator and mentor and for the student to take a few steps towards being a motivated student and an autonomous learner.

I place on record, appreciation for all members of the syllabus committee as well as the dynamic and visionary leader in the form of convenor of the syllabus committee, and congratulate them all, on behalf of faculty members and students of Zoology, for having designed this progressive syllabus for T. Y. B. Sc. (SEM V and SEM VI) in Zoology, to be implemented from the academic year 2018-19.

Dr. (Mrs.) V. I. Katchi
Convenor,
Interim BOS in Zoology.

PREAMBLE

Zoology has emerged as a progressive subject in the last decade with innovations in curricular designing and unique initiatives which attracted students, both from urban as well as rural colleges, in large numbers towards this subject. Experiments such as Need Based Flexi Syllabus, Open Unit to include latest topics any time before revision of syllabus, Pyramid Committee for continuity from Semester I to Semester VI, Workshop with Indian Merchants' Chamber for industry - academia interface, Workshop with the meritorious past students and current students for their inputs, uploading Draft Syllabus on the University website for Public Criticism, one month prior to BoS, etc., fetched rich dividends. The fundamental challenge however, was to design curricula without dissections, the backbone of the subject. We Zoologists though are firmly against cruelty to animals and practice conservation, had to take it with a pinch of salt that the dead table fish from the market and pests were also banned for dissection.

In keeping with the traditions this time the learners' space has been incorporated in the syllabus for the advanced learners and Research Based Pedagogical Tools (RBPT) are recommended for a unit after three days workshop organised by IISER and British Council Library, attended by good number of Zoology teachers from the rural area. Application of RBPT is optional. RBPT will be explained again in the post amendment workshop.

After conducting workshops for teachers and students, both in urban and rural areas, it was felt that the research project may be incorporated for additional credits only for the students who wish to pursue higher specialised studies and who may opt for a career in research oriented fields. Apart from a project in the Applied Component such students may present a research project under the guidance of a teacher from their college or any other college or from the industry or may do so on their own which shall be evaluated by the examiners at the time of the practical examinations and that the performance shall be considered separately as additional optional credits, based on the free choice of student and if permitted by the authorities then the same could be transferred to the other / higher programs if desired. It's a modest attempt of bringing choice based credit system with an option of transfer in the main stream academics of the University on the lines of the pioneering effort successfully launched in the subject of NCC, when introduced as an elective in academics.

Care has also been taken to include a unit on muscles which was much neglected so far in anatomy. Possibility cannot be ruled out that it may give further impetus to Zoology students to enter the career of Gym and Fitness. This niche of students shall have upper hand over other personnel in the fitness industry in passing international exams since they already have knowledge of physiology to a desired extent.

I am happy to present this syllabus for consideration of the authorities and I sincerely thank all the members who represented teachers, students, rank holders, people from the industry and interdisciplinary background, scientists from India and abroad, and a journalist from Sawantwadi who is an activist in biodiversity conservation. The draft was on University website for 2 months which gave ample opportunity to the society in general and teachers in particular to criticise. I thank all those who contributed suggestions. Lastly, on behalf of all the Zoologists, I thank the staff of Academic Authorities Unit who has blended so well with teachers that the product is innovations experimented successfully.

- Vinayak Dalvie
Convenor,
T. Y. B. Sc. Syllabus Committee in Zoology

PEDAGOGY

The syllabus framed by taking views of all the stakeholders, both from urban and rural areas into consideration and providing scope to the advanced learners without posing challenges before the average and above average students, certainly needs dynamic pedagogy with range of variations to deliver the objectives with desired outcome.

Course codes USZO501 and USZO601 attempt to make the learners understand the principles of taxonomy, levels of organisations, modern classification up to class and the evolutionary significance of various levels of organization like symmetry, coelom, segmentation, etc. It is desirable to take students in the field, rather than the classroom, and practice experiential learning making taxonomy live and interesting. It won't be an exaggeration if one feels that even protozoans could be observed from natural sample in the field by carrying a microscope. Ideally students should draw diagram of an organism / animal as they perceive through observation rather than copying a diagram from a book into the journal. Various schools of classification make it debatable. Care has been taken to adopt the latest approach and through appropriate pedagogical tools students should be able to attribute characters of a specimen up to specific class.

Course USZO502 introduces various aspects of human blood, clinical disorders and their diagnosis. The significance of the diagnostic tools must be stressed upon as they are relevant to human health. Teachers are expected to elucidate the scope of haematology and immunology as career options in the field of pathology. IISER, Pune in collaboration with British Council is advocating Research Based Pedagogical Tools through workshops sponsored by MHRD government of India. It is suggested that Unit II - Applied Haematology, of this course can also be taught, alternatively, using RBPT. The subtopics are in context to the real life and have a scope of research-based learning through actual laboratory work under the observation of their teachers. The knowledge base of blood and its components that the learners already have can be further enhanced through various activities that learners can undertake in order to relate the theory with the practicals and understand the clinical significance of various diagnostic tests. Course USZO602 includes enzymology, homeostasis and animal tissue culture. Documentaries based on nature and wild life can be effectively used to create interest in the learners about adaptive responses of animals to environment for their survival. Industrial visits, invited talks from industry persons will help in generating awareness about industrial significance of enzymes. Theory supplemented with hands-on practical on sterilization and culture techniques will help the learner to appreciate the importance of animal tissue culture. Visits to departments of microbiology and biotechnology in the institution may be encouraged to interact with teachers & students so as to create more interest. Student led seminars are a self-learning interactive method that may be encouraged.

The topics covered under course USZO503 includes Mammalian Histology, Basic Toxicology, General Pathology and Biostatistics. Microtomy, reintroduced, could be effectively used not only as a histo-pathological tool for clinical pathology but also to emphasize its applications in research. The toxicology studies can be made interesting by emphasizing its importance in pharmaceuticals and additionally the insights into regulatory aspect can be given to understand the practical difficulties and the norms associated with toxicity testing. Study visit to the pathological laboratory planned for unit II could also cover these aspects. Application of biostatistics in interpretation and validation of experimental data should be highlighted. The learners could be introduced to statistical software which have their applications in biostatistics. Course USZO603 includes Molecular Biology, Genetic Engineering, Human Genetics and Bioinformatics. Molecular biology and genetic engineering could be taught using ICT and videos available online. It is recommended to have an

industrial interface. Teachers are expected to explain the scope of gene manipulation techniques in medical science as well as industry. Through ICT, various concepts of bioinformatics such as protein sequencing, construction of evolutionary trees etc. can be taught. Use of available software in public domain to study human diseases could be focused on. The practical utilization of bioinformatics in preparing probes using database could be stressed.

A synergistic pedagogical approach between the theory and practical course of USZO504 could help in better understanding of the various subtopics such as integumentary system, osteology and the developmental stages of chick embryo. There is a scope for using ICT related teaching tools that would help in understanding the structural and the functional aspects of epidermal and dermal derivatives, various fore limb and hind limb muscles and their arrangement etc. Syllabus of the USZO604 deals with the various environmental issues and their management. Guest lectures could be arranged of the experts from such fields who can provide additional insights to these aspects. Informative documentaries based on wildlife conservation as well as human-animal conflict could make the topics relevant and interesting. Apart from formal teaching group discussion and experience sharing could be practiced for bioprospecting and zoopharmacognosy. Case studies could be supplemented with to understand the patterns of distribution of different animal species throughout the globe.

The learners' space provided in the syllabus is an effort to shift the pedagogy from being teacher-centric to learner-centric. It will be supportive to enthusiastic learners in gaining extra knowledge through various suggested activities to make their concepts impeccable and gain additional subject knowledge. Research project (USZOR01 and USZOR02), which is optional having additional credits could be mentored by the teachers encouraging more and more students to opt with a view to inculcate research culture.

- Co-Convenors

Syllabus for T. Y. B. Sc. Course: ZOOLOGY
Credit Based Semester and Grading System - with a Choice for Additional Credits
(To be implemented from the Academic Year 2018-2019)

SEMESTER - V					
THEORY					
COURSE NO.	**COURSE CODE**	**UNIT**	**TOPICS**	**CREDITS**	**LECTURES/ WEEK**
11	USZO501	I	Principles of Taxonomy	2.5	1
		II	Kingdom: Animalia I		1
		III	Kingdom: Animalia II		1
		IV	Type study: *Sepia*		1
12	USZO502	I	Basic Haematology	2.5	1
		II	Applied Haematology		1
		III	Basic Immunology		1
		IV	Applied Immunology		1
13	USZO503	I	Mammalian Histology	2.5	1
		II	Toxicology		1
		III	General Pathology		1
		IV	Biostatistics		1
14	USZO504	I	Integumentary system and derivatives	2.5	1
		II	Human Osteology		1
		III	Muscles of long bones of Human limbs		1
		IV	Developmental biology of Chick		1
				10	**16**
PRACTICAL					
USZOP05	Practicals based on all four courses			**06**	**16**
Total Number of Credits and Workload				**16**	**32**
Research Project					
USZOR01	Additional Credits (Choice Based / Optional)			**1**	**No Workload for Teachers**

Syllabus for T. Y. B. Sc. Course: ZOOLOGY
Credit Based Semester and Grading System - with a Choice for Additional Credits
(To be implemented from the Academic Year 2018-2019)

SEMESTER - VI					
THEORY					
COURSE NO.	**COURSE CODE**	**UNIT**	**TOPICS**	**CREDITS**	**LECTURES/ WEEK**
15	USZO601	I	Phylum Chordata: Group Protochordata and Group Euchordata I	2.5	1
		II	Group Euchordata II		1
		III	Group Euchordata III		1
		IV	Type study: Shark		1
16	USZO602	I	Enzymology	2.5	1
		II	Homeostasis		1
		III	Endocrinology		1
		IV	Animal Tissue Culture		1
17	USZO603	I	Molecular Biology	2.5	1
		II	Genetic Engineering		1
		III	Human Genetics		1
		IV	Bioinformatics		1
18	USZO604	I	Environment management	2.5	1
		II	Wildlife management		1
		III	Bioprospecting and Zoopharmacognosy		1
		IV	Zoogeography		1
				10	**16**
PRACTICAL					
USZOP06	Practicals based on all four courses			**06**	**16**
Total Number of Credits and Workload				**16**	**32**
Research Project					
USZOR02	Additional Credits (Choice Based / Optional)			**1**	**No Workload for Teachers**

T. Y. B. Sc. Zoology: Semester V (Theory)
Course Code: USZO501:
Taxonomy - Invertebrates and Type Study
Course 11

Unit I: Principles of Taxonomy (15L)

Objective:

- *To introduce the principles of taxonomy and modern system of classification in animal kingdom with evolution point of view.*

Desired outcome:

- *Learners will apprehend the basis of classification and modern classification up to class of the lower invertebrate animals.*

1.1: Levels of Organization:

1.1.1: Unicellularity, colonization of cells, multicellularity

1.1.2: Levels of Organization: Acellular, Cellular, Tissue level, Organ level and 'Organ-system' level

1.2: Symmetry

1.2.1: Basic concept and definition

1.2.2: Types:

a. Asymmetry: e.g. *Amoeba*
b. Radial symmetry: e.g. Starfish
c. Bi-lateral symmetry: e.g. Invertebrate - Planaria
Vertebrate - Man

1.2.3: Evolutionary significance of symmetry

1.3: Coelom

1.3.1: Basic concept and definition

1.3.2: Formation of coelom

1.3.3: Types:

a. Acoelomate: Platyhelminthes e.g. Liverfluke
b. Pseudocoelomate: Nematoda e.g. Roundworm
c. Coelomate: e.g. Frog

1.3.4: Evolutionary significance of coelom

1.4: Metamerism

1.4.1: Basic concept and definition

1.4.2: Types:

a. Pseudometamerism: e.g. Tapeworm

b. True metamerism:
   i. Homonomous - Annelida e.g. *Nereis*
   ii. Heteronomous - Cephalization - Insecta e.g. Dragonfly
   Cephalothorax - Crustacean e.g. Lobster

1.4.3: Evolutionary significance of metamerism

1.5: Taxonomy

1.5.1: Basic concept, definition and objectives

1.5.2: Linnaean Hierarchy, Binomial Nomenclature

1.5.3: Six Kingdom classification:

General characters of each Kingdom with examples:

- Kingdom Archaebacteria
- Kingdom Eubacteria
- Kingdom Protista
- Kingdom Fungi
- Kingdom Plantae
- Kingdom Animalia

1.6: Kingdom Protista: Animal like Protists: Protozoa

1.6.1: General characters of Protozoa

1.6.2: Classification of Protozoa with distinguishing features and suitable examples:

- Phylum Sarcomastigophora
  - Class Sarcodina e.g. *Amoeba*
  - Class Mastigophora e.g. *Trypanosoma*
- Phylum Ciliophora
  - Class Ciliata e.g. *Opalina*
  - Class Phyllopharyngea e.g. *Dysteria*
- Phylum Sporozoa
  - Class Aconoidasida e.g. *Plasmodium*
  - Class Conoidasida e.g. *Toxoplasma*

Unit II: Kingdom Animalia I **(15L)**

Objective:

- *To comprehend the general characters and classification of Kingdom Animalia from Porifera to Nematoda and specific characters of organisms belonging to these phyla.*

Desired outcome:

- *The learners will be familiarized with classification up to phylum Nematoda along with their examples.*

2.1: Phylum Porifera

a. General characters
b. Classification up to class with distinguishing features and suitable examples:
   - Class Calcarea e.g. *Leucosolenia (Branched sponge)*

- Class Hexactinellida e.g. *Hyalonema* (Glass-rope sponge)
- Class Demospongia e.g. *Euspongia* (Bath sponge)

2.2: Phylum Cnidaria

a. General characters
b. Classification up to class with distinguishing features and examples
   - Class Hydrozoa e.g. *Hydra*
   - Class Scyphozoa e.g. *Aurelia* (Jelly fish)
   - Class Anthozoa e.g. *Meandrina* (Maze Coral)

2.3: Phylum Platyhelminthes

a. General characters
b. Classification up to class with distinguishing features and examples
   - Class Turbellaria e.g. *Dugesia* (Planaria)
   - Class Trematoda e.g. *Schistosoma* (Blood-fluke)
   - Class Cestoda e.g. *Taenia* (Tapeworm)
c. Morphology, life cycle and pathogenicity of *Fasciola hepatica*

2.4: Phylum Nematoda

a. General characters
b. Classification up to class with distinguishing features and examples
   - Class: Aphasmida (Adenophorea) e.g. *Trichinella* (Trichina worm)
   - Class: Phasmida (Secernentea) e.g. *Ascaris* (Roundworm)

Unit III: Kingdom Animalia II **(15L)**

Objective:

- *To introduce basic concepts of classification up to class in animal kingdom from phylum Annelida to Hemichordata and to familiarize with their characters.*

Desired outcome:

- *Learners will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects.*

3.1: Phylum Annelida

3.1.1: General characters

3.1.2: Classification up to class with distinguishing features and examples
   - Class Polychaeta e.g. *Neries* (Clamworm)
   - Class Oligochaeta e.g. *Pheretima* (Earthworm)
   - Class Hirudinea e.g. *Hirudinaria* (Leech)

3.2: Phylum Arthropoda

3.2.1: General characters
3.2.2: Classification up to class with distinguishing features and examples
   - Subphylum Chelicerata
     - Class Arachnida e.g. *Hottentotta* (Scorpion)
     - Class Merostomata e.g. *Limulus* (Horse-shoe crab)
     - Class Pycnogonida e.g. *Nymphon* (Sea spider)

- Subphylum Crustacea
  - Class Malacostraca e.g. *Scylla* (Crab)
  - Class Maxillipoda e.g. *Balanus* (Barnacle)
- Subphylum Uniramia
  - Class Chilopoda e.g. *Scolopendra* (Centipede)
  - Class Diplopoda e.g. *Xenobolus* (Millipede) ·

  Class Insecta e.g. *Attacus* (Moth)

3.3: Phylum Mollusca

3.3.1: General characters of the Phylum

3.3.2: Classification up to class with distinguishing features and examples

- Class Aplacophora e.g. *Chaetoderma* (Glisten worm solenogaster)
- Class Polyplycophora e.g. *Chiton* (Coat-of-mail shell)
- Class Monoplacophora e.g. *Neopilina*
- Class Gastropoda e.g. *Nerita* (Nerit)
- Class Pelecypoda e.g. *Solen* (Razor clam)
- Class Scaphopoda e.g. *Dentalium* (Tusk shell)
- Class Cephalopoda e.g. *Nautilus* (Pearly nautilus)

3.4: Phylum Echinodermata

3.4.1 General characters

3.4.2 Classification up to class with distinguishing features and examples

- Class Asteroidea e.g. *Protoreaster* (Starfish)
- Class Ophiuroidea e.g. *Ophiothrix* (Brittle star)
- Class Echinoidea e.g. *Clypeaster* (Sand dollar)
- Class Holothuroidea e.g. *Cucumaria* (Sea cucumber)
- Class Crinoidea e.g. *Antedon* (Sea lily)

3.5 Minor phyla

3.5.1: General characters along with examples of

- Phylum Acanthocephala e.g. *Moniliformis*
- Phylum Onychophora e.g. *Peripatus* (Velvet worm)
- Phylum Chaetognatha e.g. *Sagitta* (Arrow worm)

3.5.2: *Peripatus*, a connecting link - Affinities with Phylum Annelida, Arthropoda and Mollusca.

3.6 Phylum Hemichordata

3.6.1: General characters, classification with distinguishing features and examples

- Class Enteropneusta e.g. *Balanoglossus* (Acorn worm)
- Class Pterobranchia e.g. *Rhabdopleura*
- Class Planctosphaeroidea e.g. *Planctosphera*

3.7 Basic concepts of phylogeny: Phylogenetic tree of invertebrates

Unit IV: Type study: *Sepia* **(15L)**

Objective

- *To acquaint learners with the details of Sepia as a representative of invertebrate animals.*

***Desired* outcome**

- *Learners will get an idea of general characteristics and details of invertebrate animal systems.*

4.1: General characters and classification, Habit and habitat, External characters, mantle cavity, locomotion, economic importance

4.2: Digestive system, Respiratory system, Circulatory system, Excretory system, Nervous system and Sense organs, Reproductive system

Course Code: USZO502:
Haematology and Immunology
Course 12

Unit I: Basic Haematology (15L)

Objectives:

- *To introduce to the learner the composition of blood, haemorrhage and haematopoiesis.*
- *To acquaint the learner with the physiology of blood clotting and clinical aspects of haematology.*

Desired outcome:

- *The learner shall comprehend basic haematology.*
- *The learner will be able to identify various components of haemostatic systems.*

1.1: Composition of plasma: Water, respiratory gases, dissolved salts, plasma proteins, nutrients, enzymes, hormones, nitrogenous waste products

1.2: Haematopoiesis: Erythropoiesis, leucopoiesis and thrombopoiesis

1.3: Erythrocytes: Structure and functions, abnormalities in structure, total count, variation in number; ESR; types of anaemia

1.4: Haemoglobin: Structure, formation and degradation; variants of haemoglobin (foetal, adult), abnormalities in haemoglobin (sickle cell and thalassemia)

1.5: Leucocytes: Types and functions, total count and variation in number; leukaemia and its types

1.6: Thrombocytes: Structure, factors and mechanism of clotting, failure of clotting mechanism

1.7: Blood volume: Total quantity and regulation; haemorrhage

Unit II: Applied Haematology (15L)

Objective:

- *To introduce to the learner the basics of applied haematology and to impart knowledge of diagnostic techniques used in pathology.*

Desired outcome:

- *The learner will be familiar with the terminology used and diagnostic tests performed in a pathological laboratory.*
- *The learner shall be acquainted with diagnostic approaches in haematological disorders.*
- *The learner will be better equipped for further pathological course or working in a diagnostic laboratory.*

2.1: Introduction and scope of Applied Haematology: Clinical, microbiological, oncological and forensic haematology

2.2: Clinical significance of Diagnostic Techniques

2.2.1: Microscopic examination of blood:

- Blood cancer (lymphoma, myeloma),
- Infectious diseases (malaria, leishmaniasis),
- Haemoglobinopathies (sickle cell anaemia, thalassemia)

2.2.2**:** Coagulopathies: Haemophilia and purpura

2.2.3**:** Biochemical examination of blood:

- Liver function tests: AST, ALT, LDH, Alkaline phosphatase , Total and direct bilirubin
- Kidney function test**:** Serum creatinine, Blood Urea Nitrogen (BUN)
- Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated haemoglobin test
- Other biochemical tests: Blood hormones - TSH, FSH, LH.

Unit III: Basic Immunology (15L)

Objective:

- *To introduce the topic of immunology by emphasizing the basic concepts to build a strong foundation and to give an overview of the immune system that plays an important role in disease resistance.*

Desired outcome:

- *The learner shall comprehend the types of immunity and the components of immune system.*
- *The learner will realize the significant role of immune system in giving resistance against diseases.*

3.1: Overview of Immunology

3.1.1: Concept of immunity

3.1.2: Innate immunity - Definition, factors affecting innate immunity, Mechanisms of innate immunity - First line of defence - physical and chemical barriers; Second line of defence - phagocytosis, inflammatory responses and fever

3.1.3: Adaptive or Acquired immunity, Antibody mediated and cell mediated immunity; Active Acquired immunity - Natural and Artificial; Passive Acquired immunity - Natural and Artificial

3.2: Cells and Organs of immune system

3.2.1: Cells of immune system - B cells, T cells and null cells, macrophages, dendritic cells and mast cells

3.2.2: Organs of immune system

- Primary: Thymus and bone marrow
- Secondary: Lymph nodes and spleen

3.3: Antigens: Definition and properties; haptens

3.4: Antibodies: Definition, basic structure, classes of antibodies - IgG, IgA, IgM, IgD and IgE

3.5: Antigen processing and presentation

3.5.1: Endogenous antigens - cytosolic pathways

3.5.2: Exogenous antigens - endocytic pathways

Unit IV: Applied Immunology (15L)

Objectives:

- *To introduce immunopathology to the learner*
- *To introduce the concept of vaccines and vaccination.*
- *To familiarise the learner to immunological perspectives of organ transplantation.*

Desired outcome:

- *The learner shall understand immunopathology and the principles and applications of vaccines.*
- *The learner will develop basic understanding of immunology of organ transplantation.*

4.1: Antigen-Antibody interaction

4.1.1**:** General features of antigen-antibody interaction

4.1.2**:** Precipitation reaction - Definition, characteristics and mechanism.

- Precipitation in gels (slide test)
- Radial immunodiffusion (Mancini method)
- Double immunodiffusion (Ouchterlony method)

4.1.3**:** Immunoelectrophoresis - Counter-current and Laurel's Rocket electrophoresis

4.1.4**:** Agglutination reaction definition, characteristics and mechanism.

- Haemagglutination (slide and micro-tray agglutination)
- Passive agglutination
- Coomb's test

4.1.5**:** Immunoassay - ELISA

4.2: Vaccines and Vaccination

4.2.1**:** Principles of vaccines - active and passive immunization, Routes of vaccine administration

4.2.2**:** Classification of vaccines:

- Live attenuated
- Whole-Killed or inactivated
- Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines

4.2.3**:** Adjuvants used for human vaccines:

- Virosomes and Liposomes
- Saponins

- Water-in-oil emulsions

4.2.4**:** Vaccines against human pathogens:

- Polio
- Hepatitis A and B
- Tuberculosis (BCG)

4.3: Transplantation Immunology: Introduction to transplantation; Types of grafts; Immunologic basis of graft rejection: MHC compatibility in organ transplantation, Lymphocyte and Antibody mediated graft rejection; Precautionary measures against graft rejection

Course Code: USZO503:
Histology, Toxicology, Pathology and Biostatistics
Course 13

Unit I: Mammalian Histology (15L)

Objectives:

- *To familiarize the learner with the cellular architecture of the various organs in the body.*
- *To make the learner understand the need and importance of different types of tissues in the vital organs and their functions.*

Desired outcome:

- *Learner would appreciate the well planned organization of tissues and cells in the organ systems.*

1.1: Vertical section (V.S.) of skin: Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors

1.2: Digestive System

1.2.1: Vertical section (V.S.) of tooth; hard tissue - dentine and enamel; soft tissue - dentinal pulp and periodontal ligaments

1.2.2: Transverse section (T.S.) of tongue - mucosal papillae and taste buds

1.2.3: Alimentary canal - Transverse section (T.S.) of stomach, small intestine, large intestine of mammal.

1.2.4: Glands associated with digestive system - Transverse section (T.S.) of salivary glands, liver.

Unit II: Toxicology (15 L)

Objectives:

- *To introduce the learner to the principles of toxicology with particular emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing.*
- *It also intends to develop amongst students an introductory understanding of regulatory affairs in toxicology.*

Desired outcome:

- *The course will prepare learner to develop broad understanding of the different areas of toxicology.*
- *It will also develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas.*

2.1: Basic toxicology

2.1.1: Introduction to toxicology - brief history, different areas of toxicology, principles and scope of toxicology

2.1.2: Toxins and Toxicants - Phytotoxins (caffeine, nicotine), Mycotoxins (aflatoxins),

Zootoxins (cnidarian toxin, bee venom, scorpion venom, snake venom)

2.1.3: Characteristics of Exposure - Duration of exposure, Frequency of exposure, Site of exposure and Routes of exposure

2.1.4: Types of Toxicity - Acute toxicity, Sub-acute toxicity, Sub-chronic toxicity and Chronic toxicity

2.1.5: Concept of LD_{50}, $^{LC}_{50}$, $^{ED}_{50}$

2.1.6: Dose Response relationship - Individual / Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety

2.1.7: Dose translation from animals to human - Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)

2.1.8: Target organ toxicity:
Hepatotoxicity: susceptibility of the liver, types of liver injury, examples of hepatotoxicants;
Neurotoxicity: vulnerability of nervous system, examples of neurotoxicants;
Nephrotoxicity: susceptibility of kidney, examples of nephrotoxicants

2.2: Regulatory toxicology

2.2.1: OECD guidelines for testing of chemicals (an overview)

2.2.2: CPCSEA guidelines for animal testing centre, ethical issues in animal studies

2.2.3: Animal models used in regulatory toxicology studies

2.2.4: Alternative methods in toxicology (*in vitro* tests)

Unit III: General Pathology (15L)

Objectives:

- *To introduce the learner to basics of general pathology.*
- *To impart knowledge of retrogressive, necrotic, pathological conditions in the body.*
- *To explain repair mechanism of the body.*

Desired outcome:

- *Learner will be familiar with various medical terminology pertaining to pathological condition of the body caused due to diseases.*

3.1: General Pathology: Introduction and scope

3.2: Cell injury: Mechanisms of cell injury: ischemic, hypoxic, free radical mediated and chemical

3.3: Retrogressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)

3.4: Disorders of pigmentation: Endogenous: Brief ideas about normal process of pigmentation, melanosis, jaundice (causes and effects)

3.5: Necrosis: Definition and causes; nuclear and cytoplasmic changes; types: coagulative, liquefactive, caseous, fat and fibroid

3.6: Gangrene: Definition and types - dry, moist and gas gangrene

Unit IV: Biostatistics (15L)

Objective:

- *To make learner familiar with biostatistics as an important tool of analysis and its applications.*

Desired outcome:

- *The learner will be able to collect, organize and analyse data using parametric and non-parametric tests.*
- *They will also be able to set up a hypothesis and verify the same using limits of significance.*

4.1: Probability Distributions: Normal, Binomial, Poisson distribution, Z-transformation, p-value, Probability - Addition and multiplication rules and their applications

4.2: Measures of Variation: Variance, standard deviation, standard error

4.3: Testing of Hypothesis: Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis, Levels of significance and testing of hypothesis

4.4: Parametric and non-parametric test: Parametric tests: two-tailed Z-test and t-test Non-parametric test: Chi-square test and its applications

4.5: Correlation: Correlation coefficient and its significance

Course Code: USZO504:
Anatomy and Developmental Biology
Course 14

Unit I: Integumentary system and derivatives (15L)

Objective:

- *To introduce the learner to understand different integumentary structures and derivatives in the vertebrates and to acquaint learners with special derivatives of integument.*

Desired outcome:

- *Learner will be able to understand the importance of various types of epidermal and dermal derivatives along with their functions.*

1.1: Basic structure of integument: Epidermis and dermis

1.2: Epidermal derivatives of Vertebrates

1.2.1: Hair, hoof, horn, claw, teeth, beak and epidermal scales (small scales, large scales, modified scales - spine)

1.2.2: Glands - types (mucous, serous, ceruminous, poison, uropygial and salt gland) and functions

1.2.3: Type of feathers

1.3: Dermal derivatives of Vertebrates: Scales in fish; scutes in reptiles and birds; dermal scales in mammals - Armadillo, Antler - Caribou

1.4: Special derivatives of integument: Wart in toad, rattle in snake, whale bone in baleen whale, kneepads in camel.

Unit II: Human Osteology (15L)

Objective:

- *To introduce the learner to different bones of human skeleton and their functional importance.*

Desired outcome:

- *Learner will be able to understand the structure, types and functions of human skeleton.*

2.1: Introduction: Bone structure (Histology), physical properties, chemical composition and general functions of bones.
Cartilage: General structure, functions

2.2: Axial skeleton

2.2.1: Skull: General characteristics of skull bones - Cranial and facial bones

2.2.2: Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacrum and coccyx)

2.2.3: Ribs and sternum: General skeleton of ribs and sternum

2.2.4: Hyoid bone: Structure and function.

2.3: Appendicular skeleton
2.3.1: Pectoral girdle and bones of forelimbs

2.3.2: Pelvic girdle and bones of hind limbs

Unit III: Muscles of long bones of Human limbs (15L)

Objectives:
- *To study long limb muscles involved in body movements.*
- *To identify various arrangements of the long limb muscles and to relate the arrangement with contraction and motion.*
- *To study muscle injuries and syndromes.*

Desired outcome:
- *Learner will be able to understand the types of long limb muscles, its arrangement and their role in body movements.*

3.1: Introduction and types of long limb muscles
3.1.1: Flexors, Extensor, Rotator, Abductors, Adductors

3.2: Muscles of forelimbs
3.2.1: Muscles that move the arm (Humerus) - *Triceps brachii, Biceps brachii, brachialis* and *brachioradialis*

3.2.2: Muscles that move the forearm (Radius-ulna) - *Flexor carpi radialis, Flexor carpi ulnaris* and *Extensor carpi ulnaris*

3.2.3: Muscles that move the wrist, hand and fingers - *Flexor digitorium superficialis, Extensor carpi radialis* and *Extensor digitorum*

3.3: Muscles of hindlimbs
3.3.1: Muscles that move the thigh (Femur) - Sartorius, Adductor group, Quadriceps group (*Rectus femoris, Vastus lateralis, Vastus medialis*), Hamstring group (*Biceps femoris, Semimembranosus, Semitendinosus*)

3.3.2: Muscles that move the lower leg (tibia-fibula) - *Fibularis longus, Gastrocnemius, Tibialis anterior, Soleus, Extensor digitorum longus* and *Fibularis tertius*

3.3.3: Muscles that move the ankle, foot and toes - *Tibialis anterior, Extensor digitorum, Longus* and *Fibularis* muscles

Unit IV: Developmental biology of Chick (15L)

Objective:

- *To introduce the learner to the basics of developmental biology with reference to chick as a model and also familiarize with experiments related to it.*

Desired outcome:

- *Learner will be able to understand the processes involved in embryonic development and practical applications of studying the chick embryology.*

4.1: Introduction to Developmental Biology: Basic concept and principles of developmental biology - morphogenesis, organogenesis, fate maps, cell adhesion, cell affinity and cell differentiation.

4.2: Development of Chick embryo

4.2.1: Structure of Hen's egg, physico-chemical nature and forms of yolk - granular, platelets and spheres; fertilization, cleavage, blastulation, gastrulation

4.2.2: Structure of chick embryo - 18hours, 24 hours, 33 hours, 48 hours and 72 hours

4.2.3: Extra embryonic membranes

4.2.4: Organizer: Introduction, Spemann Mangold experiment, Hensen's node as an organizer

Practical Syllabus for Semester V
Course code: USZOP05; Course 11

1. Classification of phyla up to class and study of the general characters up to class.
   Kingdom Protista - Animal-like Protists: Protozoa

   A. Phylum: Sarcomastigophora
      - Class Sarcodina e.g. *Amoeba*
      - Class Mastigophora e.g. *Euglena*

   B. Phylum: Ciliophora
      - Class Ciliata e.g. *Paramoecium*
      - Class Phyllopharyngea e.g. *Dysteria*

   C. Phylum: Sporozoa,
      - Class Aconoidasida e.g. *Eimeria*
      - Class Conoidasida e.g. *Sarcocystis*

   Kingdom Animalia

   D. Phylum: Porifera
      - Class Calcarea e.g. *Scypha* (Little vase sponge)
      - Class Hexactinellida e.g. *Hyalonemma* (Glass-rope sponge)
      - Class Demospongia e.g. *Spongilla* (Freshwater sponge)

   E. Phylum Cnidaria
      - Class Hydrozoa e.g. *Vellela* (By-the-wind sailor)
      - Class Scyphozoa e.g. *Rhizostoma* (Barrel jellyfish)
      - Class Anthozoa e.g. *Corallium* (Coral)

   F. Phylum Platyhelminthes
      - Class Turbellaria e.g. *Dugesia* (Planaria)
      - Class Trematoda e.g. *Fasciola* (Liverfluke)
      - Class Cestoda e.g. *Taenia* (Tapeworm)

   G. Phylum Nematoda
      - Class Aphasmida (Adenophorea) e.g. *Trichinella* (Trichina worm)
      - Class Phasmida (Secernentea) e.g. *Ascaris* (Roundworm)

   H. Phylum Annelida
      - Class Polychaeta e.g. *Arenicola* (Lugworm)
      - Class Oligochaeta e.g. *Tubifex* (Sludge worm)
      - Class Hirudinea e.g. *Pontobdella* (Marine leech)

   I. Phylum Arthropoda
   Subphylum Chelicerata
      - Class Arachnida e.g. *Hotentotta* (Scorpion)
      - Class Merostomata e.g. *Limulus* (Horseshoe crab)
      - Class Pycnogonida e.g. *Nymphon* (Sea spider)

Subphylum Crustacea

- Class Malacostraca e.g. *Panulirus* (Lobster)
- Class Maxillipoda e.g. Cyclops (Copepods)

Subphylum Uniramia

- Class Chilopoda e.g. *Scolopendra* (Centipedes)
- Class Diplopoda e.g. *Xenobolus* (Millipedes)

Class Insecta e.g. *Attacus* (Moth)

J. Phylum Mollusca

- Class Aplacophora e.g. *Chaetoderma* (Glisten worm solenogaster)
- Class Polyplacophora e.g. *Tonicella* (Lined Chiton)
- Class Monoplacophora e.g. *Neopilina*
- Class Gastropoda e.g. *Turbo* (Turban shell)
- Class Pelycypoda e.g. *Donax* (Wedge shell)
- Class Scaphopoda e.g. *Dentalium* (Tusk shell)
- Class Cephalopoda e.g. *Octopus*

K. Phylum Echinodermata

- Class Asteroidea e.g. *Asterias* (Starfish)
- Class Ophiuroidea e.g. *Ophiothrix* (Brittle star)
- Class Echinoidea e.g. *Echinus* (Sea urchin)
- Class Holothuroidea e.g. *Cucumaria* (Sea cucumber)
- Class Crinoidea e.g. *Crinoid* (Sea lily)

L. Phylum Hemichordata

- Class Enteropneusta e.g. *Saccoglossus*
- Class Pterobranchia e.g. *Rhabdopleura*
- Class Planctosphaeroidea e.g. *Planctosphaera*

2. Minor Phyla

Acoelomate

M. Phylum Acanthocephala e.g. *Echinorhynchus*

Coelomate

N. Phylum Chaetognatha e.g. *Sagitta*

O. Phylum Onychophora e.g. *Peripatus* (Velvet worm)

3. Study of *Sepia* with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected.
   a) Digestive system,
   b) Reproductive system
   c) Nervous system
   d) Jaws
   e) Radula
   f) Chromatophores
   g) Spermatophores
   h) Statocyst

4. Study tour - Visit to fish market / Aquarium / Local Gardens / Local available niche / National Parks / Sanctuaries / and such other places to observe invertebrates with special emphasis on Western Ghats and coast of Maharashtra and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.

Course code: USZOP05; Course 12

1. Enumeration of Erythrocytes - Total Count.
2. Enumeration of Leucocytes - Total Count.
3. Differential count of Leucocytes.
4. Erythrocyte Sedimentation Rate by suitable method - Westergren or Wintrobe method.
5. Estimation of haemoglobin by Sahli's acid haematin method.
6. Determination of serum LDH by using colorimeter / spectrophotometer.
7. Estimation of total serum/ plasma proteins by Folin's method.
8. Estimation of serum/ plasma total triglycerides by Phosphovanillin method.
9. Latex agglutination test - Rheumatoid Arthritis.
10. Determination of bleeding and clotting time.

Course code: USZOP05; Course 13

1. Study of mammalian tissues: V.S. of Tooth, T.S. of Stomach, T.S. of small intestine**,** T.S. of Liver.
2. Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining.
3. Identification of diseases or conditions (from slides or pictures): Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema
4. To study the effect of CCl_4 on the level of enzyme activity in liver on aspartate and alanine amino transferase, alkaline phosphatase (*in vitro* approach).
5. Study and interpretation of abnormal pathological reports: Blood (CBC), Urine (Routine) and Stool (Routine).
6. Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) and manually:
   a. Problems based on Z-test
   b. Problems based on t-test
   c. Problems based on Chi-square test
   d. Correlation, regression analysis - demonstration only.
   e. Problems based on ANOVA - demonstration only.

(Learner is expected to identify appropriate test for the given problem)

Course code: USZOP05; Course 14

1. Study of integumentary systems - V. S. of Skin of Shark, Frog, *Calotes*, Pigeon and Human
2. Study of Human Axial Skeleton - Skull (whole) and Vertebral column (axis, atlas, typical cervical, typical thoracic, typical lumbar, sacrum, coccyx)
3. Study of Human Appendicular Skeleton - Pectoral and pelvic girdle with limb bones
4. Study of muscles of forelimbs - *Biceps brachii, Brachialis, Brachio radialis, Triceps brachii, Flexor carpi radialis, Flexor carpi ulnaris* and *Extensor carpi ulnaris*
5. Study of muscles of hind limbs - Sartorius, Adductor group, Quadriceps group *Rectus femoris, Vastus lateralis, Vastus medialis, Hamstring* group (*Biceps femoris, Semimembranosus, Semitendinosus*), *Fibularis longus, Gastrocnemius Tibialis anterior, Soleus, Extensor digitorum longus, Fibularis tertius*
6. Study of ontogeny of chick embryo using permanent slides - 18 hours, 24 hours, 33 hours, 48 hours and 72 hours.
7. Preparation of temporary mounting of chick embryo up to 48 hours of incubation.

References and Additional Reading for Semester V

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- Biology of the invertebrates by Jan A. Pechenik, 7th edition,2014 publications McGraw Hill
- An introduction to the invertebrates by Janet Moore, 2ndedition2006, publications Cambridge
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ADDITIONAL READING

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- http://www.biologydiscussion.com/invertebrate-zoology/invertebrates-phyla/study-notes-on-invertebrates-phyla/28077
- http://www.asfa.k12.al.us/ourpages/auto/2014/4/23/64232119/invertebrate-animal-phyla-notes.pdf
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- https://portals.iucn.org/library/sites/library/files/documents/2012-064.pdf
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- http://www.faculty.ucr.edu/~legneref/invertebrate/inverteb.htm
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- http://bioweb.uwlax.edu/bio203/s2009/maiers_andr/Classification.htm
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- https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/worms-phyla-platyhelmintes-nematoda-and-annelida
- http://www.fossilmuseum.net/Tree_of_Life/PhylumAnnelida.htm
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- Human Osteology, 3rd Edition by Tim D. White, Michael T. Black and Pieter A. Folkens.
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- Atlas of Chick Development - By Ruth Bellairs and Mark Osmond.
- Laboratory embryology of the chick by Lloyd Eugene Downs.
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- Dictionary of Developmental Biology and Embryology by Frank J. Dye.

LEARNERS' SPACE

Course 11

1. Learners can visit different websites to get information about the invertebrates discovered recently in Maharashtra as well as in the world.
2. Learners can play games to identify kingdom, phylum or class based on the characters of animals.
3. Investigate the process of formation of first life/cell on earth
4. List the names of places in India where corals are found.
5. Study the corals as an indicator of healthy ecosystem.
6. Enlist medicinal uses of leech.
7. State the differences between *Loligo* and *Sepia*.
8. Collect information on differences between minor phyla and major phyla.
9. Study the economic importance of molluscs.
10. Collect the information on torsion-detorsion in gastropods.

Course 12

1. Study the latest medical applications of haemopoietic cells.
2. Prepare a report on thrombosis, its causes, risk factors, symptoms and prevention.
3. Other than haemophilia, there are many more coagulation factor disorders. Explore this area.
4. Investigate the traditional and recent methods of grouping and cross matching of blood.
5. Compile information on Bombay blood group.
6. Study the recent advancements in organ transplantation.
7. Autoimmune diseases are on the rise. Explore the reasons, types as well as its mechanisms.
8. Distinguish different types of hypersensitivity.
9. Make a detailed report on bone marrow transplantation.
10. Explain the application of radiation technology in vaccine development.
11. Attempt to understand immune mechanisms in invertebrates.
12. Attempt to understand immune mechanisms in pets.

Course 13

1. Define- Histopathology. Name the cytological techniques used to stain DNA in the tissues.
2. Prepare a chart as follows

Sr. No.	Type of Embryonic origin	Tissues/Organ/Gland	Position in the body of vertebrates
1.	Ectoderm		
2.	Endoderm		
3.	Mesoderm		
4.	Dual origin		

3. From internet, survey types of stains used in temporary and permanent preparation of slides.
4. Find the ways to prevent post mortem changes in histological preparation of experimental animals.
5. Enumerate sub-lethal dose or sub-lethal concentration of a toxicant.
6. Give the significance of probit analysis and comment on Finney method of toxicity evaluation.

7. Find the differences between bioaccumulation, biotransformation and bio-magnification in the trophic levels. Do search for bioremediation against pollutants.
8. Discuss the various routes of intoxication in vertebrate animals.
9. Enlist the common inflammatory diseases.
10. Define - Metastasis and Neoplasia
11. Explain the procedure of biopsy. Give its significance.
12. Prepare a chart as follows:

Sr. No.	Samples	Types of pathological test conducted.	Confirmation of diseases
1.	Blood		
2.	Urine		
3.	Sputum		
4.	Semen		
5.	Root hair somatic cell		
6.	Bone marrow		
7.	Stool		

13. Give the use of standard error in biological research.
14. Explain various types of correlations possibilities in biological events.
15. Differentiate between primary and secondary data.
16. Study computer spreadsheet programme. Find software programmes for statistical tests used in biological research.

Course 14

1. Distinguish between holocrine, merocrine and apocrine glands.
2. Explain the difference between plastic and cosmetic surgery.
3. Comment on skin cancer and its preventive measures.
4. Find the ABCD rule for recognizing melanoma
5. Elaborate the term cyanosis.
6. Find the correlation between biological clock/rhythm melanin secretion and sleep.
7. List various applications of forensic osteology and human osteoarchaeology.
8. Role of osteology in understanding human evolution and taxonomy.
9. Give the correlation between age, nutrition and growth of bones.
10. Find out the following:
    a) Correlation between muscles and body building
    b) Smallest muscle, strongest muscle and the muscle that is never tired in our body.
    c) Number of muscles required for taking one step
11. Name three muscles or muscle groups used as sites for intramuscular injections especially used in babies.
12. Distinguish between the effect of exercises on muscles of a marathon runner and a weight lifter.
13. Describe different theories of experimental embryology.
14. Collect the brief information regarding the human embryogenesis.
15. Explain recapitulation theory.
16. Use of French flag model to understand developmental biology.
17. Complete the following table:

Drosophila body Patterning		
Category of genes	**Name of genes**	**Role of genes**
Egg-polarity genes	----------	Establish the Antero-posterior axis
Gap genes	----------	Establish 3 broad segments of the embryo
Pair-rule genes	----------	Establishes odd and even segments
Segment-polarity genes	----------	Establishes anterior posterior polarity of each segment
Homeotic genes	----------	Establishes segmental identity

T. Y. B. Sc. Zoology: Semester VI (Theory)
Course Code: USZO601:
Taxonomy - Chordates and Type Study
Course 15

Unit I: Phylum Chordata: Group Protochordata and Group Euchordata I (**15L**)

Objective:

- *To introduce basic concepts of modern Chordate classification with evolution point of view and to understand the concept of taxonomy in higher animal kingdom.*

Desired outcome:

- *Learners will get an idea of origin of Chordates, its taxonomy up to class with reference to phylogeny and their special features.*

1.1: General characters, Difference between non-chordates and chordates

Origin of chordates: Annelids as ancestors, Arachnids as ancestors and affinities with Echinodermata

1.2: **Protochordata**

1.2.1: General characters of Group Protochordata

1.2.2: Distinguishing characters of Subphylum Urochordata and Cephalochordata

1.2.3: Subphylum Urochordata

- Class Ascidiacea e.g. *Herdmania*
- Class Thaliacea e.g. *Salpa*
- Class Larvacea e.g. *Oikopleura*

1.2.4: Subphylum Cephalochordata

- Class Leptocardii e.g. *Branchiostoma* (*Amphioxus*)

1.3: Group Euchordata I

Group Euchordata: General characters

- Subphylum Vertebrata: General characters
- Division Agnatha and Gnathostomata: Distinguishing characters.

General characters with examples of:

- Class Ostracodermii e.g. *Cephalaspis*
- Class Cyclostomata e.g. *Petromyzon* (Lamprey)

Unit II: Group Euchordata II **(15L)**

2.2.1: Division: Gnathostomata

- Superclass: Pisces and Tetrapoda
- Superclass - Pisces: Distinguishing characters
  - Class Placodermi e.g. *Climatius*
  - Class Chondrichthyes e.g. *Rhinobatos* (Guitar fish)
  - Class Osteichthyes e.g. *Exocetus* (Flying fish)

2.2.2: Dipnoi (Lung fish): Distribution, habit and habitat, external and internal characters, affinities with super class Pisces, affinities and differences with class Amphibia

2.3: Superclass Tetrapoda

- Class Amphibia: General characters

  Examples:

  a. Limbless amphibian e.g. *Ichthyophis* (Caecilian)
  b. Tailed amphibian e.g. *Amphiuma*
  c. Tailless amphibian e.g. *Hyla* (Tree frog)

Unit III: Group Euchordata III **(15L)**

Objective:

- *To introduce the learners to the distinguishing characters of classes Reptilia, Aves and Mammalia and their adaptive features with reference to their habitat.*

Desired outcome:

- *Learners will understand the characteristic features and examples of class of Reptilia, Aves and Mammalia.*

3.1: Class Reptilia: General characters

Examples

a. Extinct reptile e.g. *Ichthyosaurus*
b. Living fossil e.g. *Sphenodon* (Tuatara)
c. Aquatic reptile e.g. *Chelonia* (*Sea turtle*)
d. Arboreal reptile e.g. *Chamaeleo* (Chamaeleon)

3.2: Class Aves: General Characters

Examples

a. Arboreal bird e.g. *Melanerpes* (Wood pecker)
b. Terrestrial bird e.g. *Gallus* (Fowl)
c. Swimming bird e.g. *Phalacrocorax* (Cormorant)
d. Wading bird e.gs. *Ardeola* (Heron)
e. Birds of prey e.g. *Tyto* (Owl)
f. Flightless birds e.g. *Dromaius* (Emu)

3.3: Class Mammalia: General characters

Examples

a. Egg-laying mammals e.g. *Ornithorhyncus* (Duck-billed platypus)
b. Pouched mammals e.g. *Macropus* (Kangaroo)
c. Insect eating mammals e.g. *Sorex* (Common shrew)
d. Toothless mammals e.g. *Bradypus* (Sloth)
e. Gnawing mammals e.g. *Funambulus* (Squirrel)
f. Primates e.g. *Macaca* (Monkey)

Unit IV: Type study: Shark (15L)

Objective:

- *To study in depth one vertebrate animal type i. e. general characteristics and salient features of animal type - shark.*

Desired outcome:

- *Learners will get an idea of vertebrate animal life after studying one representative animal - shark.*

4.1: Habit & habitat, distribution, external characters, classification and economic importance.

4.2: Skin, exoskeleton, endoskeleton and systems

a) Digestive system
b) Respiratory system
c) Blood vascular system
d) Nervous system and receptor organs
e) Urinogenital system, copulation, fertilization and development

Course Code: USZO602:
Physiology and Tissue Culture
Course 16

Unit I: Enzymology **(15L)**

Objective:

- *To introduce to the learner the fundamental concepts of enzyme biochemistry and to enable the learner realize applications of enzymes in basic and applied sciences.*

Desired outcome:

- *The learner shall understand fundamentals of enzyme structure, action and kinetics.*
- *The learner shall appreciate the enzyme assay procedures and the therapeutic applications of enzymes.*

1.1: Introduction and Nomenclature: Definition; concept of activation energy; nomenclature and classification (based on IUB - Enzyme Commission) of enzymes; chemical nature of enzyme, co-factors and co-enzymes

1.2: Enzyme Action and Kinetics: Mechanism; Factors affecting enzyme activity - substrate, pH and temperature. Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of K_m, V_{max} and K_{cat}

1.3: Enzyme Inhibition: Competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors

1.4: Regulation of Enzyme Activity: Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH)

1.5: **Industrial applications of enzymes**: Food and detergents

Unit II: Homeostasis **(15L)**

Objective:

- *To introduce to the learner the concept of homeostasis-thermoregulation and osmoregulation*

Desired outcome:

- *The learner shall comprehend the adaptive responses of animals to environmental changes for their survival.*

2.1: Homeostasis

2.1.1: External and internal environment; Acclimation and acclimatization

2.1.2: Body clock - Circadian & Diurnal rhythm

2.2: Thermoregulation

2.2.1: Endothermy and ectothermy

2.2.2: Temperature balance: Heat production - shivering and non-shivering thermogenesis; brown fat, mechanisms of heat loss

2.2.3: Adaptive response to temperature - daily torpor, hibernation, aestivation

2.3: Osmotic and Ionic Regulation

2.3.1: Living in hypo-osmotic, hyper-osmotic and terrestrial environment - Water absorption, salt water ingestion and salt excretion, salt glands, metabolic water

2.3.2: Role of kidney in ionic regulation

Unit III: Endocrinology (15L)

Objective:

- *To introduce to the learner the details of endocrine glands and its disorders.*

Desired outcome:

- *The learner shall understand the types and secretions of endocrine glands and their functions.*

3.1: General organization of mammalian endocrine system

3.2: Hormones: Classification, properties, mechanism of hormone action

3.3: Histology, functions and disorders of the following endocrine glands:

- Pituitary
- Thyroid
- Parathyroid
- Pancreas
- Adrenal

Unit IV: Animal Tissue Culture (15L)

Objective*:*

- To *introduce to the learner the fundamental concepts of tissue culture and guide them progressively to certain areas of animal tissue culture.*

Desired outcome*:*

- *The learner shall understand the significance of tissue culture as a tool in specialized areas of research.*
- *The learner will appreciate its applications in various industries.*

4.1: Aseptic techniques

4.1.1**:** Sterilization - basic principles of sterilization, importance of sterility in cell culture

4.1.2**:** Sterile handling - swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring

4.2: Culture media

4.2.1: Types of media - Natural and Artificial media

4.2.2: Balanced Salt Solutions

4.2.3: Complete Media - amino acids, vitamins, salts, glucose, oxygen supplements, hormones and growth factors, antibiotics

4.2.4: Factors influencing cell culture - surface tension and foaming, viscosity, temperature, osmolality, pH, CO_2, bicarbonate and O_2

4.3: Advantages of tissue culture - control of the environment, *in vitro* modelling of *in vivo* conditions

4.4: Limitations of tissue culture

4.5: Culture techniques

4.5.1: Preparation of cells / organs for culture

4.5.2**:** Cover slip, Flask and Tube culture

4.5.3: Primary and established cell lines

4.5.4: Hybridoma technology

Course Code: USZO603:
Genetics and Bioinformatics
Course 17

Unit I: Molecular Biology **(15 L)**

Objectives:

- *To introduce learner to chemical and molecular processes that affect genetic material.*
- *To make learner understand the concept of DNA damage and repair, and how gene control is necessary for cell survival.*

Desired outcome:

- *Learner shall get an insight into the intricacies of chemical and molecular processes that affect genetic material.*
- *The course shall prepare learner to recognize the significance of molecular biology as a basis for the study of other areas of biology and biochemistry.*
- *Learner shall also understand related areas in relatively new fields of genetic engineering and biotechnology.*

1.1: Types of mutation

1.1.1**:** Point mutations - substitution, deletion and insertion mutations

Substitution mutations - silent, missense and nonsense mutations, transition and transversion

Deletion and Insertion mutations - frameshift mutations

1.1.2**:** Trinucleotide repeat expansions - fragile X syndrome, Huntington disease

1.1.3**:** Spontaneous mutation - tautomeric shifts, spontaneous lesions

1.2: Induced mutations

1.2.1**:** Physical agents:

- Ionizing radiation (X-rays, α, β and γ rays)
- Non-ionizing radiation (UV light)

1.2.2**:** Chemical agents:

- Base analogs (5-bromouracil)
- Intercalating agents (ethidium bromide)
- Deaminating agents (nitrous acid)
- Hydroxylating agents (hydroxylamine)
- Alkylating agents (mustard gas)
- Aflatoxin (aflatoxin B_1)

1.3: Preventative and repair mechanisms for DNA damage

1.3.1: Mechanisms that prevent DNA damage - superoxide dismutase and catalase

1.3.2: Mechanisms that repair damaged DNA - direct DNA repair (alkyl transferases, photoreactivation, excision repair)

1.3.3: Postreplication repair - recombination repair, mismatch repair, SOS repair

1.4: Eukaryotic gene expression

1.4.1: Regulatory protein domains - zinc fingers, helix-turn-helix domain and leucine zipper

1.4.2**:** DNA methylation

Unit II: Genetic Engineering (15 L)

Objective:

- *To introduce learner to a set of techniques to modify an organism's genome to produce improved or novel genes and organisms.*

Desired outcome:

- *The learner shall get acquainted with the vast array of techniques used to manipulate genes which can be applied in numerous fields like medicine, research, etc. for human benefit.*

2.1: Tools in Genetic Engineering

2.1.1: Enzymes involved in Genetic Engineering: Introduction, nomenclature and types of restriction enzymes with examples, Ligases - *E. coli* DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA polymerases, reverse transcriptase, terminal transferase

2.1.2: Vectors for gene cloning: General properties, advantages and disadvantages of cloning vectors - plasmid vectors (pBR322), phage vectors (λ Phage), cosmid vectors (c2XB)

2.1.3**:** Cloning techniques: Cloning after restriction digestion - blunt and cohesive end ligation, creation of restriction sites using linkers and adapters, cloning after homopolymer tailing, cDNA synthesis (Reverse transcription), genomic and cDNA libraries

2.2: Techniques in Genetic Engineering

2.2.1**:** PCR techniques: Principle of polymerase chain reaction (PCR), Applications of PCR

2.2.2**:** Sequencing techniques: DNA sequencing: Maxam-Gilbert method, Sanger's method Protein sequencing: Sanger's method, Edman's method Applications of sequencing techniques

2.2.3**:** Detection techniques: Blotting techniques - Southern blotting, Northern blotting and Western blotting Applications of blotting techniques

Unit III: Human Genetics (15L)

Objective:

- *To introduce learner with genetic alterations in human genome and their diagnosis.*

Desired outcome:

- *The learner shall become aware of the impact of changes occurring at gene level on human health and its diagnosis.*

3.1: Non-disjunction during mitosis and meiosis

3.1.1**:** Chromosomal Aberrations: Structural: Deletion: types, effects and disorders;
Translocation: types: Robertsonian and non-Robertsonian disorders;
Inversion: types, effects and significance;
Duplication and their evolutionary significance (multigene families)
Numerical: Aneuploidy and Polyploidy (Autopolyploidy and Allopolyploidy)

3.2: Genetic Disorders

3.2.1**:** Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism

3.2.2**:** Single gene mutation: Cystic fibrosis

3.2.3**:** Multifactorial: Breast Cancer

3.2.4**:** Uniparental Disomy: Angelman Syndrome and Prader-Willi Syndrome

3.3: Diagnosis

3.3.1**:** Prenatal Diagnosis: Amniocentesis and Chorionic villus sampling, Banding techniques (G, C, Q), FISH, Protein truncation test (PTT)

3.3.2**:** Genetic counselling

Unit IV: Bioinformatics (15L)

Objective:

- *To introduce learner to bioinformatics - a computational approach to learning the structure and organization of genomes, phylogeny and metabolism.*

Desired outcome:

- *Learner shall become aware of the computational point of view of studying the genomes.*

4.1: Introduction

4.1.1**:** Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, OMIM, PubMed)

4.1.2**:** Applications of Bioinformatics

4.2: Databases - Tools and their uses

4.2.1**:** Biological databases;
Primary sequence databases: Nucleic acid sequence databases **(**GenBank, EMBLEBI, DDBJ) Protein sequence databases (UniProtKB, PIR)
Secondary sequence databases
Derived databases - PROSITE, BLOCKS
Structure databases and bibliographic databases

4.3: Sequence alignment methods

4.3.1**:** BLAST, FASTA

4.3.2: Types of sequence alignment (Pairwise & Multiple sequence alignment)

4.3.3: Significance of sequence alignment

4.4: Predictive applications using DNA and protein sequences
4.4.1: Evolutionary studies: Concept of phylogenetic tree, convergent and parallel evolution

4.4.2**:** Pharmacogenomics: Discovering a drug: Target identification

4.4.3**:** Protein Chips and Functional Proteomics: Different types of protein chip (detecting and quantifying), applications of Proteomics

4.4.4: Metabolomics: Concept and applications

Course Code: USZO604:
Environmental Biology and Zoopharmacognosy
Course 18

Unit I: Environment management (15L)

Objective:

- *Learner should understand different factors affecting the environment and various methods to improve environmental stewardship.*

Desired outcome:

- *Learner will understand the different factors affecting environment, its impact and environment management laws.*

1.1: Natural resources and their Classification

1.1.1: Forest resources, water resources (surface and ground) and mineral resources

1.1.2: Energy resources: renewable (solar, tidal, wind, biofuel) and non-renewable resources (coal, petroleum oil, natural gas)

1.2: Exploitation and Modification of Natural Resources: Impact on climate, flora and fauna

1.3: Waste Management

1.3.1: Technologies in solid waste management:

a) Traditional methods for solid waste management: Composting, Incineration, Landfill Recycling, Windrow composting

b) Modern methods for solid waste management: Anaerobic digestion, ethanol production, biodrying, pyrolysis, Upflow anaerobic sludge blanket (UASB) technology, waste autoclave

1.3.2: e-waste and hazardous waste (biological, chemical, medical and nuclear) management

1.4: Water management

1.4.1: Rainwater harvesting: Definition ways of harvesting, components, model of rain water harvesting: Rural and Urban, Advantages and disadvantages

1.4.2: Watershed management: Definition, need and objectives, classification (mini, micro, mili, sub-watershed, macro-watershed), Watershed management practices: Contour, gully control, stone bunds. Growing greenery and integrated watershed approach (IWA).

1.4.3: Case study: Ice-stupa artificial glaciers by Sonam Wangchuk

1.4.4: Effluent treatment, recycling plants, control and treatment of sewage water.

1.5: Acts and Rules of Environment Management

1.5.1: Environment Protection Act - 1986, Air (Prevention and Control of Pollution) Act - 1981, Water (Prevention and Control of Pollution) Act - 1974

1.5.2: Hazardous Wastes (Management and Handling) Rules - 1989

1.5.3: EIA (Environmental Impact Assessment)

1.5.4: Role of Central and State Government (Pollution Control Board) and NGOs

Unit II: Wildlife Management (15L)

Objectives:

- *To sensitize learner regarding the various threats to the wildlife*
- *To introduce learner various ways that can help in the protection, conservation, management, and enhancement of wildlife populations and habitat.*

Desired outcome:

- *Learner will be able to understand various methods for wildlife conservation.*
- *Learner will be able to apply knowledge to overcome the issues related to wildlife conservation and management.*

2.1: Habit, Habitat, Territory and Niche of Wild Animals: Herbivores, carnivores, solitary, social (flock, pod, community), pack and herd, types of habitats and territories, niche concept

2.2: Threats to Wildlife

2.2.1: Poaching and hunting, deforestation, encroachment, competition (intra-specific and inter-specific), overgrazing and climate change, diseases (zoonosis and reverse zoonosis)

2.2.2: Tourism and human animal conflict

2.3: Wildlife Conservation

2.3.1: Techniques and methods used for wildlife census: Aerial counts, camera trap, line transect census and track surveys, capture mark recapture method, wildlife radio telemetry

2.3.2: Forest management, policies and Acts:
Harvesting Trees, Thinning harvest, Clearcut Harvest, Shelterwood harvest, Seed tree harvest, Group selection harvest, Single-tree selection harvest, Prescribed burning, Reforestation
Forest policy 1894, 1952, 1988;
The Indian Forest Act, 1927; Forest (Conservation) Act, 1980

Unit III: Bioprospecting and Zoopharmacognosy (15L)

Objectives:

- *To introduce the learner to the concepts of bioprospecting and zoopharmacognosy.*
- *Learner will be made aware of the process of discovery and commercialization of new products based on biological resources.*
- *To introduce learner with various ethological aspects by which non-human animals apparently self-medicate themselves.*

Desired outcome:

- *Learner will understand the paradigms of discovery and commercialization of biological resources and knowledge gained from self-medication observed in animals.*

3.1: Bioprospecting

3.1.1: Traditional and modern bioprospecting, economic value of bioprospecting

3.1.2: Bioprospecting and conservation, advantages and disadvantages

3.2: Zoopharmacognosy

3.2.1: Definition and types

3.2.2: Self-medication and its mechanism

3.2.3: Methods of self-medication through:

a) Ingestion - ants and mammals
b) Geophagy - invertebrates and birds
c) Absorption and adsorption

3.2.4: Applications - Social and trans-generational aspects of insects, birds and mammals

3.2.5: Contribution to human medicines

Unit IV: Zoogeography (15L)

O*bjectives:*

- *To introduce learner to the geographic distribution (present and past) of animal species.*
- *To introduce learner to various ways of animal distribution.*

Desired outcome:

- *The learners will become acquainted with how and why different animal species are distributed around the globe.*

4.1: Introduction: Plate tectonics and continental drift theory

4.2: Animal Distribution and Barriers

4.2.1: Isolating Mechanisms

4.2.2: Patterns of animal distribution - continuous, discontinuous and bipolar

4.2.3: Barriers of distribution -Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habit (homing instinct).

4.2.4: Means of dispersal - land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies

4.3: Zoogeographical Realms: Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic

Practical Syllabus for Semester VI
Course code: USZOP06: COURSE 15

1. Group Protochordata

- Subphylum Urochordata
  - Class Larvacea e.g. *Oikopleura* (Sea squirt)
  - Class Ascidiacea e.g. *Ciona* (Transparent Sea squirt)
  - Class Thaliacea e.g. *Salpa* (Common salp)

- Subphylum Cephalochordata
  - Class Leptocardii e.g. *Branchiostoma* (*Amphioxus*)

- Subphylum Vertebrata: Division Agnatha
  - Class Ostracodermi e.g. *Pharyngolepis*
  - Class Cyclostomata e.g. *Petromyzon* (Lamprey)

2. Division Gnathostomata

- Superclass Pisces:
  - Class Placodermi e.g. *Bothriolepis*
  - Class Chondrichthyes e.g. *Rhinobatos* (Guitar fish), *Chimaera* (Rabbitfish)
  - Class Osteichthyes e.g. *Protopterus, Clarius* (Catfish)
- Superclass Tetrapoda:
  - Class Amphibia e.g. *Alytes* (Midwife toad) and *Triton* (Salamander)
  - Class Reptilia e.g. *Varanus* (Monitor lizard) and *Crocodylus* (Crocodile)

3. Class Aves: Examples: *Eudyptes* (Penguin), *Phoenicopterus* (Flamingo) and *Gyps* (Vulture)

4. Class Mammalia: Examples: *Dasyurus* (Quoll), *Petaurista* (Flying squirrel) and *Macaca* (Monkey).

5. Study of Shark with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected.

a) Digestive system
b) Heart and Aortic arches
c) Urinogenital System
d) Endoskeleton of shark:
   i. Axial - Skull and vertebral column
   ii. Appendicular - Pelvic and pectoral fins, pelvic and pectoral girdle

6. Visit to fish market / Aquarium / Zoo/ National Park / Local Gardens / Local available niche / Sanctuaries / and such other places in Maharashtra and / or India and / or abroad to observe chordates and prepare a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.

Course code: USZOP06: COURSE 16

1. Effect of varying pH on activity of enzyme Acid Phosphatase.
2. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase.
3. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase.
4. Effect of inhibitor on the activity of enzyme Acid Phosphatase.
5. Separation of LDH isozymes by agarose / polyacrylamide gel electrophoresis.
6. Histology of endocrine glands: T.S. of pituitary, thyroid, parathyroid, pancreas, adrenal.
7. Instruments for tissue culture - Autoclave Millipore filter, CO_2 incubator, Laminar air-flow. (Principle and use).
8. Packaging of glassware for tissue culture.
9. Aseptic transfer techniques.
10. Trypsinization and vital staining using Trypan blue stain.

Course code: USZOP06: COURSE 17

1. Quantitative Estimation of RNA by Orcinol method.
2. Quantitative Estimation of DNA by Diphenylamine method.
3. Separation of Genomic DNA by Agarose gel electrophoresis.
4. Colorimetric estimation of proteins from given sample by Folin-Lowry's method.
5. Problems based on Restriction endonucleases.
6. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes (no cutting of chromosomes):
    a. Turner's syndrome
    b. Klinefelter's syndrome
    c. Down's syndrome
    d. Cri-du-chat syndrome
    e. D-G translocation
    f. Edward's syndrome
    g. Patau's syndrome

7. Interpretation of genetic formulae: Deletion, duplication, inversion and translocation.
8. Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.
9. Explore BLAST for nucleotide sequence comparison.
10. Explore the databases (Nucleotide, Protein) at NCBI for querying a nucleotide or protein sequence.
11. Exploring bibliographic database PubMed for downloading a research paper on subject of interest with the use of operators.

Course code: USZOP06: Course 18

1. Estimation of phosphates from sample water.
2. Estimation of BOD from sample water.
3. Estimation of COD from sample water.
4. Estimation of Nitrates from sample water.
5. Estimation of acidity and alkalinity of sample water by methyl orange and phenolphthalein indicator.
6. Comparative study of sound intensity in different places by Decibel meter.
7. Study of bioprospecting:
   a. Tumour suppression compounds e.g. Sponge.
   b. Skin erythema treatment from gel - *Aloe vera, Aloe ferox.*
8. Study of Zoopharmacognosy in ants, cats, elephants and dogs.
9. Indicate the distribution of fauna in the world map with respect to its realm and comment on the pattern of distribution.
   a. Palearctic: Giant Panda and Japanese Macaque
   b. Ethiopian: Common ostrich and African bush elephant
   c. Oriental: Indian one-horned Rhinoceros and Gharial
   d. Australian: Platypus and Red Kangaroo
   e. Neotropical: Guanaco and South American Tapir
   f. Nearctic: Virginia opossum and Sea otter
   g. Antarctic: Emperor Penguin and Antarctic Minke Whale
10. Excursion (Study tour / Visit) to Zoo / Sanctuary / National park / Research institute, etc. and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.

References and Additional Reading for Semester VI

Course 15

REFERENCES

- Modern text book of Zoology - Vertebrates; Professor R.L. Kotpal; Rastogipublication; Third Edition 2012.
- Vertebrate Zoology for Degree students; V. K. Agarwal; S. Chand Publication; 2012.
- Fundamentals of Zoology, Dr. K. C. Ghosh and Dr. B. Manna, New Central book Agency (P) Ltd.
- Chordate Zoology Volume II, Prof. N. Arumogam. Saras Publication.
- Chordate Anatomy Mohan P. Arora, Himalaya Publishing House, First edition.
- The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press; Third edition, 2006
- Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar; Campus Book International, First edition, 2005.
- Introduction to Zoology - Vol II: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book Agency.
- URL for search on net: https://www.amazon.com/Protozoology-Susheel-Vilas-Nikam/dp/9350300044.
- Chordate Zoology by E. L. Jordan and P. S. Verma, edition,2009, Chand publications.
- Chordate Zoology by P. S. Verma, edition,2009, Chand publications.
- Modern Textbook of Zoology Vertebrates by R.L. Kotpal, edition Jan 2015, Rastogi publications.
- Practical Zoology: Vertebrate, by S. S. Lal, 2015.
- A Textbook of Invertebrate Zoology & Cell Biology, by V. S. Kanwate, A. N. Kulkarni et al. ed. Alka Prakashan.
- The Animal Kingdom: An Elementary Textbook in Zoology; Specially Classified and Arranged for the Use of Science Classes, Schools and Colleges (Classic Reprint), by Ellis A. Davidson, Sept. 2015, Publisher: Forgotten Book.

ADDITIONAL READING

- http://faculty.collegeprep.org/~bernie/sciproject/project/Kingdoms/Animal%20Kingdom%20-%205/Local%20copy/classification/chordata.html
- http://www.ucmp.berkeley.edu/chordata/chordata.html
- http://animaldiversity.org/accounts/Chordata/
- https://www.earthlife.net/inverts/chordata.html
- http://www.nhc.ed.ac.uk/index.php?page=493.450
- https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/phylum-chordata
- http://www.nhptv.org/wild/chordata.asp
- https://www.shapeoflife.org/phylum-chordata-advanced

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- Comparative Animal Physiology; William S Hoar.
- Text book of Comparative Physiology; R Nagabhushanam, Ms Kodarkar, Sarojini R. India Book House Pvt. Ltd.
- Animal Physiology; N. Arumugam, A. Mariakuttikan; Saras Publication.
- Text book of Endocrinology; Williams .
- Textbook of Endocrinology Hardcover; Dharmalingam; 2010.
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LEARNERS' SPACE

Course 15

1. Organize a lecture and interaction of an expert working in the field of vertebrate study like wild photography, research project etc.
2. Collect information on phylogeny and geological time scale.
3. Did you notice that the number of frogs or earthworms is decreasing? Find out the probable reasons.
4. Comprehend the benefits of frog to farmer.
5. Study the reasons of extinction of dinosaurs
6. Enlist names of extinct birds.
7. Find out the reasons the *Archaeopteryx* is a connecting link between reptiles and birds.
8. Name the largest terrestrial and aquatic mammal.
9. List the scientific names of sharks found in Indian Ocean.
10. Study how is the age of the fossil decided.

Course 16

1. Elucidate on the Nobel Prize winning research work in the field of enzymology.
2. Study Eadie-Augustinsson plot and Hanes-Woolf plot of enzyme kinetics.
3. Make a report of isoenzymes (other than LDH) and their role in human body.
4. Kangaroo rats do not need to drink water at all. Explore the reason.
5. Collect information on:
   - Allen's rule
   - Bergman's rule
   - Gloger's rule
   - Jordan's rule
   - Rensch's rule
6. Review the mechanism and role of hormones like ecdysone and juvenile hormone in invertebrates.
7. Pineal gland has received attention as a 'mystery gland'. Find the reasons for it.
8. Prepare a report on therapeutic applications of hormones.
9. Present an account on recent advances in animal tissue culture.
10. 'HeLa' cells make the oldest immortal human cell line. Trace its history and significance.
11. Compare mortal and immortal cell lines.

Course 17

1. Study various types of genetic recombination. Explain any one mechanism.
2. Enlist enzymes involved in the central dogma of molecular biology. Comment on the specific biochemical reaction they catalyze.
3. Collect the information on satellite DNA. Discuss several forms of DNAs.
4. Give significance of telomere.
5. Gain information on chimeric DNA. Give its applications.
6. Comment on gene splicing.
7. Explore DNA microarray applications.
8. Comment on role of transgenic bacteria in pharmaceuticals.
9. Give interesting output of HGP.
10. Give examples of lysosomal storage disorders.
11. Explore information on lethal genes and jumping genes.
12. Enlist the variations in BLAST and FASTA.
13. Find the structure of a protein of your choice using UNIPROT.
14. Give role of bioinformatics in clinical biology.

15. Browse through website OMIA.

Course 18

1. Find out the role of an ISO 14001 environmental management system.
2. Explain environmental audit and carbon footprint.
3. Collect information on life cycle assessment (LCA) as an environmental management tool.
4. Collect the information about institutes those provide environmental management education.
5. Find out the role of industries such as TATA steel in environmental management.
6. Explain the benefits of environmental monitoring for an industry.
7. Comment on ethics of Wildlife Management and Conservation.
8. Role of WTI in wildlife research and management.
9. Comment on Sustainable Wildlife Management (SWM).
10. Convention on Biological Diversity (CBD)
11. Find the following:
    - Bioprospecting and Maya ICBG controversy.
    - Contribution of Babu Kalunde in self-medication.
12. Link the study of human evolution with Zoopharmacognosy.
13. Explain Wallace's Line and Weber's line.
14. Role of zoogeography in speciation.
15. List the animal species which exhibit homing instincts.

***Note - The practicals may be conducted by using specimens authorized by the wild life 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 regulation of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.**

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees:

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
2) A Dissection Monitoring Committee (DMC) to ensure that no dissections are done.

Composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener / Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of related department from the same College
iv) One or two members of related department from neighbouring colleges.

Use of animals for any experiment / dissection /mounting is banned. Simulations, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

Scheme of Examination (Theory and Practical)

(a) External assessment of one hundred (100) marks per course per semester should be conducted as per the following skeleton question paper pattern.

(c) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.

SKELETON- EXAMINATION PATTERN (THEORY)

Time: 3 hours **Total marks: 100**

Q1	Based on Unit 1	20 marks
Q.2.	Based on Unit 2	20 marks
Q.3.	Based on Unit 3	20 marks
Q.4.	Based on Unit 4	20 marks
Q.5.	Based on all four Units	20 marks

***Internal option scheme shall be followed from time to time as per university guidelines for T. Y. B. Sc.**

T. Y. B. Sc. Zoology: Semester V (Practical)
Course Code: USZOP05: Course 11

Skeleton of Practical Examination Question Paper

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1	Sepia: Sketch and label _____ system. (Digestive / Reproductive system / Nervous system) **OR** Identify and Describe: a, b & c (Jaws / Radula / Chromatophores / Spermatophores / Statocyst) **OR** Perform virtual dissection of _____ system.	09
Q.2.	Identify and classify giving reasons: a) Protozoa / Porifera / Cnidaria b) Platyhelminthes / Nematoda c) Annelida / Arthropoda d) Mollusca / Echinodermata	12
Q.3	Identify, classify and describe a) Acanthocephala / Chaetognatha / Onychophora b) Hemichordata c) Observe the animal* (photo/existing preserved specimen) and identify phylum giving reasons. *A suitable animal which is not prescribed in the syllabus	09
Q.4	Field report - Submission and Discussion based on any one field visit which is attended by the student to avoid disparity due to financial constraints.	10
Q.5	Viva voce	05
Q.6	Journal	05

T. Y. B. Sc. Zoology: Semester V (Practical)
Course Code: USZOP05: Course 12

Skeleton of Practical Examination Question Paper

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1 Enumerate erythrocytes in the given sample and comment on clinical condition. 15

OR

Q.1 Enumerate leucocytes in the given sample and comment on clinical condition.

OR

Q.1 Present a report on differential count of leucocytes and comment on clinical condition.

Q.2 Estimate total plasma proteins by Folin's method. 10

OR

Q.2 Estimate serum/plasma total triglycerides by Phosphovanillin method.

Q.3 Estimate haemoglobin by Sahli's acid haematin method. 10

OR

Q.3 Record Erythrocyte Sedimentation Rate by Westergren / Wintrobe method.

OR

Q.3 Determine serum LDH by colorimetric/spectrophotometric method.

Q.4 Perform Latex agglutination test - Rheumatoid Arthritis. 05

OR

Q.4 Record bleeding / clotting time and comment on clinical significance.

Q.5 Viva voce 05

Q.6 Journal 05

T. Y. B. Sc. Zoology: Semester V (Practical)
Course Code: USZOP05: Course 13

Skeleton of Practical Examination Question Paper

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1	Demonstrate the effect of CCl_4 on the level of enzyme activity of aspartate/ alanine amino transferase / alkaline phosphatase in liver (*in vitro* approach)	10
Q.2	From the infiltrated tissue prepare block, trim and mount it on the block holder.	09
	OR	
Q.2	Mount the ribbon on slide from the given block.	
	OR	
Q.2	Stain the given histological slide and identify the tissue.	
Q.3	Identify and describe a, b, c, d. a) & b) based on study of mammalian tissues c) & d) based on diseases or conditions	08
Q.4	Interpret the pathological report - blood / urine / stool.	05
Q.5	Problems in Biostatistics (Any one)	08
Q.6	Viva voce	05
Q.7	Journal	05

T.Y.B. Sc. Zoology: Semester V (Practical)
Course Code: USZOP05: Course 14

Skeleton Question Paper for Practical Examination

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1	Make a temporary mounting of chick embryo (up to 48 hours)	10
Q.2	Identify and describe a) and b) Based on integumentary system c) and d) Based on forelimb muscle e) and f) Based on hind limbs muscle g) and h) Based on osteology - human axial skeleton i) Based on osteology - human appendicular skeleton j) Chick embryo up to 72 hours	30
Q.3	Viva-voce	05
Q.4	Journal	05

T. Y. B. Sc. Zoology: Semester VI (Practical)
Course Code: USZOP06: Course 15

Skeleton of Practical Examination Question Paper

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1	Identify, classify giving reasons a) Urochordata / Cephalochordata / Ostachodermi / Cyclostomata b) Observe the animal* (photo/existing preserved specimen) and state its class giving reasons. * The animal should be other than prescribed in the syllabus	06
Q.2.	Identify, classify and describe a) Pisces b) Amphibia c) Reptilia d) Aves e) Mammalia	15
Q.3	Study of shark with the help of Specimen / Photograph / Simulation (Digestive system / Urinogenital system / Heart and aortic arches)	06
Q.4	Identify, sketch and label / Identify and describe marked portion in given diagram Skull or vertebra of shark / Fin of shark (Pectoral / Pelvic) / Girdle of shark (Pectoral / Pelvic)	03
Q.5	Field report - Submission and Discussion based on any one field visit which is attended by the student to avoid disparity due to financial constraints.	10
Q. 6	Viva Voce	05
Q.7	Journal	05

T. Y. B. Sc. Zoology: Semester VI (Practical)
Course Code: USZOP06: Course 16

Skeleton of Practical Examination Question Paper

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1 Demonstrate the effect of _____ on the activity of acid phosphatase (Substrate concentration / pH variation / Enzyme concentration / Inhibitor concentration) 15

OR

Q.1 Perform trypsinization and show the isolated cells using suitable vital stain.

Q.2 Separate LDH isozymes from the given sample by agarose / polyacrylamide gel electrophoresis 10

OR

Q.2 Demonstrate the packaging of glassware for tissue culture (any 3)

OR

Q.2 Demonstrate the technique of aseptic transfer.

Q.3 Identify and describe a, b, c, d, e 15
a to d: Slides / Photographs of based on histology of endocrine glands
e: Instruments for tissue culture (any one)

Q.4 Viva voce 05

Q.5 Journal 05

T. Y. B. Sc. Zoology: Semester VI (Practical)
Course Code: USZOP06: Course 17

Skeleton of Practical Examination Question Paper

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1	Isolation & Estimation of RNA by Orcinol method. **OR** Isolation & Estimation of DNA by Diphenylamine method.	15
Q.2	Separation of Genomic DNA by Agarose gel electrophoresis. **OR** Colorimetric estimation of proteins from given sample by Folin's method.	09
Q.3	Problems based on Restriction endonucleases (any two). **OR** Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells. **OR**	08
Q.3a	Analyse the given syndrome and comment on numerical and/or structural variations in chromosomes.	04
Q.3b	Interpretation of a genetic formula.	04
Q.4	Demonstrate the use of bioinformatics tool: BLAST for nucleotide sequence comparison. **OR** Databases at NCBI for querying a nucleotide / protein sequence with the help of suitable operator. **OR** PubMed for downloading a research paper of interest with the help of suitable operator.	08
Q.5	Viva voce	05
Q.6	Journal	05

T.Y. B. Sc. Zoology: Semester VI (Practical)
Course Code: USZOP06: Course 18

Skeleton Question Paper for Practical Examination

Time: 9.30 AM to 2.30 PM **Total Marks: 50**

Q.1	Estimation of BOD / COD / nitrates from the given water sample	10
Q.2	Estimation of phosphates / acidity / alkalinity of sample water.	08
Q.3	Identification a) Based on bioprospecting (*Sponge / Aloe ferox / Aloe vera* - any one) b) Zoopharmacognosy (ants, cats, elephants and dogs - any one)	06
Q.4	Identify the given animals with respect to their realms and comment (any two).	06
Q.5	Study tour Visit Report - Submission and Discussion based on any one field visit which is attended by the student to avoid disparity due to financial constraints.	10
Q.7	Journal	05
Q.6	Viva voce	05

Research Project (Optional with Additional Credits)
Course Code: USZOR01 and USZOR02

There shall be a component of 'Research Project' which will be optional, catering to the needs of the advanced learners and those desirous of pursuing higher studies and / or career in research. Since Research Project is optional, its credits are in addition to the credits otherwise allotted to B.Sc. program in Zoology. The credits of Research Project shall therefore be considered as additional credits, performance of which shall be separately evaluated. Needless to say that the marks / GPA / grade obtained by the learner in the Research Project shall appear separately in the marksheet or shall be certified separately by the University of Mumbai in both the semesters viz. Semester V and Semester VI. These marks shall not be added to the total / grand total of the program and shall not be considered for class / Grade / GPA / merit / rank towards this program of the University of Mumbai. Research Project shall be evaluated by allotting duty to the examiners at a centre / centres in each district where the learners who have completed the projects shall be invited for assessment on a day scheduled for the purpose by the Chairman of Practical Examinations who would plan, coordinate and notify the same officially through the University. The remuneration for assessment of the Research Project shall be as decided by the University from time to time.

The learners may seek guidance for the research work from a mentor who could be a teacher from his/her college or any other college or from the industry; though it is not mandatory to have a mentor since Research Project can also be done independently, However no leniency will be shown during assessment to maintain quality defining the candidate as advanced learner. Assessment will be based on the spiral bound Proposal submitted in Semester V and Dissertation submitted in Semester VI along with *Viva voce* conducted by the examiner, details of which shall be as follows:

In semester V the learners will submit an outline / scheme / project proposal to be evaluated by the external examiner. Evaluation will be based on the following guidelines such as Literature Search / Survey, Objectives, Work plan, Materials and Methods, Rationale, Hypothesis, Expected Outcome, Relevance and Bibliography, etc., as presented in the spiral bound research proposal which shall carry 25 marks, in Semester V. *Viva voce* conducted by the concerned external examiner on the said proposal shall carry 25 marks. Learner may opt for PowerPoint presentation on the said research proposal, if desired. Thus Research Proposal shall carry total 50 marks with a credit of (01), in Semester V.

Actual execution / practical work of this project will be completed before the Semester VI examination. The external examiner will evaluate the 'Printed Dissertation' in Semester VI, carrying 25 marks based generally on guidelines such as Abstract / Synopsis, Materials and methods, Observations, Interpretations of Results, Discussion, Conclusion and Relevance of work, Recommendation, Future scope, etc., incorporated in the Dissertation. *Viva voce* conducted by the external examiner based on the dissertation presented with the PowerPoint presentation or otherwise shall carry 25 marks. Thus Research Project with dissertation shall carry 50 marks having credit of (01) in semester VI.

A list of the candidates offering the project and the titles of their respective project should be forwarded by the College along with the examination application form in SEM-V and SEM-VI.

The total credits (02) of Research Project in Semester V and Semester VI, are additional and may be transferred to the other relevant program and/or for post-graduation program, if desired by the learner, wherever applicable and if permitted by the ordinances of the University of Mumbai, as prescribed therein, if promulgated.