

UNIVERSITY OF MUMBAI



Syllabus for F.Y.B.Sc. Program BSc Course: ZOOLOGY

Semester I and II

(Credit Based Semester and Grading System
with effect from the academic year 2015–2016)

Syllabus Committee Members

Dr. Anil S. Singh	-	Convenor
Dr. Manisha Kulkarni	-	Co-convenor
Dr. Jyotsna Mahale	-	Co-convenor
Dr. Meenakshi Sundaresan	-	Co-convenor
Prof. Lata Sardesai	-	Co-convenor
Prof. P.C. Mathew	-	Co-convenor
Dr. Dilip Kakavipure	-	Co-convenor
Dr. V.M. Patole	-	Co-convenor
Dr. Kantilal H. Nagare	-	Co-convenor
Prof. Shanta Janyani	-	Co-convenor
Dr. S. Rangoonwala	-	Co-convenor
Dr. Minakshi Gurav	-	Member (Teacher)
Dr. Shirley B. Agwuocha	-	Member (Teacher)
Dr. Vishakha Shingala	-	Member (Teacher)
Dr. Gayathri N.	-	Member (Teacher)
Dr. Ansariya Rana	-	Member (Teacher)
Dr. Aditya S. Akerkar	-	Member (Teacher)
Dr. Shashikala Prajapati	-	Member (Teacher)
Dr. R.B. Singh	-	Member (Teacher)
Prof. Nitin Wasnik	-	Member (Teacher)
Prof. Nikhil C. Disoria	-	Member (Teacher)
Ms. Purva S. Prabhu	-	Member (Student)
Ms. Sachi R. Mayekar	-	Member (Student)
Ms. Neha Vajandar	-	Member (Student)
Ms. Payal A. Shah	-	Member (Student)
Ms. Anuradha Gaikar	-	Member (Student)
Ms. Sonal S. Prabhulkar	-	Member (Student)

Syllabus for FYBSc Course – ZOOLOGY

1. Preamble
2. Pedagogy
3. Syllabus Semester I & II
4. References and Additional Reading
5. Scheme of Examination and Paper Pattern
6. Distribution of periods
7. Model Question bank

Aims

- To nurture interest in the students for the subject of Zoology
- To create awareness of the basic and modern concepts of Zoology
- To orient students about the importance of abiotic and biotic factors of environment and their conservation.
- To provide an insight to the basic nutritional and health aspects of human life.
- To inculcate good laboratory practices in students and to train them about scientific handling of important instruments.

Preamble

While presenting this new syllabus to the teachers and students of Semester I and Semester II (F.Y.B.Sc.) Zoology, I am extremely happy to state that for the first time efforts have been made to seek inputs of all the stake holders to make it more relevant.

In the first meeting of the Board of Studies an apex committee was formed to study syllabi worldwide with a view to include modern modules and plan semesters at UG and PG programs in advance to avoid overlapping and duplication of topics in various courses.

Meeting with the industry at the Indian Merchants' Chamber and with the meritorious alumni helped adding need based components. For the first time students were a part of the syllabus committee and the process became participative when the draft was finalized in an open meeting with all the Zoology teachers after having sought democratic criticism on the proposed syllabus placed on the University website for about one month.

While following the guidelines of UGC, use of animals is excluded from the practicals, substituting the same with audiovisual, ICT and simulation aids and that the syllabus is made more interesting with new, innovative topics. Providing the pedagogy as also indicating objectives and desired outcome of every topic for the teachers, and question bank for the students apart from the question paper pattern became an integral part of the syllabus, therefore.

Care is taken to provide the drafts from time to time and declare the final syllabus well in advance enabling the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The success of this revamped syllabus will depend totally on the enthusiasm of the teachers which is very high all throughout the process and their hands will be strengthened by publishing the University text books for the first time. This curriculum of the Zoologists, for the Zoologists and by the Zoologists developed with the united efforts will take our ever progressive subject to greater heights in the years to come.

- VINAYAK DALVIE, Chairman, BOS in Zoology

**Syllabus for
FYBSc.
Course – ZOOLOGY
To be implemented from Academic year 2015-16
SEMESTER - I**

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USZO101	I	Wonders of animal world	2	1
	II	Biodiversity and its conservation		1
	III	Footsteps to follow		1
USZO102	I	Laboratory safety and Units of Measurement	2	1
	II	Animal Biotechnology		1
	III	Instrumentation		1
USZOP1	Practical based on both courses		2	6

SEMESTER - II

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USZO201	I	Population Ecology	2	1
	II	Ecosystem		1
	III	National park and Sanctuaries		1
USZO202	I	Nutrition and Health	2	1
	II	Public health and Hygiene		1
	III	Common human Diseases		1
USZOP2	Practical based on both courses		2	6

SYLLABUS F.Y.B.Sc. ZOOLOGY
UNIT WISE DISTRIBUTION

Semester I		Semester II	
Course 1	Course 2	Course 3	Course 4
Unit 1 Wonders of animal world	Unit 1 Laboratory Safety and Units of Measurement	Unit 1 Population Ecology	Unit 1 Nutrition and Health
Unit 2 Biodiversity and its Conservation	Unit 2 Animal Biotechnology	Unit 2 Ecosystem	Unit 2 Public Health and Hygiene
Unit 3 Footsteps to follow	Unit 3 Instrumentation	Unit 3 National Parks and Sanctuaries	Unit 3 Common Human Diseases
Practical (USZO P1)	Practical (USZO P1)	Practical (USZO P2)	Practical (USZO P2)

PEDAGOGY

F.Y.B.Sc. Syllabus

First year B.Sc. course is the entry point for the students to undergraduate classes which acts like a guiding force for them to make up their mind in selecting a subject they would wish to pursue their studies in future for carving their career in a particular field.

The syllabus committee in the subject of Zoology for F.Y.B.Sc. Class has designed this syllabus with a view that it is most appropriate time when we transform our traditional closed classroom teaching learning practices to more of field and activity based studies, the correct methodology for the study of Natural Sciences. It is recommended to orient the students about ecosystem, bio-diversity, wildlife conservation and management with the help of models, photographs, movies, documentaries, charts and use of ICT and then take learners to field to have realistic experiences. This will enable them to get true insight about endurance of animal life in relation to human activity inducing sentiment of love, care and protection in the young mind and heart leading to understand importance of co-existence and conservation of bio-diversity. An interaction with the officials of wildlife protection force should be allowed to get basic knowledge about the relevant acts through lectures which for creating awareness about these issues and also to make best use of the knowledge in their own interest as well as for the country. Instrumentation and Animal Biotechnology component would initiate academia- industry interface and should be edified in collaboration with expertise from relevant research institutes and industrial establishments and entrepreneurs by inviting them as guest speakers or through industrial visits, excursions for practical experience about the principle, working and application of the instruments for commercial use. Population ecology need to be explained in the context with census to enlighten pupils about the effect of diversity and dynamism of human population on socio economic status of India. Experts from the field of nutrition and health can be invited to enlighten learners on the topics of nutritional value of food, balanced diet, ill-effects of eating junk food and aerated drinks. Medical professionals, relevant NGO's maybe engaged to educate students regarding myth, precautionary measures, immunization drives of common diseases, ill-effects of self-medication and stress, significance of BMI through series of programmes. During medical emergencies it is of immense importance to provide first aid assistance to the diseased within the golden period i.e. of few minutes. This enhances the possibility to save life, thus it is strongly recommended to form a consortium of colleges to conduct training in rotation of first aid techniques for teachers and students both with the help of organizations like Red Cross Society, Health Department of Civic Bodies, Civil Defence Department and Local Self Government etc.

Dr. Anil S. Singh
Convenor

F.Y.B.Sc. ZOOLOGY

(THEORY)

SEMESTER I

USZO101 (Course 1)

Wonders of Animal World, Biodiversity and its Conservation

Unit 1: Wonders of Animal World (15 L)

Objective: To take learners through a captivating journey of hoarded wealth of marvellous animal world.

Desired Outcome: Curiosity will be ignited in the mind of learners, to know more about the fascinating world of animals which would enhance their interest and love for the subject of Zoology.

- 1.1: Echolocation in Bats and Cetaceans - Dolphins and Whales
- 1.2: Mechanism of Pearl formation in Mollusca
- 1.3: Bioluminescence in Animals: Noctiluca, Glow worm, Firefly, Angler Fish (Mechanism and use for the animal)
- 1.4: Regeneration in Animals - Earthworm (Annelida) and Lizard (Reptile)
- 1.5: Mimicry in Butterflies and its significance: Great Eggfly and Common Crow, Common Palmfly and Plain Tiger.
- 1.6: Mechanism of Coral formation and types of Coral reefs
- 1.7: Bird migration: Definition, types and factors inducing bird migration
- 1.8: Adaptive features of desert animals: Reptiles (Phrynosoma) and Mammals (Camel)
- 1.9: Breeding and Parental care in:
 - 1.9.1: Pisces - Ovo-viviparous (Black Molly/Guppy), Mouth brooders (Tilapia), Brood pouches (Sea horse)
 - 1.9.2: Amphibia - Mouth brooders (Darwin's Frog), Egg carriers (Midwife Toad)

1.9.3: Mammals - Egg-laying (Duck-billed Platypus), Marsupials (Kangaroo)

1.10: Aves: Brood Parasitism (Cuckoo)

Unit 2: Biodiversity and its Conservation (15 L)

***Objective:** To orient learners about rich heritage of Biodiversity of India and make them understand significance of its conservation.*

***Desired Outcome:** Learners would appreciate treasure of Biodiversity, its importance and hence would contribute their best for its conservation.*

2.1: Introduction to Biodiversity - Definition, Concepts, Scope and Significance

2.2: Levels of Biodiversity - Introduction to Genetic, Species and Ecosystem Biodiversity

2.3: Introduction of Biodiversity Hotspots- (Western Ghats and Indo-Burma Border)

2.4: Values of biodiversity - Direct and Indirect use value

2.5: Threats to Biodiversity - Habitat loss and Man-Wildlife conflict

2.6: Biodiversity conservation and management

2.6.1: Conservation strategies: *in situ*, ex-situ, National parks, Sanctuaries and Biosphere reserves.

2.6.2: Introduction to International efforts : Convention on Biological Diversity (CBD), International Union for Conservation of Nature and Natural Resources (IUCN), United Nations Environment Program - World Conservation Monitoring Centre (UNEP-WCMC)

2.6.3: National Biodiversity Action Plan, 2002

- 2.6.4: Introduction to Indian Wildlife (Protection) Act, 1972 and Convention for International Trade of endangered species

Unit 3: Footsteps to follow (15 L)

Objective: To teach learners about innovative and novel work of scientists/philosopher/entrepreneurs in the field of biological sciences.

Desired Outcome: Minds of learners would be impulsed to think differently and would be encouraged ipso facto to their original crude ideas from the field of biological sciences.

- 3.1: Dr. Hargobind Khorana (Genetic code)
- 3.2: Dr. Varghese Kurien (Amul –White revolution)
- 3.3: Dr. Salim Ali (Ornithologist)
- 3.4: Anna Hazare (Water Conservation-Ralegan Siddhi)
- 3.5: Baba Amte (Anandvan)
- 3.6: Kiran Mazumdar Shaw (Biocon)
- 3.7: Gadre Fisheries (Surimi)

Two cases preferably of local importance to the college be additionally taught.

USZO102 (Course 2)

INSTRUMENTATION and ANIMAL BIOTECHNOLOGY

Unit 1: Laboratory safety, Units and Measurement (15 L)

Objective: To make learners aware of risks involved in handling of different hazardous chemicals, sensitive (electrical/electronic) instruments and infectious biological specimens especially during practical sessions in the laboratory and to train them to avoid mishap.

Desired Outcome: Learners would work safely in the laboratory and avoid occurrence of accidents (mishaps) which will boost their scholastic performance and economy in use of materials/chemicals during practical sessions.

1.1: Introduction to good laboratory practices

1.2: Use of safety symbols: meaning, types of hazards and precautions

1.3: Units of measurement:

1.3.1: Calculations and related conversions of each: Metric system- length (meter to micrometer); weight (gram to microgram), Volumetric (Cubic measures)

1.3.2: Temperature: Celsius, Fahrenheit, Kelvin

1.3.3: Concentrations: Percent solutions, ppt, ppm, ppb dilutions, Normality, Molarity and Molality.

1.3.4: Biostatistics: Introduction and scope, Sampling and its types, Central Tendencies (mean, median, mode) Tabulation, Graphical representations (Histograms, bar diagrams, pie diagrams).

Unit 2: Animal Biotechnology

(15 L)

Objective: *To acquaint learners to the modern developments and concepts of Zoology highlighting their applications aiming for the benefit of human being.*

Desired Outcome: *Learners would understand recent advances in the subject and their applications for the betterment of mankind; and that the young minds would be tuned to think out of the box.*

2.1: Biotechnology: Scope and achievements of Biotechnology (Fishery, Animal Husbandry, Medical, Industrial)

2.2: Transgenesis: Retro viral method, Nuclear transplantation method, DNA microinjection method and Embryonic stem cell method

2.3: Cloning (Dolly)

2.4: Ethical issues of transgenic and cloned animals

2.5: Applications of Biotechnology:

2.5.1: DNA fingerprinting: Technique in brief and its application in forensic science (Crime Investigation)

2.5.2: Recombinant DNA in medicines (recombinant insulin)

2.5.3: Gene therapy: Ex-vivo and *In vivo*, Severe Combined Immunodeficiency (SCID), Cystic Fibrosis

2.5.4: Green genes: Green Fluorescent Protein (GFP) from Jelly fish-
valuable as reporter genes used to detect food poisoning.

Unit 3: Instrumentation

(15 L)

***Objective:** To provide all learners a complete insight about the structure and train them with operational skills of different instruments required in Zoology.*

***Desired Outcome:** Students will be skilled to select and operate suitable instruments for the studies of different components of Zoology of this course and also of higher classes including research.*

3.1: Microscopy

3.1.1: Construction, principle and applications of dissecting and compound microscope.

3.2: Colorimetry and Spectroscopy - Principle and applications.

3.3: pH - Sorenson's pH scale, pH meter - principle and applications.

3.3: Centrifuge - Principle and applications (clinical and ultra centrifuges).

3.4: Chromatography - Principle and applications (Partition and Adsorption)

3.5: Electrophoresis - Principle and applications (AGE and PAGE)

SEMESTER I
Practical USZOP1 (Course I)

1. Mounting of foraminiferan shells from sand (any 3)
2. Study of types of Corals - Brain, Organ pipe, Stag Horn, Mushroom coral Study of
3. Study of the following;
 - a. Symbiosis (Termite and Trychonympha, hermit crab and sea anemone)
 - b. Camouflage (leaf insect, chameleon)
 - c. Cannibalistic mate-eating animals (Spider and Praying Mantis)
 - d. Animal architects: Termites, Harvester ant and Baya weaver bird
 - e. Study of bioluminescent organisms – Noctiluca, glow worm, fire fly, angler fish.
4. Breeding and parental care in Amphibia- *Rhacophorus*, Midwife toad, Darwin's frog, Caecilian.
5. Mounting of scales of fish (placoid, cycloid and ctenoid)
- 6
 - a) Study of Adaptive radiation in Reptiles - Turtle, Tortoise, *Phrynosoma*, *Draco*)
 - b) Identification and differentiation of venomous and non-venomous snakes (Scales, Fangs, Bite marks, etc.)
7. Study of Types of feathers(contour, filoplume, down), beaks(Nectar feeding , Insect catching, Fruit eating, Scavenging, Filter feeding), claws (perching, wading, swimming, hopping) in birds
- 8
 - a. Identification of birds - Coppersmith Barbet, Bulbul, Rose ringed Parakeet, Magpie Robin, two local birds.
 - b. Field Report – To be done in a group of ten students (submission of written / typed report preferably along with photographs/ tables/ graphs.

Other Suggested topics for field observation/survey:

- Butterflies/ Fishes/ Migratory birds of local area.
 - Variations in Human like Attached vs. Free Earlobes, Blood Groups, Eye colour, etc. using statistical method.
9. Observations of fauna in the field (with reference to theory syllabus).

***Note - The practicals may be conducted by using specimens authorised by the wild such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. Specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

#There shall be at least one excursion/field trip

SEMESTER I

Practical USZOP1 (Course II)

- Interpretation of safety symbols (toxic, corrosive, explosive, flammable, skin irritant, oxidizing, compressed gases, aspiration hazards and Biohazardous infectious material.)
1. b) Study of Central tendencies and plotting of Bar diagram, histogram and pie diagram.
 2. Identification of transgenic fish (Trout and Salmon) / cloned animals (Dolly sheep, cc cat and Snuppy dog) from photograph.
 3. Extraction of fruit juice with pectinase from apple/guava/or any other suitable fruit
 - Calculation of pH of three different samples (one each acidic, alkaline and neutral) using pH paper/Universal Indicator and confirming the result with pH meter.
 4. Application of DNA Fingerprinting in criminology (photograph of electrophoretic pattern to be given for interpretation by the students)
 5. a) Study of parts of microscope and their functions.
b) Technique of focussing a permanent slide under 10x and 45x (objectives).
 6. a) Dilution of given sample and estimation of OD by using colorimeter.
b) Calculation of concentration from the given OD using formula.
 - Calculation of pH of three different samples (one each acidic, alkaline and neutral) using pH paper/universal indicator/pH indicator from red cabbage and confirming the result with pH meter.
 7. a) Separation of amino acids from the mixture by paper chromatography.
b) Calculation of R_f value of separated pigments/amino acids from given chromatogram and their identification from standard chart.
 8. a) Separation of pigments by adsorption chromatography using chalk.
b) Separation of lipids by TLC,
 - 9.

***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 as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

Course I (USZO101)

REFERENCES AND ADDITIONAL READING

1. Wonders of the Animal World - University Text Book of Zoology, F.Y.B.Sc. Semester I Course 1. V.V. Dalvie, G.B. Raje, P. Sardesai, N.S. Prabhu, University Press.
2. Vertebrate Zoology Volume I- Jordan and Verma , S. Chand and Co.
3. Invertebrate Zoology Volume II- Jordan and Verma , S. Chand and Co.
4. Invertebrate Zoology- T. C. Majumuria , S. Nagin and Co.
5. Chordate Zoology- P. S. Dhami and J. K. Dhami , R. Chand and Co.
6. Invertebrate Zoology- P. S. Dhami and J. K. Dhami , R. Chand and Co.
7. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition
8. Zoology- S. A. Miller and J. B. Harley, Tata McGraw Hill
9. Modern Textbook of Zoology, Invertebrates, R. L. Kotpal
10. Fundamentals of Ecology- E. P. Odum , Sanders Publication
11. Fundamentals of Ecology- M.C.Dash-2nd edition, Tata McGraw Hill
12. Essentials of Ecology and Environmental Science - S.V.S Rana
13. Biodiversity- S.V.S Rana- Prentice Hall Publications
14. Modern Biology- V. B. Rastogi
15. Biology of Mollusca- D. R. Khanna
16. A Textbook of Zoology, Vol. II- T. Jeffery Parker and William. A. Haswell- Low Price Publications
17. Ecology and Environment- P. D. Sharma, R. K. Rastogi Publications
18. Introduction to Ecology- R. Dajoz
19. Wildlife Laws and its Impact on Tribes- Mona Purohit , Deep and Deep Publications
20. Biodiversity- K.C.Agarwal- Agro Botanica Publications
21. Butterflies of India – Isaac Kehimkar- BNHS Publication

Course II (USZO102)

REFERENCES AND ADDITIONAL READINGS

1. Basic Laboratory Techniques, Instrumentation and Biotechnology- University Text Book of Zoology, F.Y.B.Sc. Semester I Course 2. V.V. Dalvie, R. G. Deshmukh, R. D'souza and H.U. Shingadia University Press.
2. Introduction to Practical Biochemistry – David T. Plummer (Tata McGraw Hill Publishing Co. Ltd.)
3. Introductory Practical Biochemistry – S.K. Sawhney and Randhir Singh (Narosa Publishing House)
4. Methods in Biostatistics – B. K. Mahajan, (Jaypee Publications)
5. Microscopy and Cell Biology - V. K. Sharma, (Tata McGraw Hill Publishing Co. Ltd.)
6. Bioinstrumentation – L. Veerakumari, (M.J.P. Publishers)
7. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker, (Cambridge University Press)
8. Biotechnology- Thieman and Pallidino, Pearson edu.
9. Biotechnology –Glick and Pasternak
10. Biochemistry –Satyanarayana
11. Understanding biotechnology- Aluizio Borem ,David Bowe-Low price edition –Pearson Publication
12. A Textbook of Biotechnology – R. C. Dubey, S. Chand Publication.
13. A Manual of Medical Laboratory Technology -A. H. Patel, Navneet Prakashan Ltd.
14. Biological instruments and methodology – Dr. P. K. Bajpai, S. Chand company Ltd.
15. Calculations in Molecular biology and Biotechnology - Frank H. Stephenson, Academic Press.

SCHEME OF EXAMINATION (THEORY)

- (a) Internal assessment of twenty five (25) marks per course per semester should be conducted according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.
- (b) External assessment of seventy five (75) 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: 2.5 hours

Total marks: 75

Q.1.	UNIT 1 Answer any four out of eight (5 marks each)	20 marks
Q.2.	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.3.	UNIT 3 Answer any two out of four (10 marks each)	20 marks
Q.4.	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)	15 marks

*For Question 4 it is recommended to have objective questions 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.

MODEL QUESTION BANK SEMESTER I
USZO101(COURSE I)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT 1 - (05 Marks)

1. Write a note on echolocation in Dolphins/ Whales
2. Write a short note on : Pearl formation in Mollusca
3. Describe : Mechanism of bioluminescence
4. Enumerate the uses of bioluminescence
5. Describe the uses of bioluminescence for..... (Noctiluca, Glow worm, Firefly, Angler fish, etc.)
6. Write a short note on : Luciferin – Luciferase interaction
7. Describe the process of regeneration in Earthworm
8. What is regeneration? Explain the term with an example
9. What is mimicry? Explain with an example.
10. Describe: mimicry in butterfly
11. Describe briefly the formation of Corals
12. Write a short note on types of coral reefs.
13. Describe needs of migration in birds.
14. Describe briefly, the factors inducing migration in birds.
15. How does Camel adapt itself to the desert environment?
16. Describe parental care and breeding in (Examples of Pisces, Amphibia)
17. Describe briefly: Brood parasite
18. Explain parental care in Duck-billed Platypus

UNIT 2 - (05 Marks/10 Marks)

Questions that could be asked for 10 marks:

1. Explain biodiversity and its importance. What is a biodiversity hotspot?
Explain Western Ghats as biodiversity hotspot in India.
2. Explain: Direct use value / Indirect use value
3. Explain biodiversity and its types.
4. Enumerate and explain threats to biodiversity.
5. State the factors which amount to habitat loss.
6. Explain the concept of Man-Wildlife conflict with an example.
7. Give a detailed account on *in situ* hybridization and ex-situ hybridization

8. Describe National Park and state its importance in conservation
9. Describe Sanctuary and state its importance in conservation
10. Give a brief account on biosphere reserve.
11. Give a detailed account on: CBD (Convention on Biological Diversity).
12. Give an account of national biodiversity plan 2002.
13. Describe important clauses of Convention for International Trade of endangered species.

Questions that could be asked for 05 marks:

1. Explain biodiversity and mention its types.
2. Explain biodiversity and give two importance
3. Explain biodiversity hotspot
4. Describe *in situ* conservation strategies.
5. Write note on ex-situ conservation strategies.
6. Give an account of genetic / species / ecosystem biodiversity.
7. Enumerate importance threat to biodiversity.
8. State direct and indirect use value of biodiversity.

UNIT 3 - (10 Marks)

1. Give a detailed account on:(Name of the eminent personality) For e.g.: Gadre Fisheries, Kiran Mazumdar Shaw, Baba Amte etc.
2. Describe in detail -(Name of the case study)
For e.g.: Amul white revolution, Biocon, Genetic code etc.
3. Give a detailed account on the contribution made by Dr.Salim Ali in the field of Ornithology.
4. What is white revolution? State contribution of Dr. Verghese Kurian for it.
5. Describe the work of water conservation of Anna Hazare.

MODEL QUESTION BANK SEMESTER I USZO102 (COURSE II)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT I: (5 marks)

1. Describe in brief (Minimum five points)
 - a. Good laboratory practices
 - b. Chemical hazards in a laboratory
 - c. Physical hazards in a laboratory
 - d. Biological hazards in a laboratory
 - e. Personal hygiene in laboratory
 - f. Waste disposal
2. Define and give conversions of the three scales of measuring temperature.
3. Define Molarity. How would you prepare
 - a. 1 litre of 0.1 M NaOH solution? (Mol.wt. of NaOH=40)
 - b. 100 ml of 1M NaOH
 - c. 500 ml of 0.2 M NaOH
4. Define Normality. How would you prepare 1 litre of 2 N NaOH solution?
5. Explain briefly the measures of central tendencies?
6. Define mean, median and mode and explain each with an example.
7. The observations of length (in cm) of 10 fishes are 22, 24, 34, 26, 28, 31, 20, 25, 36, 32. Calculate the arithmetic mean of fish length (in cm).
8. Calculate the arithmetic mean for the following data on fish length by Direct method.

Class interval (length in cm)	5-15	15-25	25-35	35-45	45-55
Frequency (no. of fish)	9	21	40	22	8

9. Calculate the arithmetic mean for the above data on fish length by shortcut method.
10. How do you find the median of the data and state the significance of median?
11. What is mode? How do you calculate mode for ungrouped and grouped data?
12. What is random sampling? State the significance.
13. Explain simple, subdivided and multiple bar diagrams.
14. What is a pie diagram? Write the formula for calculating the angles of degrees for different components.
15. The following data shows the areas in million square miles of the oceans of the world. Construct a pie diagram for the data.

Ocean	Pacific	Atlantic	Indian	Antarctic	Arctic	Total
Area (million sq. miles)	70.8	41.2	28.5	7.6	4.8	152.9

t

Plot a histogram/Bar diagram? Explain how it is constructed.

UNIT 2: (5 marks)

1. Give applications of Biotechnology in the field of Medicine / Fishery / Animal Husbandry.
2. Give the Scope of Biotechnology in different areas as a diagrammatic sketch
3. What is SCID? Name the scientist who discovered the gene therapy for it.
4. In SCID which enzyme does not work properly?
5. Which cells are used for SCID gene therapy?
6. Which gene is defective in SCID?
7. Define transgenesis and mention any two transgenic animals.
8. Ethical issues of transgenesis.
9. Enlist five applications of DNA finger printing.
10. What are green genes? State one application of it.

(10 marks)

1. Describe SCID and its treatment with suitable diagram.
2. Explain various methods of transgenesis.
3. What is Cystic fibrosis? Explain its diagnostic biotechnological method.
4. Define transgenesis and explain retro viral method with its application.

UNIT 3: (10 marks)

1. Describe the components of a compound microscope giving function.

2. Explain the principle and the applications of compound microscope.
3. Discuss in detail the principle, construction and applications of dissecting microscope.
4. Write the principle and applications of
 - a. Colorimeter
 - b. Centrifuge
 - c. Spectroscopy
 - d. Compound microscope
 - e. Dissecting microscope
5. Explain the principle of centrifugation and add a note on its application.
6. What is pH? Give the principle and applications of pH meter.
7. Describe paper chromatography as a separation technique.
8. Describe Agarose gel electrophoresis. Add a note on its applications.
9. Explain the principle and applications of Polyacrylamide gel electrophoresis.
10. With the help of a diagram, explain the parts of a colorimeter. Discuss the principle and uses.
11. Describe principle and uses of colorimeter.
12. Explain the principle and application of adsorption chromatography.

PRACTICALS
USZOP1 (Course I)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs

Marks: 50

- Q.1. From the given sample mount foraminiferan shells (Minimum three types) (15 Marks)
- OR
- Mounting of scales (placoid and cycloid/ctenoid) from fishes.
- Q.2. Identify the photograph of the given animals and comment on the type of interaction /speciality. (symbiosis, camouflage, cannibalistic mate eating animals and animal architects,bioluminescence). Any two (10 Marks)
- Q.3. Identify giving reasons - Venomous/Non-venomous snake (from photographs). (5 Marks)
- Q.4. Identification (one specimen each) (10 Marks)
- a. Types of corals
 - b. Amphibians-breeding and parental care
 - c. Adaptive radiation in reptiles
 - d. Types of feathers/ claws in birds
 - e. Types of beaks in birds
- Q.5. Field study report (Biodiversity) and viva on it. (10 Marks)

Semester I
USZOP1 (Course II)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs

Marks: 50

- Q. 1 Dilute the given sample and estimate the OD using colorimeter (Three dilutions) (15marks)
OR
Calculate concentration from given OD by formula (3 concentrations)
OR
Find pH of water samples (three) and comment on their chemical nature.
OR
Using red cabbage pH indicator, determine pH of the given samples and comment on their chemical nature
OR
Extract fruit juice using pectinase and compare the result with a set without using pectinase.
- Q. 2. Perform experiment for separation of pigments by adsorption chromatography. (10Marks)
OR
Perform experiment for separation of mixture of amino acids by paper chromatography
OR
Calculate R_f value and identify the pigment from chromatogram.
OR
Perform Thin Layer Chromatography (TLC) for separation of lipids
- Q. 3. Focus the given slide under 10 X and 45 X and show it to examiner. (5 Marks)
OR
Prepare a frequency distribution table / Plot histogram / Pie diagram / Bar diagram from the given data.
- Q. 4. Identification (10 Marks)
(Safety Symbols (two), parts of compound microscope, transgenic animals, DNA fingerprinting)
- Q. 5. Journal and Viva voce(on practical component) (10 Marks)

SEMESTER-II

USZO201 (Course: 3)

Ecology and Wildlife Management

Unit 1: Population ecology:

(15 L)

***Objective:** To facilitate the learning of population ecology, its dynamics and regulatory factors important for its sustenance.*

***Desired Outcome:** This unit would allow learners to study about nature of animal population, specific factors affecting its growth and its impact on the population of other life form.*

1.1: Population dynamics

- 1.1.1: Population density
- 1.1.2: Natality
- 1.1.3: Mortality
- 1.1.4: Fecundity
- 1.1.5: Age structure
- 1.1.6: Sex ratio
- 1.1.7: Life tables
- 1.1.8: Survivorship curves
- 1.1.9: Population dispersal and distribution patterns
- 1.1.10 Niche concept

1.2: Population growth regulation

- 1.2.1: Intrinsic mechanism – Density dependent fluctuations and oscillations
- 1.2.2: Extrinsic mechanism- Density independent, environmental and climate factors, population interactions

1.3: Population growth pattern

- 1.3.1: Sigmoid
- 1.3.2: J Shaped

1.4: Human census (India) – Concept, mechanism and significance

Unit 2: Ecosystem:

(15 L)

Objective: *To impart knowledge of different components of ecosystem and educate about essentials of coexistence of human beings with all other living organisms.*

Desired Outcome: *Learners will grasp the concept of interdependence and interaction of physical, chemical and biological factors in the environment and will lead to better understanding about implications of loss of fauna specifically on human being, erupting spur of desire for conservation of all flora and fauna.*

2.1: Concept of Ecosystems

2.1.1: Ecosystem - Definition and components

2.1.2: Impact of temperature on biota

2.1.3: Biogeochemical cycles (Water, Oxygen, Nitrogen, Sulphur)

2.1.4: Fresh water ecosystem – Lentic and Lotic

2.1.5: Food chain and food web in ecosystem (Fresh water and Grass land).

2.1.6: Ecological pyramids - energy, biomass and number.

2.1.7: Animal interactions (commensalism, mutualism, predation, antibiosis, parasitism)

Unit 3: National parks and Sanctuaries of India

(15 L)

Objective: *To enlighten learners about the current status of wild life conservation in India in the light of guidelines from different relevant governing agencies vis-à-vis with adversity of poaching and biopiracy.*

Desired Outcome: *Learners would be inspired to choose career options in the field of wild life conservation, research, photography and ecotourism.*

3.1: Concept of Endangered and Critically Endangered species using examples of Indian Wildlife with respect to National Parks and Wildlife

Sanctuaries of India (Sanjay Gandhi National Park, Tadoba Tiger Reserve, Corbett National Park, Kaziranga National Park, Gir National Park, Silent Valley, Pirotan Island Marine Park, Keoladeo Ghana National Park, Bandipur Sanctuary)

3.2: Management strategies with special reference to Tiger and Rhinoceros in India

3.3: Ecotourism

3.4: Biopiracy

SEMESTER-II

Course: 4 [USZO 202]

NUTRITION, PUBLIC HEALTH AND HYGIENE

Unit 1: Nutrition and Health

(15 L)

Objective: To make learners understand the importance of balanced diet and essential nutrients of food at different stages of life.

Desired Outcome: Healthy dietary habits would be inculcated in the life style of learners in order to prevent risk of developing health hazards in younger generation due to faulty eating habits.

- 1.1: Concept of balanced diet, dietary recommendations to a normal adult, infant, pregnant woman and aged.
- 1.2: Malnutrition disorders – Anemia (B₁₂ and Iron deficiency), Rickets, Marasmus, Goiter, Kwashiorkor (cause, symptoms, precaution and remedy).
- 1.3: Constipation, piles, starvation, acidity, flatulence, peptic ulcers (cause, symptoms, precaution and remedy).
- 1.4: Obesity (Definition and consequences).
- 1.5: Importance of fibres in food.
- 1.6: Significance of breast feeding.
- 1.7: Swine flu and Dengue (cause, symptoms, precaution and remedy).
- 1.8: BMI calculation and its significance.

Unit 2: Public Health and Hygiene

(15 L)

Objective: *To impart knowledge about source, quantum and need for conservation of fast depleting water resource and essentials of maintaining proper sanitation, hygiene and optimizing use of electronic gadgets.*

Desired Outcome: *Promoting optimum conservation of water, encouragement for maintaining adequate personal hygiene, optimum use of electronic gadgets, avoiding addiction, thus facilitating achievement of the goal of healthy young India in true sense.*

2.1: Health

2.1.1: Definition of Health, the need for health education and health goal.

2.1.2: Physical, psychological and Social health issues.

2.1.3: WHO and its programmes - Polio, Small pox, Malaria and Leprosy (concept, brief accounts and outcome with respect to India).

2.1.4: Ill effects of self-medication.

2.2: Water and water supply

2.2.1: Sources and properties of water.

2.2.2: Purification of water, small scale, medium scale and large scale (rapid sand filters)

2.2.3 : Water footprint (concept, brief accounts and significance).

2.3: Hygiene:

2.3.1: Hygiene and health factors at home, personal hygiene, oral hygiene and sex hygiene.

2.4: Radiation risk:

2.4.1: Mobile Cell tower and electronic gadgets (data of recommended level, effects and precaution).

2.5: First Aid:

2.5.1: Dog bite and its treatment.

2.6: Blood bank – Concept and significance

UNIT 3: Common Human Diseases and Disorders (15 L)

Objective: *To educate learners about causes, symptoms and impact of stress related disorders and infectious diseases.*

Desired Outcome: *Learners will be able to promptly recognize stress related problems at initial stages and would be able to adopt relevant solutions which would lead to psychologically strong mind set promoting positive attitude important for academics and would be able to acquire knowledge of cause, symptoms and precautions of infectious diseases.*

3.1: Stress related disorders

3.1.1: Hypertension, Diabetes type II, anxiety, insomnia, migraine, depression (cause, symptoms, precaution and remedy)

3.2: Communicable and non-communicable diseases

3.2.1: Tuberculosis and Typhoid

3.2.2: Hepatitis (A and B), AIDS, Gonorrhea and Syphilis

3.2.3: Diseases of respiratory system- Asthma, Bronchitis.

3.2.4: Oral Cancer

(Discuss cause/causative agents, symptoms, diagnostics, precaution /prevention and remedy)

SEMESTER II
Practical USZOP2 (Course III)

1. Interpretation of the given graphs/ tables and comment on pattern of population nature :
 - i. Survivorship curve
 - ii. Life tables
 - iii. Fecundity tables
 - iv. Age structure
 - v. Sex ratio
2. a) Calculation of Natality, Mortality, Population density from given data
b) Estimation of population density by capture recapture method
3. Interpretation of Growth curves (Sigmoid and J shaped)
4. Estimation of hardness from given water sample (tap water v/s well water)
5. Estimation of Free carbon dioxide (Free CO₂) from two different samples- aerated drinks(diluted) v/s tap water
6. Identification and interpretation of aquatic and terrestrial (Grassland) food chains and food webs
7. Construction of food chain/food web using given information/data.
8. a) Identification and interpretation of ecological pyramids of energy, biomass and number
b) Construction of different types of pyramid from given data.
9. Study of the following:
 - a) Endangered (Great Indian Bustard, Asiatic lion, Blackbuck, Olive Ridley sea turtle) and critically endangered species (Slender-billed vulture, Gharial, Malabar civet) of Indian wildlife and state reasons for their decline
 - b) Study Biodiversity hotspots using world map (Western Ghats and Indo-Burma)Study of sanctuaries, national parks, biosphere reserves in India with respect to its brand fauna (as listed in theory)

***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 as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

#There shall be at least one excursion/field trip

SEMESTER II
Practical USZOP2 (Course IV)

1. Qualitative estimation of Vitamin C by Iodometric method.
2. Study of microscopic structure of starch granules of different cereals (wheat, maize and jowar).
 3. a) Estimation of maltose from brown/white bread.
 - b) Moisture content from biscuits or other suitable food products.
4. Food adulteration Test:
 - a) Milk adulterants (starch and glucose), methylene blue reduction Test (MBRT).
 - b) Adulterants in Cheese, Butter, Jaggery, Ghee, Honey, Iodised Salt.
5.
 - a) Estimation of protein content of two egg varieties.
 - b) Study of efficacy of different antacids (any two antacids).
6. .Study of Human Parasites

Endoparasites - Protozoans (*Entamoeba*, *Plasmodium*),
Helminths (*Ascaris*, *Wuchereria*),
Ectoparasites (Head louse, tick) and Exoparasites (Bed bug, Mosquito).
7. Screening of anaemic/non-anaemic persons using CuSO_4 method.
8. First Aid – Demonstration Practical Training for teachers and students to be conducted by the experts from Redcorss, Civil defence, Civic authorities by individual institute or cluster colleges in rotation.
9. BMI analysis - Measurement of Height/ Weight and calculation of BMI using formula, preparation and submission of report. (10 students/ group-50 readings/group)

***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 as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

Semester II USZOP2 (Course III)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs

Marks: 50

Q.1. Estimate Hardness from given water samples and compare the results. (15 Marks)

OR

Estimate Free CO₂ from given samples and compare the results.

Q.2. Solve the given problems (using statistical approach wherever possible) based on (Any two) (10Marks)

Natality
Mortality
Sex Ratio
Fecundity
Population density

Q.3. Identify brand animals (Min. 4) and place them in their respective National parks/ Sanctuaries on the given map quoting reasons for their decline. (5 Marks)

OR

Mark National parks and Sanctuaries on the map of India and mention the name of their brand animals stating reason for their decline. (Min. 4)

(5 Marks)

OR

Identify endangered and critically endangered animals (photographs) one each and state their reason of decline (5 Marks)

Q.4. Study the given information and give answers on the basis of food chain/food web and ecological pyramids. (10 Marks)

OR

Prepare food chain/food web and ecological pyramid from the given data and give its significance. (10 Marks)

OR

Identify and interpret the given graph/growth curve/age structure and comment on the pattern of population dispersal. (10 Marks)

OR

Determine Population density by capture and recapture method. (10 Marks)

Q.5. Journal and Viva voce (Based on practical component) (10 Marks)

Semester II USZOP2 (Course IV)
Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs

Marks: 50

- Q.1. Estimate Vitamin C from given sample. (15 Marks)
OR
Estimate Maltose content from bread.
OR
Estimate protein content from two different types of eggs.
- Q.2. Analyse the given food sample and identify food adulterants (any 2 samples). (10 Marks)
OR
Evaluate milk quality by Methylene Blue Reduction Test (MBRT).
OR
Determine efficacy of different antacids (any two) on acidic solution.
- Q.3. Determine moisture content from biscuits/ any other suitable food product. (5 Marks)
OR
On the basis of microscopic structure of starch granules identify different cereals (any two).
OR
Detect adulterants present in the given milk sample (any two).
OR
Determine whether given blood sample is from anaemic/non-anaemic person using CuSO_4
Method and suggest the appropriate diet.
- Q.4. Identification (10 Marks)
a) One specimen of Protozoan Parasites.
b) One specimen of Helminth Parasites.
c) One specimen from Ectoparasite
d) One specimen from Exoparasite
e) One specimen from Endoparasite
- Q.5. Submission of report of Body Mass Index (viva based on it) (10 Marks)

Note: There shall be at least one excursion/field trip.

USZO201 (Course III)

REFERENCES AND ADDITIONAL READING

1. Introduction to Ecology and Wildlife - University Text Book of Zoology, F.Y.B.Sc. Semester II Course 3. University Press.
2. Fundamentals of Ecology - Eugene P. Odum and Grey W. Barrett, Brook Cole/ Cengage learning
3. Fundamentals of Ecology - M. C. Dash , Tata McGraw Hill company Ltd, New Delhi
4. Ecology - Mohan P. Arora , Himalaya Publishing House
5. Field Biology and Ecology -- Alen H. Benton and William E. Werner ,Tata McGraw Hill ltd, New Delhi
6. Ecology and Environment - Sharma P. D , Rastogi Publication, Mumbai
7. Ecology : Principles and Applications - Chapman J.L , Cambridge University trust
8. Ecology - Subramaniam and Others, Narosa Publishing House
9. Wildlife laws and its impact on tribes - Mona Purohit, Deep and deep Publication
10. Biology - Eldra Solomon, Linda R. Berg and Diana W. Martin, Thomson/ Brooks/ Cole
11. Economic Zoology, Biostats and Animal Behaviour - Shukla, Mathur, Upadhyay, Prasad. Rastogi Publications.

USZO202 (Course IV)

REFERENCES AND ADDITIONAL READING

1. Common Diseases, Health and Hygiene - University Text Book of Zoology, F.Y.B.Sc. Semester II Course 4. University Press.
2. Common Medical Symptoms edited - P. J. Mehta National Inblisents and Distributions
3. Parks Textbook of Preventive and Social Medicine K. Park M/S Banarasidas Bhanot Jabalpar.
4. Human Physiology – Volume I – II C. C. Chatterjee, Medical Allied agency, Kolkatta.
5. Parasitology (Protozoology and Helminthoology) - K. D. Chatterjee, Chatterjee Medial Publishers.

6. Nand's handbook of Forensic Medicine and Toxicology - Apurba Nandy, NCBA publication.
7. Essentials of Public Health and Sanitation- Part I and Part II. All India Institute of Local Self Government.
8. Epidemiology and Management for Health Care for all. P.V. Sathe, A. P. Sathe, Popular Prakashan, Mumbai.
9. Textbook of Medical Parasitology- C. K. JayaramPaniker. Jaypee Brothers.
10. A Treatise on Hygiene and Public Health. -B. N. Ghosh. Calcutta Scientific Publishing Company.
11. Prevention of Food Adulteration, Act 1954. Asian Law House.
12. Clinical Dietetics and Nutrition - F. P. Antia and Philip, Oxford University Press.
13. A Complete Handbook of Nature Cure - Dr. H. K. Bakru, Jaico Publishing House.
14. Dietetics - B. Srilakshmi, New Age International (P) Ltd. Publishers.
15. Nutrition: Principles and Application in Health Promotion - J. B. Lippincott Company. Philadelphia.
16. Are You Healing Yourself Mr. Executive - Dr. R. H. Dastur. IBH Publishing Company.
17. Food Nutrition and Health- Dr. Shashi Goyal, Pooja Gupta, S. Chand Publications.
18. Public Health Nutrition. Edited - Michael J. Gidney, Barrie M. Margetts, John M. Kearney and Lenore Arab. Willey Blackwell Publication.
19. Food and Nutrition – Vol. I and II - Dr. Swaminathan , Bappco Publication.
20. Textbook of Human Nutrition - Mahtab Bamji, Prahlad Rao.
21. Total Health by Paramjit Rana.

SCHEME OF EXAMINATION THEORY

- (a) Internal assessment of twenty five (25) marks per course per semester should be conducted as class test according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.
- (b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton 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: 2.5 hours

Total marks: 75

Q.1.	UNIT 1 Answer any four out of eight (5 marks each)	20 marks
Q.2.	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.3.	UNIT 3 Answer any two out of four (10 marks each)	20 marks
Q.4.	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)	15 marks

*For Question 4 it is recommended to have objective questions 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.

MODEL QUESTION BANK
SEMESTER II
USZO203 (COURSE III)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT 1: (10 marks)

Describe with suitable Example

1. J-Shaped and Sigmoid growth patterns
2. Population dispersal and distribution patterns
3. Natality and Mortality
4. Natality and Fecundity
5. Fecundity and Mortality
6. Density dependant fluctuation and oscillations
7. Population interactions
8. Age structure and population density
9. Concept of niche and its significance in population ecology.

Write notes on / Give a brief account of: (5 marks)

1. Population density
2. Natality
3. Mortality
4. Fecundity
5. Age structure
6. Sex ratio
7. Survivorship curve
8. Sigmoid growth pattern
9. J-shaped growth curve
10. Intrinsic mechanism
11. Extrinsic mechanism
12. Niche
13. Population dispersal and distribution pattern

UNIT 2: (5 marks)

1. Effect of temperature on metabolism

16. Impact of temperature on reproduction
17. Effect of temperature on animal behaviour
18. Define ecosystem and describe any two abiotic factors
19. Define ecosystem and describe any two biotic factors
20. Explain producers / autotrophs
21. Give a brief account of various levels of consumers in an ecosystem
22. Describe in short the inter-relationship between biotic and abiotic factors
23. Describe the following (any one of the cycles can be asked) water cycle, nitrogen cycle and oxygen cycle, sulphur cycle.
24. Explain any one of the following - lake or river
25. Explain food chain from terrestrial or aquatic ecosystem
26. What is food web and explain the same with a suitable example
27. Give a brief account of: Energy pyramid, Pyramid of biomass, Pyramid of numbers.

Unit 3: (10 marks question)

1. State the differences between National park and Wildlife Sanctuary?
2. Write an account of critically endangered species of Indian wildlife with at least two examples.
3. Explain briefly management strategy of any one tiger project in India.
4. Briefly explain management strategy of Rhinoceros project in India.
5. Write in detail about Indian Wildlife (Protection) Act 1972.
6. What is biopiracy? Explain with suitable examples.
7. Write a note on flora and fauna of Sanjay Gandhi national park.
8. Write an account of Tadoba tiger reserve project.
9. Give an account of biodiversity of Jim Corbett national park.
10. Write a note on Ranthambore Tiger reserve.
11. Write in details about Gir Lion project.
12. Write a note on Keoladeo Ghana National park.
13. Write an account of biodiversity of Silent valley.
14. Describe in detail about Bandipur sanctuary.
15. Write a note on ecotourism in India with few examples.

MODEL QUESTION BANK (COURSE IV) SEMESTER II

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

Unit I (5 marks)

Explain the following:

1. Concept of balanced diet and dietary recommendations of any one of the following:
a) Normal adult b) Infant c) Pregnant woman d) Aged
2. Cause and symptoms of the following: a) Anemia b) B₁₂ deficiency c) Vitamin D deficiency d) Marasmus e) Kwashiorkor f) Goiter, g) Swine flu, h) Dengue
3. Precautions and remedy for all above mentioned health conditions.
4. Significance of breast feeding.
5. Importance of fibres in food.
6. Food adulterants and toxins with two side effects of each.
7. Causes, symptoms, precautions and treatment of a) Constipation, b) Piles, c) Insomnia, d) Starvation, e) Flatulence, f) Peptic ulcer, g) Obesity
8. BMI and its significance.

Unit II (5/10 marks)

Question of 5 marks:

1. Give a brief account and outcome of WHO Programs:
a) Polio b) Smallpox c) Malaria d) Leprosy
2. a) Explain the concept of health goal and health knowledge.
b) Enlist different needs of health education.
c) State five points of social health issues.

Question of 10 marks:

1. Describe sources and properties of water in relation to human consumption.

2. Describe methods of purification of water – small scale, medium scale and large scale.
3. Explain the concept of water footprint and give its significance.
4. Describe disposal of human and animal waste – STP and ETP, its functioning and significance.
5. Give a brief of risk of radiation from mobile cell towers and electronic gadgets.
6. Explain the concepts of physical health, psychological health and myth related to it.
7. Describe the term hygiene and explain in brief health factors related to it at home.
8. Explain personal hygiene, oral hygiene and sex hygiene with significance of each.
9. Describe ill effects of self medication with respect to antibiotics and steroids.
10. Give brief account of first aid symbols.

Unit III (10 marks)

1. Explain causes, symptoms, precautions and remedy
 - a) Hypertension b) Diabetes Type II c) Anxiety and Insomnia d) Migraine and depression
2. Explain causes, symptoms, precautions and remedy
 - a) Tuberculosis b) Common flu c) Dengue d) Malaria e) Typhoid
 - f) Hepatitis A g) Hepatitis B h) AIDS

UNIVERSITY OF MUMBAI

No. UG/34 of 2018-19

CIRCULAR:-

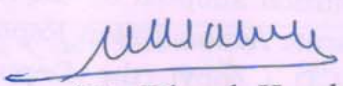
Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/02 of 2016-17, dated 21st April, 2016 relating to syllabus of the Bachelor of Science (B.Sc.) degree course.

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. 4.31 and that in accordance therewith, the revised syllabus as per the (CBCS) for the S.Y.B.Sc. in Zoology (Sem - III & IV) 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).

MUMBAI-400 032

22nd June, 2018

To


(Dr. Dinesh Kamble)
I/c REGISTRAR

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/4.31/05/05/2018

No. UG/ 34 -A of 2018

MUMBAI-400 032

22nd 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: S.Y.B. Sc.

Course: Zoology

Syllabus for Semester III & IV

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

S. Y. B. Sc. Syllabus Framing Committee Members' List

Sr. No.	Name	Address	Status
1	Dr. Anita Jadhav readersmailbox@rediffmail.com	Head & Associate Prof., Department of Zoology, ICL College, Vashi, Navi-Mumbai	I/C Chairperson, BoS in Zoology
2	Mr. Vinayak Dalvie dalvie@gmail.com	Head & Associate Prof., Mithibai College, Vile Parle (w), Mumbai- 56	Chief Coordinator
3	Dr. Gulabrao B. Raje drgbraje@rediffmail.com	Head & Associate Prof., Department of Zoology, D. B. J College, Chiplun, Dist: Ratnagiri	Coordinator
4	Cap. Nilima S. Prabhu nilsprabhu@rediffmail.com	Assistant Prof., Department of Zoology, S.S. & L.S. Patkar College, Goregaon , Mumbai-62	Convenor USZO301 & USZO401
5	Dr. Dilip K. Kakavipure dlpkakavipure@gmail.com	Associate Prof., Department of Zoology, BNN College, Bhiwandi, Dist: Thane	Convenor USZO302 & USZO402
6	Dr. Venkatesh Hegde drvnhegde@rediffmail.com	Assistant Prof., Department of Zoology, Mithibai College, Vile Parle (w), Mumbai-56	Convenor USZOE303A & USZOE403A (Elective 1)
7	Dr. Surekha Manoj Gupta gupta.surekha@yahoo.com	Assistant Prof., Department of Zoology, G. N. Khalsa College, Matunga, Mumbai-19	Convenor USZOE303B & USZOE403B (Elective 2)
8	Dr. Shaheda Rangoonwala shaheda.rangoonwala@gmail.com	Principal, V. N. College, Murud Janjira, Dist: Raigad	Co-Convenor USZO301 & USZO401
9	Dr. Shashibhal M. Pandey pandey.shashibhal@gmail.com	Assistant Prof., Department of Zoology, CHM College, Ulhasnagar-3	Co-Convenor USZO302 & USZO402
10	Dr. Leena Murlidharan leena.doctor@gmail.com	Assistant Prof., Department of Zoology, VKK Menon College, Bhandup (E), Mumbai -42	Co-Convenor USZOE303A & USZOE403A (Elective 1)
11	Dr. Shirley Bless Agwuocha shirley_bless@rediffmail.com	Assistant Prof., Department of Zoology, Thakur College of Science & Com., Kandivali (E)	Co-Convenor USZOE303A & USZOE403A (Elective 1)
12	Dr. Nisar Shaikh nisargmmwc@gmail.com	Principal, DRT's A. E. Kalsekar Degree College, Kausa Mumbra, Dist: Thane -12	Co-Convenor USZOE303B & USZOE403B (Elective 2)
13	Dr. Sushant mane sushantmane@yahoo.com	Assistant Prof., Department of Zoology, Wilson College, Girgaon, Mumbai-7	Member USZO301 & USZO401
14	Dr. Meena Punja meenaprasad123@gmail.com	Assistant Prof., Department of Zoology, CHM College, Ulhasnagar-3	Member USZO301 & USZO401
15	Mr. T. V. Bicheesh Balan bicheesh@gmail.com	Assistant Prof., Department of Zoology, Mithibai College, Vile Parle (w), Mumbai-56	Member USZO301 & USZO401

16	Mr. Nandkumar Hedulkar hedulkar@gmail.com	Head & Assistant Prof., Department of Zoology, Anandibai Raorane College, Vaibhavwadi, Dist: Sindhudurg	Member USZO302 & USZO402
16	Dr. Pratiksha P. Sawant Sawant.pratiksha52@gmail.com	Associate Prof., Department of Zoology, S.P.K. College, Sawantwadi, Dist: Sindhudurg	Member USZO302 & USZO402
17	Dr. Kantilal Hiralal Nagare Birlasparc11@gmail.com	Assistant Prof., Department of Zoology, Birla College, Kalyan, Dist: Thane -421304	Member USZOE303A & USZOE403A (Elective 1)
18	Mr. Nikhil Disoria Nikhil.disoria@gmail.com	Assistant Prof., Department of Zoology, National College, Bandra (W), Mumbai -50	Member USZOE303A & USZOE403A (Elective 1)
19	Dr. Minakshi Gurav minakshi.gurav@ruparel.edu	Assistant Prof., Department of Zoology, Ruparel College, Mahim, Mumbai -16	Member USZOE303B & USZOE403B (Elective 2)
20	Dr. Harish T. Babar harishbabar@gmail.com	Assistant Prof., Department of Zoology, D. B. J College, Chiplun, Dist: Ratnagiri- 415605	Member USZOE303B & USZOE403B (Elective 2)
21	Dr. Kamran Abbas	Head & Associate Prof., Department of Zoology, BNN College, Bhiwandi, Dist: Thane	Member USZO302 & USZO402

CONTENTS

1. Preface
2. Preamble
3. Pedagogy
4. Tables of Courses, Topics, Credits and Workload
5. Table of unit wise distribution of syllabus
6. Theory Syllabus for Semester III (Course codes: USZO301-USZOE303B)
7. Practical Syllabus for Semester III (Course codes: USZOP3)
8. References and Additional Reading (Course code: USZO301-USZOE303B)
9. Theory Syllabus for Semester IV (Course codes: USZO401-USZOE403B)
10. Practical Syllabus for Semester IV (Course codes: USZOP4)
11. References and Additional Reading (Course code: USZO401-USZOE403B)
12. Marking Scheme of Examination (Theory)
13. Skeleton - Practical Exam Question Papers (Semester III and Semester IV)
14. Model Question Bank (Semester III and Semester IV)

PREFACE

Holistic development of students is the main purpose of the curriculum. While this is attempted through prescribing dynamic and updated curricular inputs, the new course that will be effective from the academic year 2018- 2019, will follow the Semester mode. The main aim of the revision of syllabus was to modify it to meet the unique requirements of students, up gradation of knowledge in the subject of zoology and to inculcate the skill of reasoning. The contents of the syllabus have been drawn-up to accommodate the widening horizons of the discipline of Biological Sciences. All possible attempts have been made to update the syllabus by incorporating current and most recent developments in various branches of Zoological Sciences, nevertheless, classical zoology also has been given due weightage. Introduction of an elective paper in zoology will also provide a glimpse of its application. Inclusion of research methodology to the undergrads is the highlight of the course. I am sure that these revised syllabi will cater to better understanding of the subject and beyond.

I appreciate and congratulate the entire team of syllabus framing for the co-operation, tireless work and wish them success.

Dr Mrs. Vasanti Katchi.
Convenor,
Interim BOS in Zoology

PREAMBLE

As a traditional procedural norm of the University of Mumbai, it is the Board of Studies that includes various disciplines, which revived the syllabi after completion of a cycle of five years. Due to rapid advancement in technology, a number of rapid new ideas and concepts, and an ocean of information being generated every day that necessitates updating the students in this present era of exponential information and knowledge. However, in the former practice of syllabus revision, students were unable to imbibe new ideas and concepts as there was limited scope of including them within the syllabi that was theoretical with poor applicability

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

With this intention, the Board of Studies in Zoology took decision to put before the S. Y. B. Sc. Zoology students one elective, so that they can study topics of their interest. Board of Studies in Zoology is the only Board in the University that has offered two electives for the S. Y. B. Sc. students and safeguarded their career. Further, BoS formulated Four Syllabus Review Committees (one per course with composition of 01 Convenor and 04 Members). All the committee members worked extensively and exhaustively; and prepared draft of the syllabus. The said draft was uploaded on the website of University of Mumbai for public criticism. The invited opinions were thereby incorporated in the syllabus to make it versatile and student friendly with high applicability. Further, the draft syllabus was re-discussed in the workshop where several teachers and students contributed their views to improve it. In the academic year 2016-17, new syllabus was introduced but it is revived immediately after two years with inclusion of new concepts and techniques. Due care is taken to make the syllabus interdisciplinary, flexible and choice based. All the member teachers have tried their level best to come out with “Need Based Syllabus” that may spark motives in all the stakeholders. We hope that the stakeholders will enjoy the learning of this syllabus in the classrooms, laboratories and on the field.

Dr. G. B. Raje
Coordinator

PEDAGOGY

While disseminating the content of the present syllabus, it is imperative and expected that the facilitator is well versed or/and develops their Pedagogical Content Knowledge (PCK), which would include aspects like content, methodology, evaluation and so on. At the onset, the facilitator may include various topic-specific instructional strategies, employing the use of organizers (topic announcement in advance, making models, flip charts, photography, etc). Learning of topics on chromosomes, nucleic acids, cell biology, biomolecules, physiological processes are hence revised, and during the presentations by the learner, the facilitator is able to gauge the preconceptions and learning disabilities. Any misunderstanding of basic concepts can thus be clarified such as 'difference between gene and allele'. Peer teaching is another aspect of pedagogy which takes into account participative learning thus enhancing the learning of the content and making it enjoyable, for example, the use of 'Punnet squares' for working out the crosses in various illustrations on monohybrid and dihybrid ratios, problems based on inheritance, pedigree analysis, molecular biology etc. A declarative learning strategy, which employs the use of familiar contexts and analogies, illustrative diagrams, questioning techniques, discussions, may be used for topics like multiple alleles, polygenic inheritance, DNA testing for paternity issues, scientific attitude, methodology, scientific writing etc. This would enhance the relevance of these topics and engender motivation, thereby balancing the blend of content and pedagogy in teaching. The syllabus includes practical investigations, individual or group student experiments, simulations to assist learners in visualizing and /or internalizing the concepts and processes. The learner could be encouraged to organize field trips, nature trails and treks in and around the ecosystems like lakes, beaches, sanctuaries, national-parks etc. for learning topics like ethology and conservation, amazing animals, applied zoology, pollution and other such, where sensitization, awareness and action are to be invoked within the learner. Visits to museums, and an interdisciplinary approach with various departments like geology, history, geography, chemistry, psychology, medicine would bring about a multi and cross approach to learning concepts such as paleontological evidences, nucleic acids, physiological processes, biomolecules, holistic health and neurological and genetic diseases . ICT enabled learning is the need of the hour and could include screening of documentaries, videos, animations, PPT's, and the use of social media such as Whatsaap, Instagram, Facebook be employed for impactful and continued learning. Facilitators can upload the teaching material, videos of lectures, links to websites for not only enhancing but also focusing and developing the topics of interest by the learner by way of self-study. More importantly, the syllabus endeavours to develop life skills by discovering and

honing entrepreneurial skills of the learner. To accomplish this purpose, visits to apiary, vermicomposting units, and dairy could be encouraged, also interviews with various entrepreneurs, officials of funding agencies must be undertaken to comprehend the nuances of business. Also small projects on various entrepreneurial aspects like setting up vermicomposting bins and aquaria, sale of the vermicompost or setting up an ornamental fish farms, innovations in dairy products and its sale could be encouraged in the campuses. The elective papers are so construed that the learner is driven to gain knowledge, experience through activity-based assignments, and projects, which would enhance entrepreneurial skills, a logical understanding and analysis of business functions.

Capt. Nilima Prabhu
Dr. Dilip Kakavipure
Prof. Venkatesh Hegde
Dr. Surekha Gupta
Convenors

Syllabus for S. Y. B. Sc. Course: ZOOLOGY
Credit Based Semester and Grading System
(To be implemented from the Academic Year 2018-2019)

SEMESTER – III

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO301	I	Fundamentals of Genetics	2	1
	II	Chromosomes and Heredity		1
	III	Nucleic Acids		1
USZO302	I	Nutrition and Excretion	2	1
	II	Respiration and Circulation		1
	III	Control and Coordination of Life Processes, Locomotion and Reproduction		1
USZOE303A	I	Ethology	2	1
ELECTIVE 1	II	Parasitology		1
	III	Economic Zoology		1
USZOE303B	I	Maintenance of Aquarium	2	1
ELECTIVE 2	II	Agricultural, Household Pests and their Control		1
	III	Amazing Animals		1
USZOP3	Practicals 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, Scientific Writing and Ethics in Scientific Research		1
USZO402	I	Cell Biology,	2	1
	II	Endomembrane 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	1
ELECTIVE 2	II	Sericulture		1
	III	Aquaculture		1
USZOP4	Practicals based on all three courses		03	9

	UNIT WISE DISTRIBUTION OF SYLLABUS						
Semester III				Semester IV			
Course 5	Course 6	Course 7 A	Course 7 B	Course 8	Course 9	Course 10 A	Course 10 B
Unit 1 Fundamentals of Genetics	Unit 1 Nutrition & Excretion	Unit 1 Ethology	Unit 1 Maintenance of Aquarium	Unit 1 Origin & Evolution of Life	Unit 1 Cell Biology	Unit 1 Comparative Embryology	Unit 1 Dairy Industry
Unit 2 Chromosomes & Heredity	Unit 2 Respiration & Circulation	Unit 2 Parasitology	Unit 2 Agricultural & Household Pests & their 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 of Life Processes, Locomotion & Reproduction	Unit 3 Economic Zoology	Unit 3 Amazing Animals	Unit 3 Scientific Attitude, Methodology, Scientific Writing & Ethics in Scientific Research	Unit 3 Biomolecules	Unit 3 Pollution & its Effects on Organisms	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 (ZOOLOGY)

SEMESTER III

Sr. No	USZO301 (Course-V)	No. of lectures allotted	Learning pleasure
	Fundamentals of Genetics, Chromosomes and Heredity, Nucleic acids		
	Unit 1: Fundamentals of Genetics	15L	25hrs
	Objectives: <ul style="list-style-type: none"> ➤ To introduce basic terms of genetics. ➤ To develop conceptual clarity of Mendelian principles of inheritance and other forms and pattern of inheritance 		
	Desired outcome: <ul style="list-style-type: none"> ➤ Learner would 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 <ul style="list-style-type: none"> • Definition, Scope and Importance of Genetics. • Classical and Modern concept of Gene (Cistron, Muton, Recon). • Brief explanation of the following terms: Allele, Wild type and Mutant alleles, Locus, Dominant and Recessive traits, Homozygous and Heterozygous, Genotype and Phenotype, Genome. 	02L	02hrs
1.2	Mendelian Genetics <ul style="list-style-type: none"> • Mendelian Genetics: Monohybrid & Dihybrid Cross, Test Cross, Back Cross, Mendel's Laws of Inheritance, Mendelian Traits in Man. • Exceptions to Mendelian inheritance: Incomplete dominance, Co-dominance, Lethal Genes, Epistasis - Recessive, Double recessive, Dominant and Double dominant. • Chromosome theory of inheritance. • Pedigree Analysis-Autosomal dominant and recessive, X- linked dominant, and recessive. 	08L	12hrs

1.3	Multiple Alleles and Multiple Genes <ul style="list-style-type: none"> • Concept of Multiple Alleles, Coat colour in rabbit, ABO and Rh blood group systems • Polygenic inheritance with reference to skin colour and eye colour in humans. • Concept of Pleiotropy. 	03L	06hrs
1.4	Linkage and Crossing Over <ul style="list-style-type: none"> • Linkage and crossing over, Types of crossing over, Cytological basis of crossing over. 	02L	05hrs
	Unit: 2: Chromosomes and Heredity	15L	26hrs
	Objectives: <ul style="list-style-type: none"> ➤ <i>To familiarize the learners with the structure, types and classification of chromosomes.</i> ➤ <i>To introduce the concept of sex determination and its types, sex influenced and sex-limited genes.</i> 		
	Desired outcome: <ul style="list-style-type: none"> ➤ <i>Learner will comprehend the structure of chromosomes and its types.</i> ➤ <i>Learner will understand the mechanisms of sex determination.</i> ➤ <i>Learner would be able to correlate the disorders linked to a particular sex chromosome.</i> 		
2.1	Chromosomes <ul style="list-style-type: none"> • Types of Chromosomes–Autosomes and Sex chromosomes • Chromosome structure - Heterochromatin, Euchromatin • Classification based on the position of centromere • Endomitosis, Giant chromosomes- Polytene and Lamp brush chromosomes and Significance of Balbiani rings 	04L	08hrs

2.2	Sex- determination <ul style="list-style-type: none"> Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW Sex determination in Honey bees- Haplodiploidy Sex determination in <i>Drosophila</i>-Genic balance theory, Intersex, Gynandromorphs Parthenogenesis Hormonal influence on sex determination-Freemartin and Sex reversal. Role of environmental factors- Bonelia and Crocodile Barr bodies and Lyon hypothesis 	07L	10hrs
2.3	Sex linked, sex influenced and sex-limited inheritance. <ul style="list-style-type: none"> X-Linked: Colour-blindness, Haemophilia Y-linked: Hypertrichosis Sex-influenced genes Sex-limited genes 	04L	08hrs
	Unit: 3 Nucleic acids	15L	30hrs
	Objectives: <ul style="list-style-type: none"> ➤ To introduce the learner to the classical experiments proving DNA as the genetic material. ➤ To introduce the learner 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 outcome: <ul style="list-style-type: none"> ➤ Learner will understand the importance of nucleic acids as genetic material. ➤ Learner would comprehend and appreciate the regulation of gene expressions. 		
3.1	Genetic material <ul style="list-style-type: none"> Griffith's transformation experiments, Avery-Macleod and McCarty, 	07L	14hrs

	<p>Hershey Chase experiment of Bacteriophage infection</p> <ul style="list-style-type: none"> • 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 		
3.2	<p>Flow of genetic information in a eukaryotic cell</p> <ul style="list-style-type: none"> • DNA Replication • Transcription of mRNA • Translation • Genetic code 	05L	08hrs
3.3	<p>Gene expression and regulation</p> <ul style="list-style-type: none"> • One gene-one enzyme hypothesis /one polypeptide hypothesis • Concept of Operon • Lac Operon 	03L	08hrs

	SEMESTER - III		
Sr. No	USZO302 (COURSE-VI)	No. of lect allotted	Learning pleasure
	Nutrition and Excretion, Respiration and Circulation, Control and Coordination of Life Processes, Locomotion and Reproduction		
	Unit: 1 Nutrition and Excretion	15L	23hrs
	Objectives: <ul style="list-style-type: none"> ➤ <i>To introduce the concepts of physiology of nutrition, excretion and osmoregulation.</i> ➤ <i>To expose the learner to various nutritional apparatus, excretory and osmoregulatory structures in different classes of organisms.</i> 		
	Desired outcome: <ul style="list-style-type: none"> ➤ <i>Learner would understand the increasing complexity of nutritional, excretory and osmoregulatory physiology in evolutionary hierarchy.</i> ➤ <i>Learner would be able to correlate the habit and habitat with nutritional, excretory and osmoregulatory structures.</i> 		
1.1	<ul style="list-style-type: none"> • Comparative study of nutritional apparatus (structure and function): Amoeba, Hydra, Cockroach, Amphioxus, Pigeon, Ruminants. 	05L	06hrs
1.2	<ul style="list-style-type: none"> • Physiology of digestion in man. 	02L	04hrs
1.3	<ul style="list-style-type: none"> • Comparative study of excretory and osmoregulatory structures and functions. • 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 Respiration and Circulation	15L	27hrs
	Objectives:		

	<ul style="list-style-type: none"> ➤ <i>To introduce the concepts of physiology of respiration and circulation</i> ➤ <i>To expose the learner to various respiratory and circulatory organs in different classes of organisms.</i> 		
	Desired outcome: <ul style="list-style-type: none"> ➤ <i>Learner would understand the increasing complexity of respiratory and circulatory physiology in evolutionary hierarchy.</i> ➤ <i>Learner will be able to correlate the habit and habitat of animals with respiratory and circulatory organs.</i> 		
2.1	<ul style="list-style-type: none"> • Comparative study of respiratory organs (structure and function): Earthworm, Spider, Any bony fish (Rohu/<i>Anabas/Clarius</i>), Frog and Pigeon. 	03L	06hrs
2.2	<ul style="list-style-type: none"> • Structure of lungs and physiology of respiration in man 	02L	03hrs
2.3	<ul style="list-style-type: none"> • Comparative study of circulation: (a) Open and Closed type, (b) Single and Double type. 	02L	04hrs
2.4	<ul style="list-style-type: none"> • Types of circulating fluids- Water, Coelomic fluid, Haemolymph, Lymph and Composition of blood 	02L	03hrs
2.5	<ul style="list-style-type: none"> • Comparative study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon. 	04L	07hrs
2.6	<ul style="list-style-type: none"> • Structure and mechanism of working of heart in man. 	02	04hrs
	Unit: 3 Control and Coordination, Locomotion and Reproduction	15L	25hrs
	Objectives: <ul style="list-style-type: none"> ➤ <i>To introduce the concepts of physiology of control and coordination and locomotion and reproduction.</i> ➤ <i>To expose the learner to various locomotory and reproductive structures in different classes of organisms.</i> 		
	Desired outcome: <ul style="list-style-type: none"> ➤ <i>Learner would understand the process of control and coordination by nervous and endocrine regulation.</i> ➤ <i>Learner would be amazed by various locomotory structures found in the animal kingdom.</i> 		

	➤ <i>Learner would be acquainted with various reproductive strategies present in animals.</i>		
3.1	Control and coordination <ul style="list-style-type: none"> Irritability in Paramecium, nerve net in Hydra, nerve ring and nerve cord in earthworm. Types of neurons based on the structure and function. Conduction of nerve impulse: Resting potential, Action potential and Refractory period Synaptic transmission 	05L	08hrs
3.2	Movement and Locomotion <ul style="list-style-type: none"> Locomotory organs- structure and functions; <ol style="list-style-type: none"> Pseudopodia in Amoeba (Sol- Gel theory), Cilia in Paramecium Wings and legs in cockroach Tube feet in starfish Fins of fish 	04L	08hrs
3.3	Structure of striated muscle fibre in human and sliding filament theory	02L	02hrs
3.4	Reproduction <ol style="list-style-type: none"> Asexual Reproduction- Fission, Fragmentation, Gemmule formation and Budding Sexual reproduction <ol style="list-style-type: none"> Gametogenesis Structure of male and female gametes in human Types of fertilization Oviparity, Viviparity, Ovo-viviparity 	04L	07hrs

	SEMESTER III		
	USZOE1303 (COURSE-VIIA)		
	Ethology, Parasitology, Economic Zoology	15L	26hrs
	Unit: 1 Ethology		
	Objectives: <ul style="list-style-type: none"> ➤ <i>To equip learner with a sound knowledge of how animals interact with one another and their environment.</i> ➤ <i>To enable the learner to understand different behavioural patterns.</i> 		
	Desired Outcome: <ul style="list-style-type: none"> ➤ <i>Learner would gain insight into different types of animal behaviour and their role in biological adaptations.</i> ➤ <i>Learner would be sensitized to the feelings which are instrumental in social behaviour.</i> 		
1.1	Introduction to Ethology: <ul style="list-style-type: none"> • Definition, History and Scope of Ethology • Animal behaviour : Innate and Learned behaviour • Types of learning: Habituation, Imprinting and Types of imprinting - Filial and sexual, Classical conditioning • Instrumental learning and insight learning. 	4L	06hrs
1.2	Aspects of animal behaviour: <ul style="list-style-type: none"> • Communication in bees and ants • Mimicry and colourations • Displacement activities, Ritualization • Migration in fish, schooling behaviour • Habitat selection, territorial behaviour. 	7L	12hrs
1.3	Social behaviour: <ul style="list-style-type: none"> • Social behaviour in primates-Hanuman langur • Elements of socio-biology: Altruism and Kinship 	4L	08hrs
	Unit: 2 Parasitology	15L	27hrs
	Objectives:		

	<ul style="list-style-type: none"> ➤ To acquaint the learner with the concepts of parasitism and its relationship in the environment. ➤ To introduce the learner to modes of transmission of parasites. 		
	<p>Desired Outcome:</p> <ul style="list-style-type: none"> ➤ Learner would understand the general epidemiological aspects of parasites that affect humans and take simple preventive measures for the same. ➤ Learner would comprehend the life cycle of specific parasites, the symptoms of the disease and its treatment. 		
2.1	<p>Introduction to Parasitology and Types of Parasites</p> <ul style="list-style-type: none"> • Definitions: Parasitism, Host, Parasite, Vector-biological and mechanical • Types of parasites-Definitive, Intermediate, Ectoparasite, Endoparasite and their subtypes • Parasitic adaptations in Ectoparasites and Endoparasites • Types of hosts: Intermediate and definitive, reservoir 	3L	06hrs
2.2	<p>Host-parasite relationship;cHost specificity</p> <ul style="list-style-type: none"> • Definition, structural specificity, physiological specificity and ecological specificity 	2L	06hrs
2.3	<p>Life cycle, pathogenicity, control measures and treatment</p> <ul style="list-style-type: none"> • <i>Entamoeba histolytica</i>, <i>Fasciola hepatica</i>, <i>Taenia solium</i>, <i>Wuchereria bancrofti</i> 	4L	06hrs
2.4	<p>Morphology, life cycle, pathogenicity, control measures and treatment</p> <ul style="list-style-type: none"> • Head louse(<i>Pediculus humanus capitis</i>), Mite (<i>Sarcoptes scabiei</i>), Bed bug (<i>Cimex lectularis</i>) 	2L	06hrs
2.5	<p>Parasitological significance</p> <ul style="list-style-type: none"> • Zoonosis- Bird flu, Anthrax, Rabies and Toxoplasmosis 	4L	03hrs
	Unit 3 Economic Zoology	15L	24hrs
	Objectives:		

	<p>➤ To disseminate information on economic aspects of animals like apiculture, vermiculture and dairy science.</p> <p>➤ To encourage young learner for self-employment.</p>		
	<p>Desired Outcome:</p> <p>➤ Learner would gain knowledge on animals useful to mankind and the means to make the most of it.</p> <p>➤ Learner would learn the modern techniques in animal husbandry.</p> <p>➤ Learner would pursue entrepreneurship as a career.</p>		
3.1	APICULTURE	6L	08hrs
3.1.1	<p>Methods of bee keeping and management</p> <ul style="list-style-type: none"> • An introduction to different species of honey bees used in apiculture. • Selection of flora and bees for apiculture. • Advantages and disadvantages of traditional and modern methods of apiculture. • Pests and Bee enemies- Wax moth, wasp, black ants, bee-eaters, king crow and disease control 		
3.1.2	<p>Economic importance</p> <ul style="list-style-type: none"> • Honey- Production, chemical composition and economic importance • Bee wax- Composition and economic importance. • Role of honey bee in pollination. 		
3.2	VERMICULTURE	4L	08hrs
3.2.1	<p>Rearing methods, management and economic importance</p> <ul style="list-style-type: none"> • An introduction to different species of earthworms used in vermiculture. • Methods of vermiculture. • Maintenance and harvesting • Economic importance: advantages of vermiculture, demand for earthworms; market for vermicompost and scope for entrepreneurship. 		

3.3	DAIRY SCIENCE	5L	08hrs
3.3.1	Dairy development in India <ul style="list-style-type: none"> • Role of dairy development in rural economy, employment opportunities 		
3.3.2	Dairy Processing <ul style="list-style-type: none"> • Filtration, cooling, chilling, clarification, pasteurization, freezing 		
3.3.3	Milk and milk products <ul style="list-style-type: none"> • Composition of milk • Types of milk: <ul style="list-style-type: none"> A. Buffalo milk and B. Cow milk (A1 and A2) • Whole milk and toned milk • Milk products 		

	SEMESTER III		
	USZOE2303 (COURSE - VIIB)		
	Maintenance of Aquarium, Agricultural and Household pests and their control , Amazing animals	15L	26hrs
	Objectives: <ul style="list-style-type: none"> ➤ <i>To develop skills for maintenance of aquarium and budgeting for setting up an aquarium and ornamental fish farm.</i> ➤ <i>To study the biology of ornamental fishes, its food and feeding and their transportation.</i> 		
	Desired Outcome: <ul style="list-style-type: none"> ➤ <i>Learner will develop skills for maintenance of aquarium and become familiar with the budgeting aspects for setting up an ornamental fish farm.</i> ➤ <i>Learner will derive knowledge about the biology of ornamental fishes, its food and feeding habits and their transportation.</i> 		
	Unit.1 Maintenance of Aquarium		
1.1	Introduction and scope.	2L	04hrs
1.2	Exotic and Endemic species.	2L	06hrs
1.3	Biology of aquarium fishes: <ul style="list-style-type: none"> • Guppy • Molly • Gold fish 	2L	08hrs
1.4	Common characters and sexual dimorphism of marine fishes: <ul style="list-style-type: none"> • Anemone fish • Butterfly fish 	2L	06hrs

1.5	Food and feeding: <ul style="list-style-type: none"> • Live fish feed • Formulated fish feed 	2L	04hrs
1.6	Fish transportation: i) Handling ii) Packing iii) Transport	3L	05hrs
1.7	General maintenance of aquarium and budget for setting up an ornamental fish farm.	2L	04hrs
	Unit: 2 Agricultural pests and their control	15L	27hrs
	Objectives: <ul style="list-style-type: none"> ➤ To study different types of pests. ➤ To comprehend various aspects of agricultural and household pests and their economic implications. ➤ To learn about the different pest control measures and plant protection appliances. 		
	Desired Outcome: <ul style="list-style-type: none"> ➤ Learner will gain information on the different types of pests and comprehend various aspects of agricultural and household pests and its economic implications. ➤ Learner will derive knowledge of pest control measures and appliances used for plant protection against pests. 		
2.1	Introduction and concept of pest	2L	06hrs
2.1.1	Types of pests: <ul style="list-style-type: none"> • Agricultural • Household • Stored grains • Structural • Veterinary • Forestry 	3L	06hrs

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) Rice weevil e) Pink bollworm	3L	06hrs
2.3	Other pests: Rats and bandicoots, crabs, snails, slugs, birds and squirrels.	2L	06hrs
2.4	Pest control measures: 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
	Objectives: ➤ 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 would 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	4L	08hrs

	<p>lizard and Gharial</p> <p>d) Feathered Biped: Kingfisher, Drongo</p> <p>e) Mammals of India: Malabar giant squirrel</p>		
3.2	<p>The world's most amazing animals (emphasis should be given only on amazing aspects)</p> <p>a) Octopus</p> <p>b) Spider</p> <p>c) Mudskipper</p> <p>d) Flying fish</p> <p>e) Pebble toad</p> <p>f) Strawberry poison frog</p> <p>g) Komodo dragon</p> <p>h) Lesser flamingo</p> <p>i) Great white pelican</p> <p>j) Spatule -tailed hummingbird</p> <p>k) Cheetah</p>	5L	10hrs
3.3	<p>Five most incredible animals discovered within the last decade</p> <p>a) The Purple (joker) crab,</p> <p>b) The African dwarf sawshark (stabbing shark),</p> <p>c) The Psychedelic (crime fighting) gecko,</p> <p>d) The Matilda viper</p> <p>e) The Myanmar snub-nosedmonkey</p>	3L	5hrs
3.4	<p>Marvels of Animals</p> <p>a) Mantis shrimp: Fastest punch</p> <p>b) Homing in Pacific salmon</p> <p>c) Sperm whale: Mechanism of deep sea diving.</p>	3L	08hrs

	PRACTICAL 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: (photograph to be provided)
9	Pedigree analysis
10	Problems based on molecular biology

	SEMESTER III
	Practical USZOP3 (Course - VI)
1	Urine analysis—Normal and Abnormal constituents
2	Detection of ammonia excreted by fish from aquarium water
3	Detection of uric acid from excreta of birds
4	Study of striated and non-striated muscle fibre
5	Study of nutritional apparatus (Amoeba, Hydra, Earthworm, Pigeon, 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/ Clarius, e. Air sacs of Pigeon.
7	Study of locomotory organs (Amoeba, Bivalve, Cockroach, Starfish, Fish, and Bird).
8	Study of hearts (Cockroach, Shark, Frog, Garden lizard, Crocodile, Mammal).
9	Study of permanent slides on Reproduction: (a) Sponge gemmules, (b) Hydra budding, (c) T.S. of mammalian testis, (d) T.S. of mammalian ovary.

	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) Animal instinct c) Imprinting d) Communication in animals: Chemical signals and Sound signals e) Displacement activities in animals: Courtship and mating behaviour in animals and Ritualization
6	Study of Protozoan parasites: a. <i>Trypanosoma gambiense</i> b. <i>Giardia intestinalis</i>
7	Study of Helminth parasites: a) <i>Ancylostoma duodenale</i> b) <i>Dracunculus medinensis</i>
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 (e.g. Apiculture/ Sericulture/ Lac culture / Vermicompost technique / Construction of artificial beehives /Animal husbandry/ Aquaculture etc)

	SEMESTER III
	Practical USZOE2P3 (Course - VIIB)
1	Maintenance of Aquarium—equipment required for setting up of aquarium – Types of filter, type of gravel, aerator pump, lighting, nets, different species of aquatic plants and ornamental fishes.
2	Types of pests –Agricultural-aphids,Household-cockroaches, housefly, Structural-termites,Stored grains-grain borer, Veterinary- fleas, Forestry-caterpillar.
3	Other pests- a) Invertebrates -nematodes, leech, snails, slugs. b) Vertebrates-rats, birds
4	Types of pest control –a) Physical b) Biological c) Electronic d) Insecticides, Rodenticides and Special Treatments
5	Hybrid animals- a) Liger b) Wholphin c) Zebroid d) Savannah cat
6	Most incredible animals in last decades – a) Joker crab b) Snub nose monkey c)Matilda viper
7	Most endangered animals of India – a) One horned rhino b) Asiatic Lion c) Royal Bengal tiger d) Snow leopard
8	A project of aquarium setting in laboratory or vermicomposting.
9	A field visit to study the natural flora and fauna; and submission of report with photographs.

***Note-** The practicals may be conducted by using preserved specimens/permanent slides authorized by the wild life and such other regulating bodies though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/ models etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for 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)
 - 2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done, using animals

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 neighboring colleges.

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

Semester –III

REFERENCE BOOKS AND ADDITIONAL READING

USZO301 (COURSE - V)

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, Leeland H. Hartwell, Leroy Hood, Michael 7. L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education

USZO302 (COURSE - VI)

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- Majumuria 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.

USZOE1303 (COURSE - VIIA)

1. Animal Behaviour- David McFarland
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 Saxena S. C. Oxford and IBH Publishing Co New Delhi. Bombay. Calcutta
8. Bee and Bee Keeping- Roger A. Morse, Cornell University Press London
9. Vermiculture Technology - Clive A. Edwards, Norman Q. Arancon and Rhonda Sherman
10. Parasitology- Chatterjee K.D., Chatterjee Medical Publishers.
- 11 Medical Parasitology- Arora
12. Textbook of Medical Parasitology-.C.K Jayaram Paniker, Jaypee Brothers.
13. A text book of Parasitology- Kochhar S.K. Dominant Pub.& Dis, New Delhi.
14. Essentials of Parasitology- Gerald D. Schmidt: Universal Bookstall, New Delhi.
15. Introduction to Parasitology- Sharma P.N.and Ratnu L.S., Chand S &Co.Pvt.Ltd.
16. Introduction to Parasitology- Chandler and Read John Wiley & Sons
- 17.Economic Zoology Biostatistics and Animal behaviour – S.Mathur, RastogiPublicatons.
18. Economic Zoology- Shukla G.S. & Upadhyay V.B., Rastogi Publications.
19. A handbook on Economic Zoology, S.Chand & Co.

USZOE2303 (COURSE - VIIB)

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. Economic Zoology- Shukla G.S. &Upadhyay V.B., Rastogi Publications.
14. A handbook on Economic Zoology, S. Chand & Co.
15. 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.
16. Park, Y. W., &Haenlein, G. F. (Eds.). (2013). Milk and dairy products in human nutrition: production, composition and health. John Wiley & Sons.
17. Venkatasubramanian, V., Singh, A. K., &Rao, S. V. N. (2003). Dairy development in India: An appraisal of challenges and achievements. Concept Publishing Company.
18. Shrivastava, J. S. M. (2008). Dairy Development In The New Millennium (The Second White Revolution). Deep and Deep Publications.
19. <http://listverse.com/2012/12/03/10-amazing-animal-abilities/>
20. www.toptenz.net/top-10-amazing-animals-discovered-within-the-last-decade.php
21. dailynewsdig.com/top-10-amazing-animal-hybrids.
22. <https://www.pinterest.com/pin/16044142395584735/>
23. www.naturalhistorymag.com/
24. <https://naturalhistory.si.edu/>.

SEMESTER IV

Sr. No	USZO401 (COURSE - VIII)	No. of lect allotted	Learning pleasure
	Origin and Evolution of Life, Population Genetics and Evolution, Scientific Attitude, Methodology, Scientific Writing and Ethics in Scientific Research		
	Unit 1: Origin and Evolution of Life	15L	30hrs
	Objectives: <ul style="list-style-type: none"> ➤ <i>To impart scientific knowledge about how life origin of life on our planet</i> 		
	Desired outcomes: <ul style="list-style-type: none"> ➤ <i>Learner will gain insights into the origin of life.</i> ➤ <i>Learner will analyse and critically view the different theories of evolution.</i> 		
1.1	Introduction <ul style="list-style-type: none"> • Origin of the 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 <ul style="list-style-type: none"> • Evidences from geographical distribution, palaeontology, anatomy, embryology, physiology and genetics 	04L	08hrs
1.3	Theories of organic evolution <ul style="list-style-type: none"> • Theory of Lamarck • Theory of Darwin and Neo- Darwinism • Mutation Theory • Modern synthetic theory • Weismann's Germplasm theory 	06L	12hrs

	Unit: 2: Population Genetics and Evolution	15L	28hrs
	Objective: <ul style="list-style-type: none"> ➤ <i>To develop an understanding of genetic variability within a population and learn as to how the change in the gene pool leads to evolution of species</i> 		
	Desired outcomes: <ul style="list-style-type: none"> ➤ <i>Learner would understand the forces that cause evolutionary changes in natural populations</i> ➤ <i>Learner would comprehend the mechanisms of speciation</i> ➤ <i>Learner will be able to distinguish between microevolution, macroevolution and megaevolution</i> 		
2.1	Introduction to Population genetics <ul style="list-style-type: none"> • Definition • Brief explanation of the following terms: Population, Gene pool, Allele frequency, Genotype frequency, Phenotype frequency, Microevolution 	01L	03hrs
2.2	Population genetics <ul style="list-style-type: none"> • Hardy- Weinberg Law • Factors that disrupt Hardy Weinberg equilibrium: Mutation, Migration (gene flow), Non-random mating (inbreeding, inbreeding depression, assortative mating (positive and negative), disassortative mating, Genetic drift (sampling error, fixation, bottleneck effect and founder effect) • Natural Selection: Patterns of Natural Selection- Stabilizing selection, Directional selection (examples: peppered moth, antibiotic resistance in bacteria, pesticide resistance) and Disruptive selection 	05L	08hrs
2.3	Evolutionary genetics <ul style="list-style-type: none"> • Genetic variation: Genetic basis of variation-mutations and recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random union of gametes during fertilization) • Nature of genetic variations: Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism- 	07L	13hrs

	<p>Heterozygote advantage and frequency dependent selection,</p> <ul style="list-style-type: none"> • 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) 		
2.4	Macroevolution and megaevolution: Concept and Patterns of macroevolution (stasis, preadaptation /exaptation, mass extinctions, adaptive radiation and coevolution), Megaevolution	02L	04hrss
	Unit: 3 Scientific Attitude Methodology, Scientific Writing and Ethics in Scientific Research	15L	32hrs
	<p>Objective:</p> <p>➤ <i>To inculcate scientific temperament in the learner</i></p>		
	<p>Desired outcome:</p> <p>➤ <i>The learner would develop qualities such as critical thinking and analysis</i></p> <p>➤ <i>The learner will imbibe the skills of scientific communication and he/she will understand the ethical aspects of research</i></p>		
3.1	<p>Process of science:</p> <ul style="list-style-type: none"> • A dynamic approach to investigation: The Scientific method, Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery (serendipity) • Scientific research: Definition, difference between method and methodology, characteristics, types • Steps in the Scientific method: Identification of research problem, formulation of research hypothesis, testing the hypothesis using experiments or surveys, preparing research/study design including 	04L	10hrs

	<p>methodology and execution (appropriate controls, sample size, technically sound, free from bias, repeat experiments for consistency), documentation of data, data analysis and interpretation, results and conclusions</p> <ul style="list-style-type: none"> • Dissemination of data: Reporting results to scientific community (publication in peer- reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation) • Application of knowledge: Basic research, Applied research, Translational research, Patent 		
3.2	<p>Scientific writing:</p> <ul style="list-style-type: none"> • Structure and components of a research paper: (preparation of manuscript for publication of research paper- title, authors and their affiliations, abstract, keywords and abbreviations, introduction, material and methods, results, discussion, conclusions, acknowledgement, bibliography; figures, tables and their legends) 	04L	10hrs
3.3	<p>Writing a review paper</p> <ul style="list-style-type: none"> • 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	<p>Ethics</p> <ul style="list-style-type: none"> • Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Dissection Monitoring Committee (DMC) • Ethics in clinical research: Approval from clinical research ethics committee or/and informed consent • 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.	USZO402 (Course - IX)	No. of lectures allotted	Learning pleasure
	Unit 1: Cell Biology	15L	24hrs
	Objective: <ul style="list-style-type: none"> ➤ <i>To study the structural and functional organization of cell with an emphasis on nucleus, plasma membrane and cytoskeleton.</i> 		
	Desired outcome: <ul style="list-style-type: none"> ➤ <i>Learner would acquire insight into the composition of the transport mechanisms adopted by the cell and its organelles for its maintenance and composition of cell</i> 		
1.1	Introduction to cell biology <ul style="list-style-type: none"> • Definition and scope • Cell theory • Generalized prokaryotic, eukaryotic cell: size, shape and structure 	02L	04hrs
1.2	Nucleus <ul style="list-style-type: none"> • Size, shape, number and position • Structure and functions of interphase nucleus • Ultrastructure of nuclear membrane and pore complex • Nucleolus: general organization, chemical composition & functions • Nuclear sap/ nuclear matrix • Nucleocytoplasmic interactions 	05L	06hrs
1.3	Plasma membrane <ul style="list-style-type: none"> • Fluid Mosaic Model • Junctional complexes • Membrane receptors • Modifications: Microvilli and Desmosomes 	04L	08hrs
1.4	Transport across membrane <ul style="list-style-type: none"> • Diffusion and Osmosis • Transport: Passive and Active • Endocytosis and Exocytosis 	02L	04hrs
1.5	Cytoskeletal structures <ul style="list-style-type: none"> • Microtubules: Composition and functions • Microfilaments: Composition and functions 		

	Unit: 2: Endomembrane System	15L	28hrs
	Objective: ➤ <i>To acquaint the learner with ultrastructure of cell organelles and their functions</i>		
	Desired outcome: ➤ <i>Learner would appreciate the intricacy of endomembrane system.</i> ➤ <i>Learner would understand the interlinking of endomembrane system for functioning of cell</i>		
2.1	Endoplasmic reticulum (ER): General morphology of endomembrane system, ultrastructure, types of ER and biogenesis of ER • Functions of Rough Endoplasmic Reticulum(RER) and Smooth Endoplasmic Reticulum(SER)	01L	03hrs
2.2	Golgi complex: Ultrastructure of Golgi complex, functions of Golgi complex (protein glycosylation, lipid and polysaccharide metabolism, protein sorting and secretion, Golgi Anti-Apoptotic Protein -GAAP)	06L	10hrs
2.3	Lysosomes: Origin, occurrence, polymorphism and functions; Peroxisomes: Origin, morphology & functions	03L	5hrs
2.4	Mitochondria: Ultrastructure, chemical composition, functions of mitochondria and bioenergetics (Chemical energy & ATP, Krebs cycle, respiratory chain and oxidative phosphorylation)	05L	10hrs
	Unit: 3 Biomolecules	15L	30hrs
	Objective: ➤ <i>To give learner insight into the structure of biomolecules and their role in sustenance of life.</i>		
	Desired outcome: ➤ <i>The learner will realize the importance of biomolecules and their clinical significance.</i>		
3.1	Biomolecules: Concept of micromolecules and macromolecules	02L	05hrs

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

	SEMESTER IV		
	USZOE1403 (Course - XA)		
	Comparative Embryology, Aspects of Human Reproduction, Pollution and its effect on organisms		
	UNIT 1: Comparative Embryology	15L	25hrs
	Objective: ➤ <i>To acquaint the learner with key concepts of embryology.</i>		
	Desired Outcome: ➤ <i>Learner will be able to understand and compare the different types of eggs and sperms</i> ➤ <i>Learner will be able to understand and compare the different pre- embryonic stages</i>		
1.1	Types of Eggs- Based on amount and distribution of yolk	3L	4hrs
1.2	Structure and Types of Sperms	2L	4hr
1.3	Types of Cleavages	2L	4hrs
1.4	Types of Blastulae	2L	4hrs
1.5	Types of Gastrulae	2L	4hrs
1.6	Coelom -Formation and types	4L	6hrs
	UNIT 2: Aspects of Human Reproduction	15L	30 hrs
	Objectives: ➤ <i>To acquaint the learners with different aspects of human reproduction.</i> ➤ <i>To make them aware of the causes of infertility, techniques to overcome infertility and the concept of birthcontrol</i>		
	Desired Outcome: ➤ <i>Learners will be able to understand human reproductive physiology</i> ➤ <i>Learners will become familiar with advances in ART and related ethical issues.</i>		
2.1	Human reproductive system and hormonal regulation <ul style="list-style-type: none"> Anatomy of human male and female reproductive system 	2L	4hrs

	<ul style="list-style-type: none"> Hormonal regulation of reproduction and impact of age on reproduction - menopause and andropause 		
2.2	Contraception & birth control <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> Causes - Failure to ovulate; production of infertile eggs; damage to oviducts (oviduct scarring and Pelvic inflammatory disease -PID, TB of oviduct), Uterus (TB of uterus and cervix) Infertility associated disorders - Endometriosis, Polycystic Ovarian Syndrome (PCOS), Primary ovarian failure(POF),Sexually Transmitted Infections (STIs) - gonorrhoea, chlamydia, syphilis and genital herpes; Antibodies to sperm; Genetic causes- recurrent abortions Role of endocrine disruptors 	4L	8hrs
2.5	Treatment of infertility <ul style="list-style-type: none"> Removal /reduction of causative environmental factors Surgical treatment Hormonal treatment- fertility drugs Assisted Reproductive Technology (ART) - <i>Invitro</i> fertilization (IVF); Embryo transfer (ET); Intra-Fallopian transfer (IFT), Gamete Intra-Fallopian Transfer (GIFT) &Intra-Zygote Transfer (ZIFT); Intra-cytoplasmic Sperm Injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsies; Testicular sperm extraction (TESE). 	4L	8hrs

	<ul style="list-style-type: none"> • Sperm banks, cryopreservation of gametes and embryos • Surrogacy 		
	UNIT3: Pollution and its effect on organisms	15L	27hrs
	Objective: ➤ <i>To provide a panoramic view of impact of human activities leading to pollution and its implications.</i>		
	Desired Outcome: ➤ <i>The learners will be sensitized about the adverse effects of pollution and measures to control it.</i>		
3.1	Air Pollution <ul style="list-style-type: none"> • Types and sources of air pollutants • Effects of air pollution on organisms, its control and abatement measures 	3L	6hrs
3.2	Water Pollution <ul style="list-style-type: none"> • Types and sources of water pollutants • Effects of water pollution on organisms, its control and abatement measures 	3L	6hrs
3.3	Soil Pollution <ul style="list-style-type: none"> • Types and sources of soil pollutants • Effects of soil pollution on organisms, its control and abatement measures 	3L	4hrs
3.4	Sound pollution <ul style="list-style-type: none"> • Different sources of sound pollution • Effects of sound pollution on organisms, its control and abatement measures 	1L	3hrs
3.5	Pollution by radioactive substances	1L	2hrs
3.6	Pollution by solid wastes <ul style="list-style-type: none"> • Types and sources, • Effects of solid waste pollution, its control and abatement measures 	2L	4hrs
3.7	Pollution – Climate Change and Global Warming	2L	2hrs

	USZOE2403 (Course - XB)		
	Dairy Industry, Sericulture and Aquaculture		
	UNIT 1: Dairy Industry	15L	30hrs
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ <i>To comprehend the functioning of various aspects of dairy industry.</i> ➤ <i>To study different indigenous and exotic cattle breeds including buffalo breeds of India.</i> ➤ <i>To develop an understanding of the different systems of breeding and various aspects dealing with housing of dairy animals.</i> 		
	<p>Desired Outcome:</p> <ul style="list-style-type: none"> ➤ <i>Learner would gain knowledge on the functioning of various aspects of dairy industry, indigenous, exotic cattle and buffalo breeds in India.</i> ➤ <i>Learner will study different systems of breeding and gain information regarding various aspects pertaining to housing of dairy animals.</i> 		
1.1	<p>Indian Cattle breeds – Origin, distribution, distinguishing characters and economic uses;</p> <ul style="list-style-type: none"> • Malvi • Hariyana • Deoni • Red sindhi • Khillari 	2L	4hrs
1.2	<p>Exotic breeds - Origin, distribution, distinguishing characters and economic uses;</p> <ul style="list-style-type: none"> • Jersey • Holstein 	2L	4hr
1.3	<p>Indian buffalo breeds - Origin, distribution, distinguishing</p>	2L	4hrs

	characters and economic uses; <ul style="list-style-type: none"> • Nagpuri • Bhadawari • Murrah • Jafrabadi 		
1.4	Systems of inbreeding and crossbreeding	3L	6hrs
1.5	Maintenance of dairy farm	2L	4hrs
1.6	Weaning of calf, castration and dehorning	2L	4hrs
1.7	Diseases and control	2L	4hrs
	UNIT 2: Sericulture	15L	30 hrs
	Objectives: <ul style="list-style-type: none"> ➤ <i>To comprehend the functioning of sericulture industry and its scope in India.</i> ➤ <i>To study the varieties of silk-worms and host plants.</i> ➤ <i>To critically study the life history and rearing of <i>Bombyx mori</i>, harvesting, processing of cocoon, production of silk and diseases afflicting silk-worms.</i> 		
	Desired Outcome: <ul style="list-style-type: none"> ➤ <i>Learner would understand the basics of the functioning of sericulture industry and its scope in India.</i> ➤ <i>Learner shall gain knowledge on the varieties of silk-worms, host-plants and aspects on silk extraction and the diseases afflicting silk-worms.</i> 		
2.1	Introduction and scope of sericulture	2L	4hrs
2.2	Varieties of silk worm, host plants	2L	4hrs
2.3	Life history and rearing of <i>Bombyx mori</i>	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
	Objectives: <ul style="list-style-type: none"> ➤ <i>To comprehend various kinds of aquaculture practices and its scope as fishery resource in India.</i> ➤ <i>To study various techniques employed in aquaculture practices</i> 		
	Desired Outcome: <ul style="list-style-type: none"> ➤ <i>Learner shall understand the aquaculture practices and the scope of fishery in India.</i> ➤ <i>Learner would gain knowledge of various techniques employed in aquaculture practices.</i> 		
3.1	Pisciculture: <ul style="list-style-type: none"> • Definition and scope of fishery resources in India • Finfish culture – monoculture and polyculture • Role of exotic fishes in polyculture • Cage culture • Fish seed transport • Fish diseases, symptoms and control 	5L	6hrs
3.2	Prawn/shrimp culture: Sources, seed, culture methods – <ul style="list-style-type: none"> • Giant fresh water prawn (<i>Macrobrachium rosenbergii</i>) • White shrimp (<i>Penaeus vannamei</i>) 	5L	6hrs
3.3	Pearl culture: <ul style="list-style-type: none"> • Pearl producing species and their distribution • Pearl culture methods • Composition of pearl 	5L	4hrs

	SEMESTER IV
	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 based on research paper.

	SEMESTER IV
	Practical USZOP4 (Course - IX)
1	Study of permeability of cell through plasma membrane (osmosis in blood cells)
2	Measurement of cell diameter by oculometer (by using permanent slide)
3	Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test, Anthrone test)
4	Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)
5	Qualitative test for lipids (Solubility test, Sudan III test)
6	Study of rancidity of lipids by titrimetric method
7	Ultrastructure of cell organelles (Electron micrographs) of: <ul style="list-style-type: none"> 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 / symptoms to be given and disorder to be identified) a. Hyperglycemia, Hypoglycemia. b. Thalassemia, Kwashiorkar, Marasmus c. Obesity, Atherosclerosis

	SEMESTER IV
	Practical USZOE1P4 (Course - XA)
1	Study of air microflora.
2	Estimation of dissolved oxygen from the given water sample.
3	Estimation of salinity by refractometer from the given water sample.
4	Estimation of conductivity by conductometer from the given water sample.
5	Study of physical properties of soil: Temperature, Moisture and Texture
6	.Study of chemical properties of soil- pH, organic matter
7	Study of sound pollution monitoring device
8	Detection of pregnancy hormone from given sample of urine/birth control pill
9	Study of birth control devices applicable to humans
10	Study of the following permanent slides, museum specimens and materials a. Mammalian sperm and ovum b. Egg types –fish egg, frog egg, hen's egg c. Cleavage, blastula and gastrula (Amphioxus, Frog and Bird)
11	Review writing based on programmes telecast by Doordarshan, Gyandarshan, UGC programmes or other media sources
12	Study of natural ecosystem and field report of the visit

	SEMESTER IV
	Practical USZOE2P4 (Course - XB)
1	Comparison of protein content : Cow and Buffalo milk.
2	Comparison of fat content : Cow and Buffalo milk.
3	Preparation of falooda.
4	Preparation of caramel custard.
5	Restraining devices used in cattle farming- Halters, gags, bull-rings, muzzles, cradle, crush and ropes.
6	Study of Life cycle of <i>Bombyx mori</i>
7	Study of commercially important fishery.(Catla, Rohu, Catfish, Mackeral, Pomfret, Bombay duck, Prawn/Shrimp, Crab, Lobster, Edible oyster)
8	Study of Crustacean fishery – common characters and sexual dimorphism in lobster (<i>Panulirus spp.</i>),prawn (<i>Penaeus spp.</i>),crab (<i>Scylla spp.</i>)
9	Visit to dairy farm /aquaculture and submit report of the same.

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

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 as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for 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/DISSECTION/MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Semester IV

References and additional reading

USZO401 (COURSE - VIII)

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

USZO402 (COURSE - IX)

1. Cell Biology. Singh and Tomar, Rastogi Publication.
2. Cell and Molecular Biology E.D.P De Robertis and E.M.R Robertis ,CBS Publishers and Distributors.
3. The cell A molecular Approach GoeffreyM.Coper ASM Press Washington D.C.
4. A textbook of cytology SuruchiTyagi Dominant Publishers and Distributors New Delhi.
5. Cell and molecular biology Gupta P.K ,Rastogi Publication, India.
6. Cell Biology Pawar C.B. Himalaya publication
7. Molecular Biology of the cell (6thed) by the Insertus
8. Campbell Biology (9th Ed.)
9. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M ,
10. Biochemistry, Dushyant Kumar Shrma, 2010, Narosa Publishing house PVT.Ltd.
11. Fundamentals of Biochemistry, Dr AC Deb, 1983, New Central Book Agency Ltd.
12. A Textbook of Biochemistry, 9th edition, Dr. Rama Rao A.V.S.S and Dr A Suryalakshmi.
13. Biochemistry-G Zubay , Addison Wesley, 1983
14. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989 , Freeman and Co. NY
15. Harper's Biochemistry, 1996, 26th edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA
16. Outline of Biochemistry, 1976, E.E. Conn and P.K. Stumpf. John Wiley and Sons USA

USZOE1403 (COURSE - XA)

References of Elective 1

1. Developmental Biology- 5th Edition, Scot F.Gilbert, Sinauer Associates Inc.
2. Developmental Biology- Subramoniam T., Narosa Publishers.
3. Developmental Biology-Berril N.J., Tata McGraw –Hill Publication.
4. Essential Reproduction-Martin H. Johnson, Wiley-Blackwell Publication.
5. Chick Embryology- Bradley M. Pattern.
6. Embryology-Mohan P. Arora.
7. Chordate Embryology-Dalela, Verma and Tyagi
8. Human Anatomy and Physiology. E. L. Marieb, Pearson Education Low Price Edition
9. Biological Science. Taylor, Green and Stout. Cambridge Publication
10. Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
11. Human Biology-Daniel D Chiras Jones and Bartlett
12. The Physiology of Reproduction Vol I & II - E.K .Nobil and JU. D.Neil, Raven Press, New York.
13. Air Pollution,Kudesia V.P. PragatiPrakasan,Meerut
14. Fundamentals of Air PollutionDaniel A.Vallero,Academic press 5th Edition
15. Principles and Practices of Air Pollution Control and Analysis J.R. Mudakani I K International Pub. House Pvt. Ltd.
16. Text Book of Air Pollution and its Control,S.C.Bhatia Atlantic
17. Water Pollution,Kudesia V.P.,PragatiPrakasan,Meerut
18. A text book of Environmental Chemistry and Pollution Control,S.S.Dogra,SwasticPub,New Delhi
19. Practical Methods for water and Air Pollution Monitoring,S.K.Bhargava,New Age International
20. Hand Book of Water and waste water Analysis,Kanwaljit Kaur,Atlantic
21. Aquatic Pollution by Edward A.Laws
22. Environmental Science and Technology,Stanely E.Manahan
23. Environmental Chemistry,A.K.De, New Age International
24. A Text Book of Environmental Studies,Gurdeep R.Chatwal,Harish Sharma,Madhu Arora,

USZOE2403 (COURSE - XB)

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. Thompson and Lathasabikhi
New India Publishing agency, New delhi
 7. Outlines of Dairy Technology Sukumar De Oxford University Press, New delhi
 8. Food Microbiology William C. Frazier, Dennis C. Westoff Tata McGraw 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. Latest Aquaculture, Principles and Practices by Pillay T.V.R. – Fishing News Books (1988).
 16. Course Manual in Fishing Technology by Latha Shenoy, CIFE, Versova, Mumbai.
 17. Prawn and Prawn Fisheries by Kurian and Sebastian
 18. Freshwater R.k. rathy Scientific publication
- aquaculture
- | | | | |
|----|--|-----------------|----------------------|
| 19 | A text book of fish biology and fisheries | Khanna & Singh | Narendra Publication |
| 20 | Handbook of fisheries and aquaculture | Yadav | ICAR |
| 21 | Fish processing technology | Gopakumar | ICAR |
| 22 | Ornamental fish farming | Saroj. K, swain | ICAR |
| 23 | Sport fisheries of india | K.I. sehgal | ICAR |
| 24 | Coldwater fisheries of india | V.g. jhingran | ICAR |
| 25 | Fish nutrition in aquaculture | Sena s. Desilva | ICAR |
| 26 | Practical course manual fishery and gear
technology | Lathashenoy, y | CIFE, Mumbai |
| 27 | Breeding and seed production of finfish and
shellfish | Thomas, rath | Daya pub. |
| 28 | Fundamental of fish taxonomy | Jayaram, KC | Narendra |
| 29 | Limnology | Welch | Narendra |
| 30 | Model question bank on ICAR J.R.F | Ratanankumar, K | Narendra |
| 31 | Manual of freshwater biota | Jayshree Datta | Narendra |

		Munshi	
32	Ornamental fish culture and aquarium management	Dholakia	Astral
33	Postharvest technology of fish and fish products	Balachandran	Astral
34	Handbook of freshwater fishes of India	Beaven R	Techno
35	Conservation and management of aquatic ecosystems	Unni, K Sankaran	Daya
36	Modern fishing gear technology	Hameed, M Shahul	Daya
37	Introduction to fish physiology	Smith, L.S	Narendra
38	Textbook of fish biology and fisheries	Khanna/Singh	Narendra
39	Textbook of fish diseases	Amalacher, E	Narendra
40.	Indian silk - monthly journal		
41.	Seri business manual – a user’s guide (Eng)		
42.	Handbook of Sericulture Technologies 4th Edition (Tamil)		
43.	Handbook of Sericulture Technologies 5th Edition (English)	44.	Handbook of Sericulture Technologies 4th Edition (Kannada)
45.	Vanya Silk Directory (English)		
46.	Compendium of statistics of silk industry – 1999 in English		
47.	Sericulture & silk industry statistics – 2003 (with CDR version)		
48.	Sericulture & silk industry statistics – 2007 (with CD version)		
49.	Sericulture & silk industry statistics – 2012 (with CD version)		
50.	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		
51.	Cac text books in English		
	* Silkworm Rearing Technology		
	* Mulberry Cultivation & Physiology		
	* Mulberry Crop Protection		
	* Sericulture Extn. Management & Economics		
	* Silkworm Crop Protection		
	* Silkworm Breeding & Genetics		

52. Handbook of practical sericulture (english & hindi)
53. Handbook of muga culture in english
54. Sericulture in india in english
55. Tips to successful silkworm cocoon crops
56. Guidelines for bivoltine rearing:
57. CSR & TI (mysore) bulletins on improved practices of sericulture in Hindi & Telugu
58. Reports of Indian Delegations: Sericulture in Japan & South Korea Vol. I & II in English
59. Proceedings of the International Congress on Tropical Sericulture - 1988 in English
60. Satellite Remote Sensing Applications for Sericulture Development in English

MARKING 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

Draw neat and labeled diagrams wherever necessary

Time: 3 hours

Total Marks: 100

Q1	Objective*	20 marks
Q.2.	UNIT 1 a. Answer any one of the two (10 marks) b. Answer any two out of the four (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 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.5.	Answer any four out of six Unit 1 - (Two notes of five marks each) Unit 2 - (Two notes of five marks each) Unit 3- (Two notes of five marks each)	20 marks

Note: 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

PRACTICAL (SEMESTER III)

USZOE1P3 (Course - VIIA)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min**Marks: 50**

Major Question

12

Q1. Extraction of casein from milk and its qualitative detection

OR

Q1. Preparation of paneer from the given milk sample.

OR

Q1. Measurement of density of different ssamples of milk by lactometer

Minor Question (Sketch and label)

08

Q2. Life cycle of honey bee

OR

Q2. Mouthparts of honey bee

OR

Q2. Legs of honey bee

OR

Q2. Sting apparatus of honey bee

Q3. Identify and describe as per instructions

15

- Ethology
- Protozoan parasites
- Helminth parasites
- Ectoparasites
- Parasitic adaptations

Q4. a) Project submission

06

b) Viva based on project

04

Q5. Journal

05

////////////////////////////////////

PRACTICAL (SEMESTER IV)

USZOP4 (Course - VIII)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min

Marks:

50

Major Question

Q1. Study Population density by Line transect or Quadrant method and calculate Biodiversity

Indices (any 2)

12

Minor Question

08

Q2. Prepare a smear to show prokaryotic cell

OR

Q2. Prepare a smear to show eukaryotic cell

Q3. Identify and describe as per instructions

08

a. Fossil b. Speciation

Q4. From the given article, prepare the bibliography/ abstract

06

Q5. Power point presentation

06

Q6. Viva

05

Q.7.Journal

05

[illegible]

PRACTICAL (SEMESTER IV)

USZOP4 (Course - IX)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min**Marks:**

50

Major Question

15

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

OR

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

Minor Question

10

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, Xanthoprotein 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

i. Ultrastructure of cell organelles (a, b & c)

ii. Clinical disorders (d & e)

Q4. Viva

05

Q5. Journal

05

////////////////////////////////////

PRACTICAL (SEMESTER IV)

USZOE1P4 (Course - XA)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min**Marks: 50**

Major Question

12

Q1. Estimation of Dissolved Oxygen from the given water sample

OR

Q1. Detection of pregnancy hormone from given sample of urine/birth pill

OR

Q1. Determination of organic matter from the given soil sample.

Minor Question

08

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 the pH of the given soil sample

OR

Q2. Determine the texture of the given soil sample

Q3. Identify and describe as per instructions

15

i. Permanent slides (a &b)

ii. Fishery (c,d & e)

Q4. Field Report and viva based on it.

10

Q5. Journal

05

////////////////////////////////////

PRACTICAL (SEMESTER IV)

USZOE2P4 (Course - XB)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min**Marks:**

50

Major Question

15

Q1.Comparison of protein content from cow and buffalo milk

OR

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

Minor Question

08

Q.2 Preparation of falooda

OR

Q.2 Preparation of caramel custard

Q.3 Identification (3 marks each)

12

- Restraining device
- Any stage of life cycle of *Bombyx mori*
- Commercial fishery
- Crustacean fishery

Q4. Project report submission and Viva based on it

10

Q5. Journal

05

[illegible]

MODEL QUESTION BANK SEMESTER III

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

USZO301 (COURSE - V)

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. Write a note on the chromosome theory of inheritance
5. Describe co-dominance with a suitable example
6. Give an account of the symbols used in human Pedigree analysis
7. Characteristics of autosomal dominant traits
8. Characteristics of X-linked recessive traits
9. Characteristics of autosomal recessive traits
10. Characteristics of X-linked dominant traits
11. Intermediate lethal alleles
12. Explain the inheritance of skin colour in humans
13. Write a note on pleiotropy.

Unit: 2 (10 Marks).

1. Explain the structure of eukaryotic Chromosome
2. Classify chromosomes on the basis of the 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 Honey bee and 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 Gynandromorphs
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 limited 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

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

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

MODEL QUESTION BANK SEMESTER – III

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

USZO302 (COURSE-VI)

Unit 1: (10 Marks)

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

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. Describe briefly excretory and osmoregulatory structures in arthropods.
11. Write a note on structure of mammalian kidney.
12. Write a note on Ammonotelic organisms.
13. Write a note on Ureotelic organisms.
14. Write a note on Uricotelic organisms.
15. 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 book lungs in spider.
3. Explain the structure of gills of bony fish
4. Describe briefly lungs as respiratory organs in frog.
5. Describe briefly lungs as respiratory organs in man.
6. Write short note on open circulation.
7. Write short note on closed circulation.
8. Write a note on heart of cockroach
10. 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. Explain Sol-Gel theory of amoeboid movement.
5. Describe ciliary movement in *Paramecium*.
6. Give an account on types of wings in insects.
7. Explain types of fins in Pisces.
8. Describe sliding filament theory.
9. Describe briefly asexual reproduction in animals.
10. Describe the structure and function of tube feet.
11. Describe spermatogenesis.

12. Describe oogenesis.
13. Describe briefly the structure of mammalian gametes.
14. 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-viviparity.
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 animals.

MODEL QUESTION BANK SEMESTER – III

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

USZOE1303 (COURSE - VIIA)

Unit 1: (10 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 animal 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. Comment on any two aspects of non-human primate social behaviour.

Unit 1: Write short notes on: (5 marks)

- i. Mimicry
- ii. Innate learning
- iii. Acquired learning
- iv. Warning colouration
- v. Imprinting
- vi. Classical Conditioning
- vii. Territorial behaviour
- viii. Schooling behaviour
- ix. Altruism
- x. Kinship
- xi. Displacement activities
- xii. Ritualization

Unit 2: (10 Marks)

1. Give an account of the life history and pathogenicity of the parasite causing amoebic dysentery.
2. Describe the life history of *Taenia solium*.
3. Give an account of parasitic adaptive features of *Taenia solium*.
4. Give an account of the life history of *Fasciola hepatica*.
5. Give an account of the life history of filarial worm and discuss its pathogenic effects.
6. Describe the life history of bedbug and suggest some control measures.
7. Give an account of the life history of *Sarcoptes scabiei*.
8. Give an account of the life history of head louse *Pediculus*.
9. What is bird flu? How it spreads and what are its symptoms?
10. How would you control the transmission of anthrax among humans?
11. 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 pathogenicity of *E. histolytica*.
4. Briefly describe the life cycle of *E. histolytica*.
5. Illustrate the complete life history of *T. solium* with the help of diagram only.
6. What is the effect of *Fasciola* on the hosts?
7. What are the primary and secondary hosts of *Wuchereria bancrofti*? 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 in human?
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. Pathogenicity 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. Enumerate the advantages of vermiculture
5. Describe any two methods of vermiculture.
6. Describe the processing of raw milk.
7. Write a brief note on Type A1 and A2 cow milk.

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 whole milk and toned milk? How is toned milk prepared?

MODEL QUESTION BANK SEMESTER – III

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

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 behaviour of Octopus and spider as most dedicated mothers in the world.
3. Describe marvellous characters of fan throated lizard and flying frog.
4. Describe marvellous characters of Mantis shrimp.
5. Give a brief account on Malabar giant squirrel
6. Describe marvellous characters of the Purple (Joker) crab and lesser flamingo.
7. Describe marvellous characters of the Stabbing Shark and Crime Fighting gecko.
8. Describe marvellous characters of the Gharial and the Matilda Viper

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. Rice weevil.
5. Non-insect pests
6. Cultural control
7. Physical control
8. Mechanical control
9. Chemical control
10. Biological control,
11. 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 squirrel

10. Cheetah,

11. Octopus

MODEL QUESTION BANK SEMESTER - IV

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

USZO401 (COURSE - VIII)

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. Discuss evidences in favour of organic evolution by giving examples of geographical distribution
3. Discuss evidences in favour of organic evolution by giving examples based on genetic studies.
4. Discuss evidences in favour of organic evolution by giving examples based on physiological studies.
5. Give a brief account on the origin of eukaryotic cell

Unit 1: (5 Marks)

1. Describe Miller-Urey experiment simulating Chemical evolution.
2. Describe chemical evolution as postulated by the 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
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 scientific research

MODEL QUESTION BANK SEMESTER - IV

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

USZO402 (COURSE - IX)

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 interactions.
7. Describe fluid mosaic model of plasma membrane.
8. Give an account of active and passive transport
9. Describe various modifications of plasma membrane
11. Explain endocytosis and exocytosis
12. Give an account on cell permeability
13. Differentiate prokaryotic and eukaryotic cell

Unit 1: Write a short note on (5 Marks)

1. Virus
2. Nuclear matrix
3. Number and position of nucleus.
4. Nucleolus
5. Membrane receptors

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 on glycolysis
17. Write a short note on Krebs's cycle
18. Write a short note on oxidative phosphorylation

Unit 3: (10 Marks)

1. Explain the concept of micromolecules and macromolecules.
2. Define carbohydrate. Add a note on its classification.
3. What are carbohydrates? Explain the classification of carbohydrate with suitable examples.
4. Explain with suitable example monosaccharide and disaccharide.
5. Discuss the properties of carbohydrates.
6. What are disaccharides? Draw the structures of maltose and sucrose.

7. What are polysaccharides? How are they classified? Write the structures of glycogen and heparin/ chitin and heparin.
8. Discuss about chemical structure of the monosaccharides/ disaccharides.
9. What are amino acids? Discuss classification of amino acids based on R group.
10. Give an account of primary and secondary structure of proteins.
11. Write an account on tertiary and quaternary structure of proteins.
12. Describe the structure of saturated and unsaturated fatty acids.
13. What are fatty acids? Add a note on types of fatty acids.
14. Describe the structure and functions of water soluble vitamins.
15. 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.
10. Explain 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. Sterols
17. Describe properties of 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/amino acids?
21. Describe the structure and functions of vitamin A/ vitamin B/ vitamin C/ vitamin D.

MODEL QUESTION BANK SEMESTER - IV

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

USZOE1403 (COURSE - XA)

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

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
- 8) Explain the process of gastrulation.

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)?

Unit 2: (5 Marks)

1. Write a note on impact of age on reproductive stage –
 - a. Menopause
 - b. Andropause
2. What is amenorrhea?
3. How does sterilization act as a method of contraception?
4. Write a note on birth control.
5. What is the difference between natural and artificial methods of contraception?
6. How is T.B. a cause of female infertility?
7. What are the genetic causes of infertility?
8. Write a note on STD's as infertility related disorders?
9. What are the roles of endocrine disruptions in infertility?
10. Explain the role of the following in infertility:
 - a. Gonorrhoea
 - b. Syphilis
 - c. Genital Herpes
 - d. Chlamydia
11. Write a note on treatment of infertility by removal of causative environmental factors.

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. What is ocean littering? Explain in detail the causes and control measures for ocean littering?
7. Describe the alteration of metabolism of micro-organisms due to soil pollution.
8. Explain noise pollution along with its measurement and permissible limits.
9. Give a brief account of methods to control gaseous / particulate matters.
10. What is pollution? Add notes on:
 - a. Effect of air pollution on vegetation.
 - b. Effect of noise pollution on animals.

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 ionizing radiation
6. How is oil spills a cause of water pollution / ocean littering?
7. How do pesticides and fertilizers contaminate water?
8. How can oil be retracted back from sea / ocean?
9. What are the effects of soil pollution on food chain?
10. What are the auditory / non – auditory effects of noise pollution.

MODEL QUESTION BANK SEMESTER - IV

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

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 pisciculture, add a note 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. Fish diseases
5. Symptoms of diseases
6. Control of diseases

-----*The End*-----

UNIVERSITY OF MUMBAI

No. UG/17 of 2018-19

CIRCULAR:-

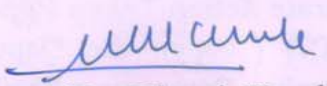
Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/153 of 2017-18, dated 3rd August, 2017 relating to syllabus of the Bachelor of Science (B.Sc.) degree course.

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).

MUMBAI - 400 032

14th June, 2018

To


(Dr. Dinesh Kamble)
I/c REGISTRAR

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

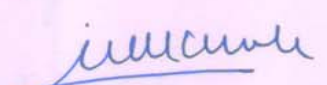
No. UG/17 -A of 2018

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)	Dr. Ghanashyam K. Amte (Co-Convenor)
Capt. Dr. A. A. Dalvi (Co-Convenor)	Dr. Jayasree Sasangan (Co-Convenor)
Dr. Mrinalini Kagwade (Co-Convenor)	Dr. Supriya Deshpande (Co-Convenor)
Dr. Vinod Ragade (Co-Convenor)	Mrs. Usha Anilkumar (Co-Convenor)
Dr. Sharad Mahajan (Co-Convenor)	Dr. Bhavita Chavan (Co-Convenor)
Dr. Kishori Sinnarkar (Co-Convenor)	Dr. D. L. Bharamal (Co-Convenor)
Dr. G. S. Margaj (Co-Convenor)	Dr. Vasantao Patole (Co-Convenor)
Dr. Leena Meshram (Co-Convenor)	Dr. Ugeshkumari Singh (Co-Convenor)
Dr. Shaila Mane (Co-Convenor)	Mr. Sachin Gosavi (Co-Convenor)
Dr. Vishakha Shingala (Co-Convenor)	Dr. Utkarsha Chavan (Co-Convenor)
Dr. Snehal Donde	Dr. Sudesh Rathod
Dr. Shantaj Deshbhratar	Dr. Roshan D'Souza
Dr. Satish Sarfare	Dr. Aamod Thakkar
Dr. Gulabrao Raje	Mr. V. B. Dandwate
Dr. Rupinder Kaur	Dr. Rana Ansaria
Mrs. Parimita Sharma	Dr. Janhavi Bhagwat
Mr. Deepak Poojary	Mr. Vishal Nangare
Dr. Pawankumar Mudbe	Dr. Udayan Apte
Dr. D. V. Pawar	Mr. Rohit Nagalgaon
Mr. Ashish Sharma	Ms. Neha Vajandar
Mr. Abhimanyu Londhe	Ms. Uma Bandekar
Ms. Rajeshree Prasad	Ms. Shagufa Shaikh
Mr. Kaustubh Bargode	Ms. Reena Patil
Ms. Mahalaxmi Pillai	Ms. Nausheen Shaikh
Mr. Sankalp Bandekar	Ms. Kranti Patil
Mr. Saurabh Kadam	

CONTENTS

- 1. Preface**
- 2. Preamble**
- 3. Pedagogy**
- 4. Tables of Courses, Topics, Credits and Workload**
- 5. Theory Syllabus for Semester V (Course codes: USZO501-USZO504)**
- 6. Practical Syllabus for Semester V (Course code: USZOP05)**
- 7. References and Additional Reading (Course codes: USZO501-USZO504)**
- 8. Learners' Space (Course codes: USZO501-USZO504)**
- 9. Theory Syllabus for Semester VI (Course codes: USZO601-USZO604)**
- 10. Practical Syllabus for Semester VI (Course code: USZOP06)**
- 11. References and Additional Reading (Course codes: USZO601-USZO604)**
- 12. Learners' Space (Course codes: USZO601-USZO604)**
- 13. Marking Scheme of Examination (Theory and Practical)**
- 14. Skeleton Practical Exam Papers: Semester V and Semester VI**
- 15. Add-on Project (Course codes: USZOR01 and USZOR02)**

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: <i>Sepia</i>		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 Archaeobacteria
- 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

- General characters
- 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

- General characters
- 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)
- Morphology, life cycle and pathogenicity of *Fasciola hepatica*

2.4: Phylum Nematoda

- General characters
- 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 Aplousobranchia e.g. *Chaetoderma* (Glistening worm solenogaster)
- Class Polyplacophora 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 Asterozoa e.g. *Protoreaster* (Starfish)
- Class Ophiurozoa e.g. *Ophiothrix* (Brittle star)
- Class Echinozoa e.g. *Clypeaster* (Sand dollar)
- Class Holothurozoa e.g. *Cucumaria* (Sea cucumber)
- Class Crinozoa 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 Planctosphaerozoa e.g. *Planctosphaera*

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 LD₅₀, LC₅₀, ED₅₀

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 digitorum 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. *Paramecium*
- 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 Aphasmda (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 CCl₄ 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

Course 11:

REFERENCES

- A manual of Zoology - Part I, Invertebrata; Ayyar, M. Ekambaranath
- Invertebrate Zoology - Volumes of different Phyla; Hyman L.H.
- Instant Notes in Animal Biology by Richard D. Jurd.
- Introduction to Zoology - Vol I: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book Agency.
- Modern text book of Zoology - Invertebrates; Eleventh; Edition Professor R.L. Kotpal; Rastogi publication
- Invertebrate Zoology by E. L. Jordan & P. S. Verma Rev. edition, 2009, Chand publications
- Invertebrate Zoology by P. S. Verma, edition, 2009, Chand publications
- Zoology for degree students, Non chordates by V.K. Agarwal 2011, S. Chand Publication
- Zoology for Degree Students, B.Sc. First Year, by V. K. Agarwal, Pub. S. Chand Coy.
- B. Sc. Zoology, Invertebrate Zoology by V.K. Aggarwal 2017, S. Chand publications
- Invertebrate Zoology by Fatik Baran 2012, PHI Learning
- A Textbook of Invertebrates by N.C. Nair et al. 2010 Saras publications
- Practical Zoology: Invertebrate, by S. S. Lal, 2016
- Invertebrate Zoology by Ruppert, Fox, Barnes, 7th edition, 2003 publications Cengage Learning
- Invertebrate Zoology by D.T. Anderson 2nd edition 2002, publications Oxford
- Invertebrates by Richard C. Brusca et. al, 3rd edition 2016, publications Oxford
- Biology of the invertebrates by Jan A. Pechenik, 7th edition, 2014 publications McGraw Hill
- An introduction to the invertebrates by Janet Moore, 2nd edition 2006, publications Cambridge
- Protozoology, by S. V. Nikam & S. T. Tanveer ed. 2011, Pub. Oxford Book Company (N.B.: This book includes Phylum Sarcomastigophora)

ADDITIONAL READING

- <https://www.earthlife.net/inverts/an-phyla.html>
- <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>
- <http://www.biology-pages.info/I/Invertebrates.html>
- <https://portals.iucn.org/library/sites/library/files/documents/2012-064.pdf>
- <http://instruction2.mtsac.edu/mcooper/Biology%202/Labs/ProtistLab1.pdf>
- <http://www.faculty.ucr.edu/~legneref/invertebrate/inverteb.htm>
- <http://www.cbv.ns.ca/mchs/diversity/ProtozoansPage1.html>
- http://bioweb.uwlax.edu/bio203/s2009/maiers_andr/Classification.htm
- <https://www.earthlife.net/inverts/annelida.html>
- <https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/worms-phyla-platyhelminthes-nematoda-and-annelida>
- http://www.fossilmuseum.net/Tree_of_Life/PhylumAnnelida.htm
- <http://www.austincc.edu/sziser/Biol%201413/LectureNotes/InexamIII/Phylum%20Annelida.pdf>
- <http://animaldiversity.org/accounts/Annelida/classification/>

- <http://faculty.college-prep.org/~bernie/sciproject/project/Kingdoms/Animal%20Kingdom%20-%205/Local%20copy/classification/arthropoda.html>
- http://bio.rutgers.edu/~gb102/lab_2/309am-arthro.html
- <http://www.auburn.edu/academic/classes/biol/1030/boyd/lect10-14outline.htm>
- http://www.fossilmuseum.net/Tree_of_Life/PhylumArthropoda.htm
- <http://www.geo.arizona.edu/geo3xx/geo308/FoldersOnServer/2003/3Mollusca.htm>
- http://www.fossilmuseum.net/Tree_of_Life/PhylumMollusca.htm
- <http://www.geo.arizona.edu/geo3xx/geo308/FoldersOnServer/2003/Lab7EchinoArthro.htm>
- <https://www.earthlife.net/inverts/echinodermata.html>
- <http://www.uky.edu/OtherOrgs/KPS/paleoclass/pages/wimbergechinodermata.htm>
- http://www.fossilmuseum.net/Tree_of_Life/Phylum-Echinodermata.htm

Course 12

REFERENCES

- Human Physiology - Volume 1; C.C. Chatterjee.
- Essentials of Haematology; Shirish M. Kawthalkar; Jaypee Brothers.
- Williams Hematology; Kenneth Kaushansky, Marshall A. Lichtman, E. Beutler, Thomas J. Kipps, Josef Prchal, Uri Seligsohn.
- Essential Haematology; Victor Hoffbrand, Paul Moss, John Pettit.
- Rapid Review of Hematology; Ramadas Nayak; Jaypee Brothers.
- Precise Haematology; Usha Rusia, Meera Sikka, Renu Saxena; Wiley India.
- Short Textbook of Haematology; Shah B.S.; C.B.S. Publisher and Distributor.
- Practical Zoology; Second Edition; Dr. K.C. Ghose & Dr. B. Manna; New Central Book Agency Pvt. Ltd., Kolkata; 1999.
- Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
- A Text book of Practical Physiology; First Edition; V.G. Ranade; A.V.G. Prakashan, Pune; 1968.
- Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.; 2012.
- Biochemistry; Fourth Edition; U. Satyanarayana & U. Chakrapani; Elsevier; 2013.
- Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006.
- Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014.
- Harrison's Hematology and Oncology; 3rd Edition (Harrison's Specialty); Dan Longo; McGraw-Hill.
- Essentials of Haematology; Second Edition; Kawthalkar Shirish M.; Jaypee; 2013.
- Medical Biochemistry by C. Jaypee; 2012.
- Essentials in Hematology and Clinical Pathology; Nayak, Ramadas.
- Clinical Pathology and Hematology; Maheshwari, Nanda; Jaypee.
- Practical Hematology; Dacie J V; Churchill Livingstone; 2006.
- Lecture Notes: Haematology; Hatton, Chris S. R. Hughes-Jones, Nevin C. Hay, Deborah; Wiley-Blackwell.
- ABC series: ABC of Clinical Haematology; Provan; Drew Publisher: BMJBooks.
- Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.; 2012.
- Biochemistry; Fourth Edition; U. Satyanarayana & U. Chakrapani; Elsevier; 2013.
- Immunology - Introductory Textbook; Shetty N.; New Age International; 2005.
- Immunology - Essential and Fundamental; Pathak S., & Palan U.; Science Publishers; 2005.
- Immunology: A textbook; Rao C. V.; Alpha Science Int'l Ltd.; 2005.
- Ananthanarayan and Paniker's textbook of Microbiology; C. J. Paniker (Ed.); Ananthanarayan R.; Orient Blackswan; 2005.
- Textbook of Immunology; Haleem Khan, Rajendra Sagar, Sadguna.
- Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher J. Woolverton; McGraw-Hill Education; 2014.
- Immunology; Third Edition; Janis Kuby; W.H. Freeman; 1997.
- Kuby Immunology; Sixth Edition; Thomas J. Kindt, Richard A. Goldsby, Barbara Osborne & Janis Kuby; W.H. Freeman; 2007.
- Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006.

- Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014.
- Cellular and Molecular immunology; Abbas A. K., Lichtman A. H. & Pillai S.; Elsevier Health Sciences; 2014.
- Roitt's Essential Immunology - Vol. 20; Delves P. J., Martin S. J., Burton D. R., & Roitt I. M.; John Wiley & Sons; 2011.
- The Elements of Immunology; Khan F.H.; Pearson Education, India; 2009.
- Kuby Immunology; Sixth Edition; Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne & Janis Kuby; W.H. Freeman; 2007.
- Janeway's Immunobiology; Murphy K. & Weaver C.; Garland Science; 2016.
- Fundamental Immunology; Paul W. E.; Philadelphia: Lippincott-Raven; 1999.
- Immunology - Introductory Textbook; Shetty N.; New Age International; 2005.
- Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher J. Woolverton; McGraw-Hill Education; 2014.
- Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014.
- Lehninger's Principles of Biochemistry; David Lee Nelson, A. L. Lehninger, Michael M Cox; W.H. Freeman, New York; 2008.
- Biochemistry; 5th ed.; J M Berg, J L Tymoczko and Lubert Stryer; W.H. Freeman, New York; 2002.
- Biochemistry; 2nd edition; Donald Voet and Judith G Voet; J. Wiley and Sons, New York; 1995.

ADDITIONAL READING:

- Biology - A Global Approach; Tenth Edition (Global Edition); Campbell, Reece, Urry, Cain, Wasserman, Minorsky & Jackson; Pearson Education Ltd., England; 2015.
- Biology; Seventh Edition; Neil A. Campbell & Jane B. Reece; Pearson Education, Inc.; 2005.
- Biology; Student Edition; Kenneth R. Miller & Joseph S. Levine; Prentice Hall; 2007.
- Biology: Eleventh Revised Edition; Sylvia S. Mader & Michael Windelspecht; McGraw-Hill Education; 2012.
- Biology - Concepts & Applications; Sixth Edition; Cecie Starr; Brooks/ Cole; 2005.
- The Emperor of All Maladies: A biography of Cancer; Siddhartha Mukherjee; Scribner, New York; 2010.
- Molecular Cell Biology; Fifth edition; Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky & James Darnell; W.H. Freeman & Company, New York; 2004.
- 'India facing shortage of life-saving albumin serum'; written by Abantika Ghosh, New Delhi; The Indian Express, October 16, 2014, 2:25 am.
- Articles on "Blood groups"; (1) The Indian Express, August 15, 2012/ Times of India, August 16, 2012; (2) Times of India, September 11, 2014.
- 'Nanoparticle vaccine shows potential as immunotherapy to fight multiple cancer types'; UT Southwestern Medical Center; Science Daily, April 24 2017; <https://www.sciencedaily.com/>.
- Textbook of Biochemistry with clinical correlations; Fourth Edition: Edited by Thomas M.Devlin; Wiley-Liss Publication.
- Biochemistry; Third Edition: Pamela C. Champe, Richard A. Harvey, Denise R. Ferrier; Indian Edition by JP Publication.

Course 13

REFERENCES

- A Textbook of Histology; Deshmukh Shivaji; Dominant Pub.
- Colour Textbook of Histology; Gartner, Leslie P.; Saunders.
- A Textbook of Histology; Mathur Ramesh; Anmol Pub.
- A Textbook of Histology and A Practical Guide; Gunasegaran J.P.; Elsevier
- A Textbook of Histology; Khanna D.R.; Sonali Pub.
- Practical Zoology; Second Edition; Dr. K.C. Ghose&Dr. B. Manna; New Central Book Agency Pvt. Ltd. , Kolkata; 1999.
- Casarett and Doulls Toxicology - The basic science of poisons; Edited by Curtis Klaassen; McGraw-Hill; 2001.
- Toxicological testing handbook - Principles, applications and data interpretation; David Jacobson-Kram and Kit Keller; CRC Press; 2006.
- Principles and methods of toxicology; A. Wallace Hayes; CRC Press; 2007.
- Toxicology - principles and methods; M.A. Subramanian; MJP Publishers, Chennai; 2004.
- Fundamentals of Toxicology; Kamleshwar Pandey and JP Shukla; New Central book agency Ltd., Kolkata; 2011.
- Elements of Toxicology; Kamleshwar Pandey and JP Shukla; Wisdom Press, New Delhi; 2010.
- Principles and Applications of Toxicology; Lahir Y.K.; Seekay Publications; 2013.
- Essentials of Clinical Toxicology; Lall S.; Narosa Publishing House; 1998.
- A Textbook of Veterinary and General Pathology; Second edition; J. L. Vagad; IBDC Publishers.
- Clinical Pathology; Guru G.; NCERT; 1988.
- Clinical Pathology; Batra Neelam; Vikas Publishing House Pvt. Ltd.; Nov. 1982.
- Essentials of General Pathology; Dr. Sudha Shivraj, Dr. Satish Kumar Amarnath, Dr. Sheela Devi; Exclusively distributed by CBS Publishers & Distributors.
- Textbook of Pathology; Harsh Mohan; Jaypee Publishers.
- Biostatistics - The Bare Essentials; Third Edition; Geoffrey R. Norman, David L. Streiner; B.C. Decker, Inc., Hamilton; 2008.
- Fundamentals of Biostatistics; Second Edition; Veer Bala Rastogi; Ane Books Pvt. Ltd., New Delhi; 2009 (Reprint 2010).
- Fundamentals of Biostatistics; Second Revised Edition; Irfan Ali Khan and Atiya Khanum; Ukaaz Publications, Hyderabad; 2004.
- Instant Medical Biostatistics; Dr. Ranjan Das and Dr.Papri N. Das; Ane Books Pvt. Ltd., New Delhi; 2009.
- Primer of Biostatistics; Fifth Edition; Stanton A. Glantz; McGraw-Hill Companies, Inc.; 2002.
- Basic Biostatistics - Statistics for Public Health Practice; Second Edition; B. Burt Gerstman; Jones and Bartlett Learning Burlington; 2015.
- Biostatistics - A Guide to Design, Analysis, and Discovery; Second Edition; Ronald N. Fortthofer, Eun Sul Lee and Mike Hernandez; Elsevier, Inc., (Academic Press), USA; 2007.
- Statistics in Biology and Psychology; Sixth Edition; Debajyoti Das and Arati Das; Academic Publishers, Kolkata.

ADDITIONAL READING:

- Biology - A Global Approach; Tenth Edition (Global Edition); Campbell, Reece, Urry, Cain, Wasserman, Minorsky & Jackson; Pearson Education Ltd., England; 2015.
- Biology; Seventh Edition; Neil A. Campbell & Jane B. Reece; Pearson Education, Inc.; 2005.
- Biology; Student Edition; Kenneth R. Miller & Joseph S. Levine; Prentice Hall; 2007
- Biology: Eleventh Revised Edition; Sylvia S. Mader & Michael Windelspecht; McGraw-Hill Education; 2012.
- Biology - Concepts & Applications; Sixth Edition; Cecie Starr; Brooks/ Cole; 2005.
- Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher J. Woolverton; McGraw-Hill Education; 2014.
- Disease & Medicine in India - A Historical Overview; Deepak Kumar; Tulika Books, India; 2012.

Course 14

REFERENCES

- Comparative Anatomy of the Vertebrates; Ninth Edition; Kent, G.C. and Carr R.K.; The McGraw-Hill Companies; 2000.
- Text book of Chordates; Saras publication.
- Modern text book of Zoology; Prof. R.L. Kotpal.
- Integumentary system and its derivatives; Samuel D. Hodge.
- Atlas of Human Anatomy - Vol I; R.D. Sinelnikov; Mr. Publishers Moscow.
- A Guide of Osteology (for medical students); Prakash Kendra, Lucknow.
- Text Book of Comparative Anatomy and Physiology; Tortora.
- Human Osteology - Tim D White.
- Text Book of Human Osteology - Singh Inderbir.
- Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
- Human Anatomy - John W. Hole, Jr., Karen A. Koos, Publisher: W. C. Brown Publisher, USA.
- Principles of Anatomy and Physiology - Gerard T. Tortora and Sandra Reynolds Grabowski. Publisher: Harpers Collins College Publishers (7th Edition).
- Developmental biology - Gilbert.
- Development of Chick - Patten.
- Developmental Biology - Wolpert.
- Text book of Embryology - N. Arumugam.
- Chicken Development - Embryology; W.H. Freeman & B. Bracegirdle.
- Practical Zoology; Second Edition; Dr. K.C. Ghose & Dr. B. Manna; New Central Book Agency Pvt. Ltd. , Kolkata; 1999.

ADDITIONAL READING

- Comparative Anatomy of Vertebrates by Sumitra Saxena and R. K. Saxena. • Comparative Anatomy of Vertebrates by S. K. Kulshrestha.
- Vertebrates: Comparative Anatomy, Function, Evolution by Kenneth Kardong. • Comparative Anatomy of the Vertebrates by George C Kent and Robert K. Carr. • Comparative Anatomy of Vertebrates by Robert Wiedersheim.
- Illustrations of Comparative Anatomy, Vertebrate and Invertebrate - For The Use of Students In The Museum Of Zoology And Comparative Anatomy.
- Human Osteology, 3rd Edition by Tim D. White, Michael T. Black and Pieter A. Folken.
- Hand Book of Osteology, 13th Edition by S. Poddar and Ajay Bhagat.
- The Anatomy and Biology of the Human Skeleton by D. Gentry Steele.
- Atlas of Chick Development - By Ruth Bellairs and Mark Osmond.
- Laboratory embryology of the chick by Lloyd Eugene Downs.
- Vertebrate Embryology: A Laboratory Manual - Richard M. Eakin.
- Molecular Embryology: Methods and Protocols by Paul T. Sharpe, Ivor.
- 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.g. *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. *Ornithorhynchus* (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, CO₂, bicarbonate and O₂

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 B₁)

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, EMBL, 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)

Objectives:

- *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.

- Digestive system
- Heart and Aortic arches
- Urinogenital System
- Endoskeleton of shark:
 - Axial - Skull and vertebral column
 - 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, CO₂ 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; Rastogi publication; 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>

Course 16

REFERENCES

- Comparative Animal Physiology; Knut Schmidt Nielson; Cambridge Press.
- Comparative Animal Physiology; Prosser and Brown.
- 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.
- Endocrinology; 6th Edition; Mac Hadley , Jon E. Levine.
- Bailey's textbook of histology Hardcover; Frederick R Bailey.
- Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
- Culture of animal cells - A manual of basic technique; R. Ian Freshney; John Wiley and Sons Publications; 2005.
- Basic cell culture - A practical approach; J. M. Davis; Oxford University Press; Indian edition; 2005.
- Animal cell culture - Biotechnology Series: Vol.1; Bina Mishra, B. P. Mishra, Pran P. Bhat, P.N. Bhat; Studium Press (India) Pvt. Ltd; 2011.
- Animal cell culture - Concept and Applications; Shweta Sharma; Oxford book Company; 2012.
- Biotechnology of Animal Tissues; Dr. P. R. Yadav and Dr. Rajiv Tyagi; Discovery Publishing House, New Delhi; 2006.

ADDITIONAL READING:

- A textbook of Enzymes: Shailendra Singh; Campus Book International, New Delhi 2007.
- Biochemical Adaptation: Mechanism and Process in Physiological Evolution: Peter W. Hochachka& George N. Somero, Oxford University Press.
- Comparative Animal Physiology: P. C. Withers, Thomson Publishing Co.
- Mammalian Endocrinology: Ashoke Kumar Boral. New Central Book Agency Ltd.
- Endocrinology-Hormones and Human Health: Prakash S. Lohar, MJP Publishers, Chennai. 2005.
- Biotechnology-an introduction: Second Edition: S. Ignacimuthu, S. J, Narosa Publications.
- Animal Biotechnology: R. Sasidhara, MJP Publishers, Chennai. 2006.

Course 17

REFERENCES

- Genetics - The continuity of life; Daniel Fairbanks and Ralph Andersen; Brooks/ Cole Publishing Company; 1999.
- Introduction to Molecular Biology; Peter Paoletta; Tata McGraw Hill; 2010.
- Molecular Biology; David Freifelder; Narosa Publishing House; 2008.
- Genetics; Robert Weaver and Philip Hedrick; McGraw Hill; 2001.
- iGenetics - A Molecular Approach; Third Edition; Peter J. Russell; Pearson Education, Inc. (Benjamin Cummings), San Francisco; 2010.
- Molecular Biology - Academic Cell Update; Update Edition; David Clark; Elsevier, Inc.; 2010.
- Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978.
- Principles of Genetics; Eighth Edition; Gardner, Simmons and Snustad; John Wiley and Sons (Asia) Pte. Ltd., Singapore; 2002.
- The Science of Genetics - An Introduction to Heredity; Fourth Edition; George W. Burns; Macmillan Publishing Co., Inc., New York; 1980.
- Molecular Biology - Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013.
- <https://www.ncbi.nlm.nih.gov/books/>
- Current Protocols in Molecular Biology; Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, Seidman J. G., John A. Smith and Kevin Struhl; John Wiley & Son, Inc.; 2003.
- Introduction to Proteomics; Daniel C. Liebler; Humana Press; 2002.
- Molecular cloning; Joseph Sambrook, David William Russell; Third Edition; CSHL Press; 2001.
- Gene Cloning - An Introduction; Brown .T.A; Fourth Edition; Wiley-Blackwell; 2011.
- Recombinant DNA - Genes and Genomes- A short course; 3rd Edition; Watson, J.D., Myers, R.M., Caudy A., Witkowski, J.K.; Freeman and Co. NY; 2007.
- Principles Of Gene Manipulation & Genomics; Primrose SB and R. Twyman; Blackwell Science Publications; 2006.
- Methods In Enzymology, Vol 152; Berger SI, Kimmer AR; Academic Press; 1987.
- Genomes 3; Third Edition; T.A.Brown; Garland Science Publishing; 2007.
- Molecular Biotechnology - Principles and applications of recombinant DNA; Glick, B.R. and Pasternak, J. J.; ASM press, Washington; 2010.
- Microbiology; Fifth Edition; Pelczar, M.J. et al; Tata McGraw-Hill Co., New Delhi; 2001.
- Introduction to Protein Structure; Second Edition; Branden C. and Tooze J.; Garland Publishing; 1999.
- Proteins; Second Edition; Creighton T.E.; W.H. Freeman; 1993.
- Proteomics - Protein Sequence to Function; Pennington, S.R and M.J. Dunn; Viva Books; 2002.
- Genetic engineering - Principles and Practice; Sandhya Mitra; Macmillan India Ltd., New Delhi.
- Biotechnology - Fundamentals and Applications; Third Enlarged Edition; S.S. Purohit; Student Edition, Jodhpur; 2005.
- Biotechnology - Expanding Horizons; B.D.Singh; Kalyani Publishers, Ludhiana.
- A textbook of Biotechnology; R.C.Dubey; S.Chand and Company Ltd., New Delhi.
- Cell and Molecular Biology; Eighth Edition; E.D.P. De Robertis, E.M.F. De Robertis Jr.; Info-Med Ltd.; 1988.

- Genetics (Bios Instant Notes); Third Edition; G.I. Hickey, H.L. Fletcher and P. Winter; Taylor and Francis Group, New York; 2007.
- Genetics - A Conceptual Approach; Third Edition; Benjamin A. Pierce; W.H. Freeman and Company, New York; 2008.
- New Clinical Genetics; Second Edition; Andrew Read and Dian Donnai; Scion Publishing Ltd., UK; 2011.
- Genetics; Third Edition; Robert F. Weaver and Philip W. Hedrick; Wm. C. Brown Publishers (The McGraw-Hill Companies, Inc.); 1997.
- Human Molecular Genetics; Fourth Edition; Tom Strachan and Andrew Read; Garland Science, USA; 2011.
- Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978.
- Human Genetics - An Overview; Alice Marcus; Narosa Publishing House; 2010.
- The Science of Genetics - An Introduction to Heredity; Fourth Edition; George W. Burns; Macmillan Publishing Co., Inc., New York; 1980.
- <https://www.ncbi.nlm.nih.gov/books/>
- <https://ghr.nlm.nih.gov/>
- Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi & others; CBS Publishing; 2003.
- Bioinformatics - A practical guide to analysis of Genes & Proteins; Andreas D Baxevanis & B F Francis; John Wiley; 2000.
- Introduction to Bioinformatics; 1st Edition; T K Attwood, D J parry-Smith; Pearson Education, 11th Reprint; 2005.
- Bioinformatics; 1st Edition; C S V Murthy; Himalaya Publishing House; 2003.
- Bioinformatics sequence and genome analysis; David W. Mount; Cold spring Harbor Laboratory Press; 2004.
- Basic Bioinformatics; S. Ignacimuthu, S.J.; Narosa Publishing House; 1995.
- An Introduction to Bioinformatics Algorithms; Neil C. Jones and Pavel A. Pevzner; MIT Press, First Indian Reprint; 2005.
- Bioinformatics - Managing Scientific Data; Zoe Lacroix, Terence Critchlow; Morgan Kaufmann Publishers (Elsevier Science); 2003 (for the V unit).
- Phylogenetics: Theory and Practice of Phylogenetic Systematics; Second edition; Bruce S. Lieberman; Wiley-Blackwell; 2011.
- Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Dr Edward C. Holmes; Well Publishing; 1998.
- Essential Bioinformatics; Jin Xiong; Cambridge University Press; 2006.
- Proteomics - From Protein Sequence to Function; 12 S. R. Pennington, M. J. Dunn; First edition; Springer publications; 2001.
- Proteomics; Timothy Palzkill; Springer; 2002.
- Metabolomics - A Powerful Tool in Systems Biology; Jens Hřiriis Nielsen, Michael C. Jewett; Springer; 2007.
- Systems Metabolic Engineering; Dr. Christoph Wittmann, Sang Yup. Lee; Springer; 2012
- Bioinformatics (Bios Instant Notes); Second Edition (Special Indian Edition); T. Charlie Hodgman, Andrew French and David R. Westhead; Garland Science (Taylor and Francis Group); 2010.
- Understanding Bioinformatics; Marketa Zvelebil and Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008.

- Bioinformatics Computing - The complete practical guide to bioinformatics for life scientists; Bryan Bergeron; Eastern Economy Edition; Prentice-Hall of India Pvt. Ltd., New Delhi; 2003.
- Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009.
- Introduction to Bioinformatics; First Edition; S. Sundara Rajan and R. Balaji; Himalaya Publishing House, Mumbai; 2002.
- Molecular Biology - Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013.

ADDITIONAL READING

- The Gene: An Intimate History; Siddhartha Mukherjee; Scribner, New York; 2016.
- The Handling of Chromosomes; Sixth Edition; C.D. Darlington & L.F. La Cour; George Allen & Unwin Ltd., London; 1976.
- Molecular Cell Biology; Fifth edition; Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky & James Darnell; W.H. Freeman & Company, New York; 2004.

Course 18

REFERENCES

- Essentials of Environmental Science; N. Vasudevan; Narosa Publishing House Pvt. Ltd. New Delhi 110002.
- Environmental Biology; P.S Verma, V.K Agarwal; S. Chand & company Ltd. New Delhi 110055.
- A textbook of Environmental Science; Arvind Kumar; A P H Publishing Corporation, New Delhi 110002.
- Environmental Biotechnology - Basic Concepts and Application; Indu Shekhar Thakur; I. K. International Pvt. Ltd. New Delhi 110016.
- Text book of environmental science; S. C. Santra.
- Wild life management; Rajesh Gopal.
- Wildlife Management and Conservation - Contemporary Principles and Practices; Paul R. Krausman and James W. Cain III.
- Wildlife Ecology, Conservation, and Management; John M. Fryxell, Anthony R. E. Sinclair, Graeme Caughley.
- Molecular Biotechnology - Principles and Practices; Channarayappa.
- Biotechnology - P. K. Gupta.
- Biotechnology - B. D. Singh.
- Biotechnology Fundamentals & Applications - S. S. Purohit.
- Pharmacognosy and Pharmaco biotechnology- Ashutosh Kar.
- Trease and Evans Pharmacognosy - Evans, W.C.
- Pharmacognosy - Kokate, C. K. A. and Purohit, A.P.
- Practical Pharmacognosy- Gokhale, S. B. and Kokate, C. K.
- Text book of Pharmacognosy; T. E. Wallis.
- Zoogeography - The Geographical Distribution of Animals; Philip J. Darlington JR; Academic Publishers, Kolkata
- Animal Geography - Newbegin.
- Vertebrate Paleontology - Romer.
- Ecological animal geography- Allee, Park and Schmidt.
- Zoogeography of India and South East Asia - Dr. S. K. Tiwari; CBS Publishers and Distributors, Delhi; 1985.

ADDITIONAL READING

- Environmental Management: Principles and Practice by Christopher J. Barrow.
- Introduction to Environmental Management by Mary K. Theodore and Louis Theodore.
- Effective Environmental Management: Principles and Case Studies by Rory Sullivan and Hugh Wyndham.
- Solid Waste Management: Principles and Practice by Ramesha Chandrappa, Diganta Bhusan Das.
- Solid Waste Management: An Indian Perspective by M. S. Bhatt and Asheref Illiyan.
- Solid Waste Management by Subhash Anand.
- Watershed Management by Vijay P. Singh and Ram Narayan Yadava.
- Watershed Management by J. V. S. Murty.
- Water Resources, Conservation and Management by S.N. Chatterjee.
- Watershed Management - By Madan Mohan Das, Mimi Das Saikia.
- Concepts in Wildlife Management by B. B. Hosetti.
- Wildlife Management Practices by James Durell.

- Wildlife: management and conservation by M. M. Ranga.
- Ecological Census Techniques: A Handbook by William J. Sutherland - 2006.
- CRC Handbook of Census Methods for Terrestrial Vertebrates by Davis.
- Selecting Wildlife Census by R. F. H. Collinson.
- Forest Measurements: Fifth Edition by Thomas Eugene Avery and Harold E. Burkhardt.
- Techniques for wildlife investigations and management by Clait E. Braun, Wildlife Society.
- Zoopharmacognosy by Jesse Russell, Ronald Cohn.
- News Feature: Animals that self-medicate by Joel Shurkin.
- Zoopharmacognosy and Herbal Pharmacology by Thomas H. Ingraham.
- How Animals Heal Themselves: Self-Selection: Self-Selection: Giving Animals the Choice to Select Their Own Natural Medicines: Ingraham Applied Zoopharmacognosy by Caroline Ingraham.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4267359/>.
- Zoopharmacognosy: The Use of Medicinal Plants by Animals by Eloy Rodriguez and Richard Wrangham https://link.springer.com/chapter/10.1007/978-1-4899-1783-6_4
- <http://www.calmercreatures.co.uk/zoopharmacognosy-dogs/>.
- Zoopharmacognosy, The Self-Medication Behavior Of Animals by Eraldo Medeiros Costa-Neto.
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.940.6592&rep=rep1&type=pdf>

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 09
(Jaws / Radula / Chromatophores / Spermatophores / Statocyst)
OR
Perform virtual dissection of _____ system.
- Q.2. Identify and classify giving reasons:
a) Protozoa / Porifera / Cnidaria
b) Platyhelminthes / Nematoda 12
c) Annelida / Arthropoda
d) Mollusca / Echinodermata
- Q.3 Identify, classify and describe
a) Acanthocephala / Chaetognatha / Onychophora
b) Hemichordata
c) Observe the animal* (photo/existing preserved specimen) and identify 09
phylum giving reasons.
*A suitable animal which is not prescribed in the syllabus
- 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 10
constraints.
- 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 CCl₄ 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. 08
a) & b) based on study of mammalian tissues
c) & d) based on diseases or conditions
- 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 | 30 |
| 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 | |
| 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 / Osteichthyes / Cyclostomata
b) Observe the animal* (photo/existing preserved specimen) and state its class giving reasons. 06
* The animal should be other than prescribed in the syllabus
- Q.2. Identify, classify and describe
a) Pisces
b) Amphibia
c) Reptilia 15
d) Aves
e) Mammalia
- 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.	15
	OR	
Q.1	Isolation & Estimation of DNA by Diphenylamine method.	
Q.2	Separation of Genomic DNA by Agarose gel electrophoresis.	09
	OR	
Q.2	Colorimetric estimation of proteins from given sample by Folin's method.	
Q.3	Problems based on Restriction endonucleases (any two).	08
	OR	
Q.3	Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.	
	OR	
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:	08
	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.	
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	06
	a) Based on bioprospecting (<i>Sponge</i> / <i>Aloe ferox</i> / <i>Aloe vera</i> - any one)	
	b) Zoopharmacognosy (ants, cats, elephants and dogs - any one)	
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.

UNIVERSITY OF MUMBAI



Program: B.Sc.

(Credit Based Semester and Grading System)

Course: Marine Science
(Applied Component)

Syllabus for Semester V & VI

(with effect from the academic year 2017-18)

CONTENTS

- 1. Preface**
- 2. Preamble**
- 3. Pedagogy**
- 4. Tables of courses, topics, credits and workload**
- 5. Theory syllabus for semester V (course code USACMSC501)**
- 6. Practical syllabus for semester V (course code USACMSC5P1)**
- 7. Theory syllabus for semester VI (course code USACMSC601)**
- 8. Practical syllabus for semester VI (course code USACMSC6P1)**
- 9. References and additional reading (course code USACMSC501 & USACMSC601)**
- 10. Scheme of Examination (Theory and Practical)**
- 11. Practical skeleton paper semester V & VI**
- 12. Annexure I – Suggested topics for assignment (semester V)**
- 13. Annexure II – Suggested field visits (semester VI)**
- 14. Annexure III – Suggested topics for projects (semester VI)**
- 15. Annexure IV – Learners' space**
- 16. Annexure V – Playand Ponder**
- 17. Model Theory Question Papers Semester V and Semester VI**

PREFACE

Applied Component was introduced for T. Y. B. Sc. class in the academic year 1979-80 with a view to enhance the essence for employability. The syllabus is a blend of concepts with four electives. It gives me immense pleasure to present these four applied component courses namely Marine Science, Fishery Biology, Economic Entomology and Environmental Science under the umbrella of BOS in Zoology.

In the syllabi of these applied components, applied topics having commercial propositions have been incorporated that further adds to the enhancement of entrepreneurial potential and skills amongst the learners. In the past our syllabus focused mainly on theory as a way of providing knowledge base and preparation for students. We have attempted to go beyond this tradition, while doing so, equal emphasis is laid on theory and corroborative practicals. From the academic year 2011-12, the University has introduced Credit Based Semester and Grading System (CBSGS). Accordingly the existing syllabi of these applied components were restructured to fit into the CBSGS pattern. The concept of flexi syllabus was introduced offering opportunity to learners to study any four out of a total of eight units in each course. Now that the syllabus is restructured and to be introduced from the academic year 2017-2018, we have included a novel concept of open unit and case studies. This approach, I'm sure will enhance the critical and analytical thinking abilities of the students.

I take this opportunity to thank the experts in various field for giving valuable, beneficial and constructive suggestions during framing of the syllabus. The syllabus committee under the convenorship of Mr. Vinayak Dalvie has done a commendable job of timely framing the syllabus with a highest degree of precision and accuracy. While appreciating the efforts, I also express my thanks and heartfelt gratitude to the entire team.

– Dr. Anita Jadhav
Chairperson
Ad-hoc, BOS in Zoology

PREAMBLE

As a convener when I mooted the concept of flexi-syllabus, first of its kind, in the academic year 2009-10 it was grossly misconstrued. To add to it I also placed an idea of including case studies and introducing a new concept of "Open Unit". Both were rejected then. I had also proposed a new subject "Entrepreneurial and Industrial Biology" in place of the existing Applied Components usually offered by the students of Biological Sciences. 20 workshops in different districts with teachers and students of various subjects were conducted to explain these four concepts. A twenty one days refresher course for teachers, sponsored by UGC was also conducted in the new subject of "Entrepreneurial and Industrial Biology" which was much appreciated by the then Director of NAAC, Prof H. A. Ranganath, who is from Biological Sciences, understanding the potential of the subject. However, implementation was postponed for technical reasons thus permitting innovation limited to the flexi-syllabus, implemented in 2010-11, which has inherent capacity to cater to the diverse needs of the region and the industry by allowing students and teachers to choose a desired capsule of eight topics, with various permutations and combinations from the menu of sixteen based on the interest, resources, expertise and need. It took care of a range of students by also providing learners' space to high IQ students. Yet the possibility of exclusion of some important topics cannot be ruled out apart from some new avenues developed during the lag phase of revision of syllabi. Open unit will permit a good teacher to keep pace with the development and adopt latest topics instantly without waiting till it becomes obsolete in the gap of 5 years that the University generally takes to revise the syllabus. It may also allow students to learn the existing topic in more details and depth under the open unit thus making them specialized in need based areas enhancing employability. Assignments would add to their understanding of Govt schemes, regulations and market, while projects will augment Business Sense or Scientific Acumen, as the case may be. Case studies and simulations, introduced for the first time in Zoology, would pose challenge for true application of knowledge to real life situations with thought provoking questions demanding analytical solutions. Pedagogy of such dynamic syllabus will range from use of ICT in the class to teaching directly in the field with a blend of participative and experiential learning with group dynamics gaining true knowledge apart from developing personality of the students and above all making them apply 'Common Sense' which is the essence of life. I am sure dedicated team of Zoologists which has placed the subject on top in the past 5 years is poised to make it a success in every college befitting the purpose of introducing applied component by the University in the academic year 1979-80.

– VINAYAK DALVIE
Convener,
Syllabus Committee

PEDAGOGY

The concept of having a flexi syllabus is a unique feature of this syllabus and implementing it creatively and diligently would be a meaningful exercise. This would ensure that learner and facilitator have the liberty to select any four units out of eight which can be decided by both teacher and students of the course collectively. While selecting, both shall ensure that it is done systematically, maintaining the relevance of topics in every unit taught in the semester. An exciting aspect adding a new dimension to the flexi-syllabus concept is the idea of making various permutations and combinations of the units in every semester. It would take into consideration the need, resources and the expertise that the department, college possesses/ provides or can make available.

A major thrust should be to direct the learner to maximize the use of ICT, watch films related to the topics, You-tube clippings and extra read material in the form of articles and magazines for all the topics, 'Buzz sessions' should be held after showing films, short video clippings etc., whereby the learner is encouraged to summarize the contents, or debate or ask questions related to the topics. This exercise would initiate a 'thought process' with respect to the subject, ensuring that the learner develops a habit of ruminating over the information to gain conceptual clarity and insights.

Field trips, study tours and Industrial visits both short and long are recommended, relevant to the units prescribed and selected for teaching so as to provide desired exposure. For e.g. Units consisting of zonation in sea, deep sea fishing & research vessels, mechanised boat and modern gears, should not be taught only in class-rooms but, on locations, to promote experiential learning.

'Case studies' should be conducted through discussion in a group of 10 students for every case. It must be developed and presented by the facilitator (teacher) with thought provoking approaches expecting students to think analytically and derive an appropriate solution after critically evaluating all the solutions, given within the group.

The inclusion of the concept of 'open unit' encourages the creative teacher-facilitator to choose a topic from the existing units which needs to be further elucidated or taught or researched so as to gain in depth knowledge on the topic and can hence be covered extensively. On the other hand the topic taught could also be a 'need based' one either comprehensively covered by the syllabus or totally ignored. If the facilitator has the ability to include a newly developed area arising due to the need of such a study, within the vicinity, then it may be included in the open unit with the consent of the Head of the Department and the Principal of the institution.

This new syllabus takes into consideration the applied approach, and therefore the topics chosen are practical although few theory based topics are retained. All the practical experiments are application oriented and simple since the learner has had exposure to them while performing them in the former years or in their mainstream subject covered under the science streams. While performing them the learner develops the aptitude of putting them into practice scientifically, logically and appropriately for studying various aspects of marine fauna and flora, hydro-biological parameters and new trends emerging in the vast but under-explored fields of oceans/seas. Facilitators must encourage the learners to comprehend and generate ideas for the applicative value of these experiments.

The syllabus has also incorporated the skeleton question paper for the practical examination and the model question paper for the theory units so as to resolve any doubts and ensure uniformity in the drafting of the question paper pattern for the semester end examination in all affiliated colleges.

Co-Convenors
Syllabus Committee

T. Y. B. Sc.
(Credit Based Semester and Grading system)
Marine Science (Applied Component)
Syllabus
(to be implemented from the academic year 2017-18)

Semester V
Oceanography & Capture Fisheries

Oceanography & Capture Fisheries				
Theory (Any four units to be opted)				
Course	Unit	TOPIC	Credits	L/Week
USACMSC501	1	Zonation in the sea and marine biodiversity	2	4
	2	Physical oceanography and ocean related climatic changes		
	3	Chemical oceanography		
	4	Oceanographic instruments		
	5	Sustainable fishery		
	6	Deep sea fishing vessels and research vessels.		
	7	Mechanized boat and modern gears		
	8	Case study and simulation		
Practical				
USACMSC5P1		Practicals based on course USACMSC5P1	2	4

Semester VI
Production and Management

Production and management				
Theory (Any four units to be opted)				
Course	Unit	TOPIC	Credits	L/Week
USACMSC501	1	Introduction to commercial culture	2	4
	2	Marine value added product		
	3	Introduction to quality control, preservation and processing		
	4	Fish pathology		
	5	New avenues		
	6	Financial management		
	7	Marketing		
	8	Open unit		
Practical				
USACMSC5P1		Practicals based on course USACMSC6P1	2	4

Semester V: Theory
Oceanography & Capture Fisheries
Course code: USACMSC501
(Any four units to be opted)

Lectures 60
Credits 02

Unit 1: Zonation of the Sea and Marine Biodiversity

Objective: *To make learner get idea of geological distribution of sea and its relation to biodiversity.*

Desired outcome: *Learner would understand different zones of sea (marine habitat) and their impact on biodiversity.*

- 1.1 Zonation of the Sea –Vertical and Horizontal
- 1.2 a) Plankton classification and adaptations
b) Nekton adaptations
- 1.3 **Benthic adaptations** (two examples of each group)
 - a) Inter-tidal organisms (rocky, muddy & sandy shores)
 - b) Deep sea organisms

Unit 2: Physical oceanography and ocean related climatic changes

Objective: *To make learner understand different physical factors of ocean and their role in bringing out climatic changes.*

Desired outcome: *Learner will get to know physical factors of ocean during different climate and their effect on marine organisms.*

- 2.1 Physical parameters of the sea
 - a) Density
 - b) Illumination
 - c) Temperature
 - d) Pressure
- 2.2 Influence of the following water movements in sea
 - a) Currents – wind driven and thermohaline circulation
 - b) Types of waves (including Tsunami)
 - c) Tides
- 2.3 Influence of the following climatic phenomena
 - a) Monsoon
 - b) Cyclone (including Phyan)
 - c) El Nino

Unit 3: Chemical oceanography

Objective: *To give learner an idea of normal chemical constituents of sea water and their importance to marine ecosystem.*

Desired outcome: *Learner will understand normal values of different chemical nutrients of sea water and their importance for the flora and fauna.*

3.1 Parameters of the sea water

- a) Salinity
- b) pH
- c) Dissolved gases (oxygen and carbon dioxide)

3.2 Nutrients in sea water

- a) Minor constituents (nitrates, phosphates and silicates)
- b) Dissolved organic matter

Unit 4: Oceanographic instruments

Objective: *To orient learner about different oceanographic instruments, their design, mode of working and analysis of result using them.*

Desired outcome: *Learner will come to know about important modern instruments used in the field of oceanography and different chemical, physical and biological parameters studied by using them.*

4.1 Instruments used for marine biological sampling

- a) Niskin water samplers
- b) Dredge and Petersen Grab
- c) Corer
- d) Plankton net (Typical plankton net, Hensen net & Indian Ocean standard net)

4.2 Instruments used for measurement of physical factors

- a) Protected and unprotected reversing thermometer
- b) Current meter
- c) Secchi disc
- d) Echosounder
- e) Wave recorder
- f) CTD (Conductivity, temperature and depth)

4.3 Introduction to fish finding equipments and methods

- a) GPS
- b) SONAR
- c) Remote sensing and satellite oceanography

Unit 5: Sustainable fishery

Objective: *To educate learner about declining marine fish landings, different rules and regulations for sustainable fishery.*

Desired outcome: *To educate learner about declining marine fish landings, different rules and regulations for sustainable fishery.*

5.1 Fishery acts and monitoring bodies

5.2 Remote sensing and forecasting

5.3 Time series analysis, understanding trend for forecasting

Unit 6: Deep-Sea Fishing vessels and Research Vessels

Objective: *To expose learner to research vessels, deep sea fishing vessels and the advancement in oceanographic research.*

Desired outcome: *Learner will understand recent trends in oceanographic research which will motivate them to become budding scientist of tomorrow.*

- 6.1 ORV Sinddhu Sadhana
- 6.2 ORV Sinddhu Sankalp
- 6.3 ORV Sagar Nidhi,
- 6.4 FORV Sagar Sampada

Unit 7: Mechanized boat and modern gears

Objective: *To introduce learner to boat building, its maintenance and operation of fishing gears.*

Desired outcome: *Learner will gain knowledge of boat building, its maintenance and operational methods of gears to optimise fish catch.*

- 7.1 Boat design, building and maintenance
- 7.2 Engines – 2 stroke and 4 stroke
- 7.3 Purse seine, Drag net (shore seine), Hooks and Lines, Squid jigs, Tuna long line, Pelagic and Bottom Trawls.

Unit 8: Case study and Simulation

Case Study and Simulation is one of the eight units and hence may or may not be opted by the college. If opted, teachers in consultation with the students shall select the case studies for this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/institutes have to select the topics as per their needs and available resources. It is pertinent to note that the case studies and simulations shall be operational and available in the syllabus only till it comes under the scope of internal assessment.

Objective: 1. *To encourage abilities of learner to better understand the concepts.*
2. *To develop better analytical abilities to assess varying dimensions while making decisions.*

Desired outcome: 1. *Learner will comprehend and develop better acumen so as to, take wise and necessary decisions while participating in environment related projects or framing policies/assessing environmental damages/carrying out entrepreneurial activities beneficial to environment.*

2. *Learner shall primarily learn to tackle real life situations with common sense.*

(Any eight from suggested below or more, developed by teacher)

- 1. Pirotan island marine park
- 2. Challenger expedition
- 3. Indian ocean expedition
- 4. Antarctica expedition
- 5. Destruction of Mangrove along western coastline of Mumbai
- 6. Chartered vessel scheme for technology transfer

7. Ban on exports due to *Salmonella* contamination in 1990's, a lack of sanitary facilities on board
8. Mithi river and Mahim creek: yesterday, today and tomorrow
9. Trilok Foods DST Entrepreneurship model of Public Private Partnership developed through incubation model
10. Tsunami at Andamans.
11. Minamata bay incident – biomagnifications

Semester V: Practical
Course code: USACMSC5P1

02 Credits

1. **Chemical analysis of sea water:** Silicates, Phosphates, pH and Salinity
2. **Study of oceanographic instruments:**
 - Niskin Water Sampler
 - Van-Veen Grab
 - Reversing Thermometer
 - Current Meter
 - SecchiDisc
 - Standard Plankton Net
 - Echosounder
 - Corer
3. **Ecological adaptations: Intertidal animals**
 - Porifera: Sponge (Sycon)
 - Coelenterata: Sea anemone, Coral, Jelly fish
 - Annelida: *Nereis*, *Arenicola*
 - Arthropoda: *Balanus*, Hermit Crab
 - Mollusca: Oyster, *Mytilus*, *Sepia*, *Loligo*, *Teredo*
 - Echinodermata: Starfish, Sea urchin
 - Coral fish: Clown Triggerfish, Queen Angelfish
 - Deep Sea Animals: Solefish (*Psettodes* and *Cynoglossus*), Angler Fish
4. **Study of zooplanktons:** (Any ten)
5. **Endangered marine species:** Identification and reason for decline of Salmon, Sturgeon, Sea-lion, Seal and Whale
6. Identification and operation of traditional crafts and gear.
7. Photographic documentation of Marine Science related issues.
Submission of soft & hard copy of 5 original photographs taken by the learner (Exif details required)
8. Assignment (may be submitted in a group not exceeding three students).
Please refer to Annexure- I for suggested topics for assignment.

*Note- The practical may be conducted by using specimens authorised 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 practical 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 or mountings are done using animals.

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, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Semester VI: Theory
Production and Management
Course code: USACMSC601
(Any four units to be opted)

Lectures 60
Credits 02

Unit 1: Introduction to commercial aquaculture

Objective: *To make learner acquire in-depth knowledge about marine aquaculture of commercially important fishes and prawn.*

Desired outcome: *Learner will take the first step to become entrepreneur in the field of culture fishery with basic knowledge of marine aquaculture.*

- 1.1 Brackish water aquaculture of *Litopenaeus vannamei* (Pacific White Shrimp)
- 1.2 *Lates calcarifer* (Asian Sea Bass) culture in race ways.
- 1.3 Cage farming of *Rachycentron canadum* (Cobia)

Unit 2: Marine value added products

Objective: *To give learner an overview of value added products from marine organisms.*

Desired outcome: *Learner will be acquainted with variety of marine value added products, their nutritional values and economic significance.*

- 2.1 Fish protein concentrate, fish maws, isinglass, oils (body and liver), chitin, chitosan, Fish/ Prawn pickle and chutney, fish wafers, surimi, imitation products.

Unit 3: Introduction to quality control, preservation and processing

Objective: *To make learner understand different methods of preservation and processing of marine products for maintaining its nutritional quality.*

Desired outcome: *Learner will acquire knowledge of specific methods of preservation and processing for different fish products for enhancing their shelf life and commercial value.*

- 3.1 Methods of evaluating freshness and quality of fish and prawn. (Organoleptic, Microbial and Chemical)
- 3.2 Mechanisms of spoilage (Hyperemia, *rigor mortis*, Autolysis, Rancidity)
- 3.3 Methods of preservation— Icing, Drying, Salting, Canning, Pickling, Freezing

Unit 4: Fish pathology

Objective: *To acquaint learner to fish diseases, causative agents, prevention techniques and treatment.*

Desired outcome: *Learner will gain expertise to identify causative agents, symptoms and treatment for different fish diseases.*

- 4.1 Fish diseases caused by:
 - a) Protozoan
 - b) Bacteria

- c) Fungi
- d) Worms
- e) Crustaceans
- f) Non parasitic diseases
- g) Fish tumour

4.2 Symptoms and Treatment of the above Diseases

4.3 Prevention techniques: Crop Rotation, Immune Stimulants, Genetic Improvement.

Unit 5: New avenues

Objective: *To expose learner to the new avenues in the field of oceanography*

Desired outcome: *The learner will become aware of new trends of oceanography which would make them expert in exploiting these opportunities to become successful entrepreneur.*

5.1 Bioactive Compounds

- a) Sea as treasure house of new chemicals
- b) Bioactive metabolites from sponges and bacteria
- c) Bioactive toxins and eutrophication
- d) Bioactive compounds as marine drugs from Demospongiae, Actinobacteria and *Conus*.

5.2 Sea weeds

- a) Classification and Distribution of Seaweeds
- b) Commercial uses of sea weeds as food: Nori (*Porphyra*), Kombu (*Laminaria*), Arame (*Eisenia*), Dulse (*Palmaria*)
- c) Liquid Seaweed Fertilizer
- d) Sea weed as source of Bio-fuel

Unit 6: Financial management

Objective: *To make learner aware of different funding schemes for fishery and basics of financial management.*

Desired outcome: *Learner will be equipped with knowledge on various schemes available for obtaining finance from different government and semi government agencies and financial management.*

6.1 Procuring finance

- a) Financial Institutions and Funding Agencies
- b) Schemes and subsidies

6.2 Financial Management: Costing, Budgeting, Fund flow, Auditing and Preparation of Feasibility Report.

6.3 Role of NABARD for refinancing and NFDB (National Fishery Development Board, Hyderabad) for funding through State Board.

Unit 7: Marketing

Objective: *To provide learner with information on fishery marketing in local, national and international level.*

Desired outcome: *Learner will gain knowledge on working of fishery markets and exports.*

- 7.1 Basic concepts of Micro and Macro marketing of fish product.
- 7.2 Traditional Marketing vis-à-vis Operations of Fishery Co-operatives (Sasoon, Karanja, Satpati model)
- 7.3 Global Marketing
- 7.4 Export and Import Procedures

Unit 8: Open unit

Open unit is one of the eight units which may or may not be opted by the college. Teachers in consultation with the students shall define syllabus under this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/institutes have to select the topics as per their needs and available resources. It is pertinent to note that the open unit shall be operational and available in the syllabus only till it comes under the scope of internal assessment.

Objective:

- 1. To teach any one of the units prescribed in the syllabus with more details and in depth leading to specialization in the capsule of units selected.*
- 2. To incorporate the topics of special need of the area which are otherwise not covered in the syllabus.*
- 3. To give scope to creativity and wisdom of a teacher who wants to deal with the latest developments in the subject without waiting for the university to revise the syllabus.*

**Semester VI: Practical
Marine Science
Course code: USACMSC6P1**

Credits02

1.
 - a) Estimation of primary productivity
 - b) Estimation of Biological Oxygen Demand (BOD)
2. Identification of Common edible marine fauna:
 - a) Fish: *Polynemus* spp, *Lates calcarifer*, *Pampus argenteus*, *Formio niger*, *Rastrelliger kanagurta*, *Cybium guttatum*, *Harpodon nehereus*, *Sardinella longiceps*
 - b) Molluscs: Oyster, *Sepia*, *Loligo*
 - c) Crustaceans: Shrimp, Lobster, Crab
3. Identification of molluscan shells: *Trochus*, *Umbonium*, *Oliva*, *Conus*, Conch shell, *Telescopium*, *Mytilus*, *Donax*, *Katelysia*.
4. Determining feeding habits of fish from jaws and gills.
5. Identification of common marine algae: *Ulva*, *Sargassum*, *Padina*, *Fucus*, *Polysiphonia*, *Laminaria*.
6. Fish diseases: Identification from photograph / specimen.
7. Identification of foraminiferan shells
8. Visit to any of the research institutes, fishery industry, landing centres, boat building industry, research vessel, fish market, fishery co-operative societies, funding agencies office and processing units and submission of report.
9. Project and submission of report (Project report may be submitted in a group not exceeding three students).

Please refer to Annexure- II for suggested Field Visits and Annexure III for suggested topics for projects for Course code USACMSC6P1.

***Note- The practicals may be conducted by using preserved specimens / permanent slides authorized by the wild life and such other regulating bodies though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/models etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.**

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 or mountings are done using animals.

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, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

References and additional reading

USACMSC501 & USACMSC601

1. A Textbook of Marine Ecology – Nair, N.B. & Thumpty, D.H., the Macmillan Book Company of India Ltd.
2. Biology of intertidal animals - Newell, R.C., Lagos Press.
3. Crafts and Gear of India– Y. Shrikrishna & Latha Shenoy – ICAR Publication
4. Data site: data.gov.in.
5. Ecological Methods for Field and Laboratory Investigations – P.Michael. •Course Material in Fishing Technology – LathaShenoy, CIFE, Versova, Mumbai.
6. Elementary Statistics - Yule & Kendell, Charless Griffin & Co. London.
7. Fisheries Biology, Assessment and Management – Michael King – Fishing New Publishers, 1995.
8. Fisheries Bioeconomics – Theory, Modeling and Management – FAO Fisheries Technical Paper 368 – FAO, 2001.
9. Fish and Fisheries – Chandy, National Book Trust.
10. Financial Management – Prasanna Chandra, 7th Edition.
11. Financial Management – Khan & Jain.
12. Financial Management –I .M. Pandey.
13. Fish and fisheries of India, Jhingran J.S. Hindustan Publication.
14. Fish handling & Processing – Aitikin A: 2nd edition, min. Agr. Fish and Food U.K.
15. Fundamentals of Applied Statistics - Gupta S. C. &. Kapoor V. K., Fourth edition, Sultan Chand & Sons.
16. Glimpses of the Indian Ocean – S.Z. Qasim, University Press (India Ltd. 1998).
17. Handbook Fish Biology and Fisheries, Ed. J.B. Hart & John Reynold.
18. History Of Marine Sciences in India – Dr. B.F. Chhapgar Centenary issue BNHS.
19. Introductory Oceanography – 8thEdn. Harold Thurman, Prentice Hall.
20. Introduction to Physics and Biological Oceanography, King C.A.H, ELBS Ltd. London
21. Marine Ecology – Tait.
22. Marine Fisheries of India – D.V. Bal and K.V. Rao, Tata McGraw – Hill Publishing Co. Ltd., New Delhi.
23. Modern Fishing Gear Technology – N. Shahul Hameed, Boopendranath – Daya Publishing House, 2000).
24. Marketing Management – Philip Kotler.
25. Operations Research Theory and Application, Third edition, Sharma J. K.: Macmillan India Ltd.
26. Pollution and Toxicology, Venugopalan, V.K.: CAS in Marine Biology.
27. Prawn and Prawn Fisheries – Kurian & Sebestian.
28. Project Management – Prasanna Chandra.
29. Refrigeration by Arora.
30. Textbook of Marine Pollution - Prakesh P.
31. The Oceans – Svedrup, H.V. et al, Asian Publishing House.
32. The Book of Indian Shells – Deepak Apte, Oxford University Press.

- 33. Text book of fish biology and Indian Fisheries by Dr. R.P. Parihar, Central Publication House, Allhabad.
- 34. Understanding The Sea – Dr. B.F. Chhapgar, Oxford University Press.
- 35. Wealth of India: Vol. 4 CSIR Publication.

For additional and latest information on the topics, various websites can be visited.

SCHEME OF EXAMINATION (THEORY & PRACTICAL)

- a) Internal assessment of twenty five (25) marks per course per semester should be conducted according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.
- b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton question paper pattern.
- c) One practical examination of one hundred (100) marks per course each should be conducted at the end of every semester.

Modality of Assessment:
Theory Examination Pattern:

A)	Internal Assessment (Theory)	25Marks	25%
B)	External examination	75 Marks	75%

A)	Internal Assessment (Theory)	25Marks	25%
Sr. No.	Evaluation type	Marks	
1.	Class test to be conducted as per following pattern	20	
	a. Match the column/Fill in the blanks/Multiple Choice Questions(1/2 mark each)	05	
	b. Answer in 1 or 2 lines(Concept based questions) (1 mark each)	05	
	c. Answer in brief (Attempt any 2 out of the 3) (5 marks each)	10	
2.	Overall conduct as a responsible student, manners, attentive and inquisitiveness skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05	

B) External examination 75 Marks 75%

1. Duration: The examination shall be of two and half hours duration.
2. Theory question paper pattern:
 - a. Q. 1 shall comprises 16 short notes (14 if case studies/open unit is not opted) representing all the units in the syllabus equally, of which students are expected to solve any five.
 - b. Q.2 to Q.9 (Q. 8 if case studies/ open unit are not opted) will be based on unit I to unit VIII of the syllabus respectively.
 - c. Q.2 to Q.9 (Q. 8 if case studies/ open unit are not opted) shall have the following pattern.

Q. No. **A)** 15 Marks

OR

- B)**
1. 07 Marks
 2. 08 Marks

Practical skeleton paper
Course code : USACMSC5P1

Duration : 04 Hrs.

Marks: 100

- Q.1** Identification **20**
Identify spots 'a' to 'e' as per instructions
- a & b Identify and describe the given instrument
c & d Identify and describe with reference to ecological adaptations of intertidal organisms.
e. Identify and describe the endangered marine organism and give reasons of its decline.
- Q.2** Estimation of silicates from sea water. **25**
OR
- Q.2** Estimation of phosphates from sea water. **25**
- Q.3** Estimation of pH of sea water. **15**
OR
- Q.3** Estimation of salinity of sea water. **15**
OR
- Q.3** Identify and comment on features of zooplankton. (Any five) **15**
- Q.4** **a.** Submission of five original photographs of different seashore, crafts (boats), gears, marine organisms, sea weeds, etc. **10**
b. Submission of assignment and viva based on it. **20**
- Q.5** Certified journal. **10**

Practical skeleton paper
Course code : USACMSC6P1

Duration : 04 Hrs.

Marks: 100
20

- Identification
- Q.1** Identify spots 'a' to 'e' as per instructions.
a & b Identify and describe the given fish.
c Identify and describe the given Mollusc
d Identify and describe the given Crustacean
e Identify and describe the given shell / alga
- Q.2** Estimation of primary production. **25**
- OR**
- Q.2** Estimation of Biological Oxygen Demand (BOD) from given water sample. **25**
- Q.3** Identify and draw foraminiferan shells.(Any three) **15**
- OR**
- Q.3** Identify and comment on fish diseases and their remedial measures. (Any three) **15**
- Q.4** Project report and Viva based on it. **20**
- Q.5** Field report. **10**
- Q.6** Certified journal. **10**

ANNEXURES

ANNEXURE – I Suggested topics for assignment USACMSC5P1

(Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students)

1. Survey of frozen marine fish products on shelf in malls.
2. Survey of ready to eat fish food products on shelf in malls
3. Survey of ready to cook fish food products on shelf in malls.
4. Survey of prices of Marine Aquarium fishes
5. Survey of types and prices of Live Marine Aquarium fish food
6. Survey of types and prices of Marine Aquarium plants
7. Survey and listing of fishes and their prices from local market.
8. Survey of various aquarium equipments and their prices
9. Survey of fish by-products in cosmetic industry
10. Survey of fish by-products in pharmaceutical industry.

All topics mentioned above are suggestive, more creative and innovative topics are expected from the students, under the able guidance of the concerned teacher, to suit the expertise, human resources, infrastructure and local needs as also the interest of the students.

The assignment may be submitted in a group not exceeding three students.

ANNEXURE – II Suggested Field Visits USACMSC6P1

- There shall be various short and long excursions / study tours / field visits / industrial visits in every semester, at least one of which shall be financially affordable to every student in the class; and that assessment and marks of field trips shall be solely based upon such where no student was restrained for financial limitations.
- Field visits are to be organized to facilitate students to have firsthand experience & exposure to technology/production/functioning of organization/units or witness a relevant activity.
- Each student must make at least 01 (one) such visit to the units/treatment plants/aquatic or terrestrial habitat organized by the College.
- The list is suggestive and not exhaustive.

1. Visit to net manufacturing industry
2. Visit to boat building industry
3. Visit to fish preservation/ processing industries
4. Visit to local fish markets
5. Visit to fish landing centre
6. Visit to shore for studying important intertidal organisms
7. Visit to research institutes
8. Visit to Government and Semi-Government organizations like fishery departments, MPEDA and financial institutions
9. Visit to hatcheries and/or farms
10. Visit to fishery co- operative societies

ANNEXURE – III Suggested Topics for Projects USACMSC6P1

(Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students)

1. Prepare feasibility report for setting up an aquarium shop on small/large scale.
2. Prepare feasibility report for setting up an industry for manufacturing any one or more fish by-products.
3. Prepare feasibility report for setting up a fish culture unit.
4. Prepare feasibility report for building up a prawn culture unit.
5. Prepare feasibility report for various aspects of cold storage.
6. Prepare feasibility report for fish preservation unit.
7. Study of seasonal variation in nutrient content of marine water of any coast (silicates, phosphates, nitrates).
8. Analysis of marine water samples collected from different beaches.
 (DO/BOD/COD/Salinity/pH)
9. Study of Mangroves of coastal region.

The project may be submitted in a group not exceeding three students.

ANNEXURE – IV Learners' space

When education system today has identified special needs of slow learners we are still silent about needs of high IQ students. Teachers are therefore recommended to identify and encourage such students to undertake research with a view to publish paper/s in peer reviewed International Indexed Journals with high impact factor thus providing 'learners' space'.

Some of the suggestive avenues are listed below which can certainly be not exhaustive since the said students under the guidance of teachers can identify latest areas of research. Needless to say that 'learners' space' is optional additional activity which may not be undertaken by college if not befitting.

1. Developing statistical model for forecasting fish landing of prominent fishes.
2. Undertaking physicochemical oceanographic research at the established centres in the deep sea preferably in collaboration with reputed research institutes.
3. Working on qualitative and quantitative analysis of plankton yielding to calculation of indices.
4. Addressing issues of marine oil pollution.

ANNEXURE – V Play and Ponder

While learners' space is for high IQ Students, play and ponder could be a general activity creating interest in the subject and could also be a part of pedagogy wherein it may be considered as innovative teaching methodology. Needless to say that 'play and ponder' again is not mandatory and is an additional activity if desired by the students.

Following are some of the suggestive activities though, of course, teachers can creatively develop more in the years to come.

1. Knitting/ Preparing different fishery gear (nets).
2. Making models of different fishing crafts (boats) using biodegradable materials.
3. Preparation of marketable Prawn pickle and fish pickle and obtaining feedback from 10 students and 5 teachers.

MODEL QUESTION PAPER USACMSC501

Duration
2.5 Hrs.
N.B.

Marks
75

1. Question no.1 is compulsory.
2. Attempt any **four** questions from question no.2 to 9.
3. Draw neat labeled diagrams wherever necessary.

- Q.1** Write short notes on: **Any five** of the following (Mixed questions from all units) **15**
- a) Vertical zonation
 - b) Benthic adaptations
 - c) Effect of temperature on marine organisms
 - d) Effect of pressure on marine organisms
 - e) Effect of tides
 - f) Effect of salinity
 - g) Niskin water sampler
 - h) Secchi disc
 - i) Mechanism of fishing, boat maintenance
 - j) Purse seine
 - k) Drag net
 - l) Two stroke engine
 - m) Dredge
 - n) Wave recorder
 - o) -----(from Case study, if opted)
 - p) -----(from Case study, if opted)

- Q.2** Explain vertical zonation of the sea. **15**
(Unit 1)

OR

- Q.2** a. Give an account of intertidal organisms with reference to muddy shore. **08**
(Unit 1) b. Give an account of benthic adaptations of deep sea organisms **07**

- Q.3** Explain the effect of physical parameter of the sea with reference to density. **15**
(Unit 2)

OR

- Q.3** a. Give an account of wind driven and thermohaline circulation. **07**
(Unit 2) b. Explain types of waves. **08**

Q.4 (Unit 3)	Give an account of effect of the chemical parameter of the sea water with reference to salinity.	15
OR		
Q.4 (Unit 3)	a. Explain impact of dissolved oxygen in the sea water.	07
	b. Give an account of dissolved organic matter in the sea water.	08
Q.5 (Unit 4)	Describe Niskin water sampler.	15
OR		
Q.5 (Unit 4)	a. Describe protected and unprotected reversing thermometer.	07
	b. Describe Sonar used as fishing methods with reference to location and harvesting.	08
Q.6 (Unit 5)	Give an account of fishery acts for sustainable fishery.	15
OR		
Q.6 (Unit 5)	a. Explain different monitoring bodies for sustainable fishery.	08
	b. Describe components of time series and state its models.	07
Q.7 (Unit 6)	Give an account of any one deep sea fishing vessel.	15
OR		
Q.7 (Unit 6)	a. Give an account of any one deep sea research vessel.	08
	b. Give an account of deep sea research fishing vessel with reference to ORV Sinddhu Sankalp.	07
Q.8 (Unit 7)	Explain mechanism of boat building and maintenance.	15
OR		
Q.8 (Unit 7)	a. Give an account of two stroke engine used in fishing crafts.	08
	b. Describe purse seine and drag net.	07
Q.9 (Unit 8)	Case study/simulation (if opted)	

Case Study: Trilok Foods DST Entrepreneurship model of Public Private Partnership developed through incubation model

Gaurang Kotnis, a student of Agricultural University, Rahuri, approached Mr. Vinayak Dalvie for inplant training. To judge his abilities he was given an assignment of finding out information on Surimi. Mr. Dalvie noticed a spark of an entrepreneur in him in the process. Gaurang after, graduating in agriculture with merit failed to seek a seat in post-graduation

in the institute of his choice and approached Mr. Dalvie again for guidance. He was discouraged to do post-graduation but advised to start some business. Gaurang started distributorship of ready to cook food products and achieved some success in it. Mr. Dalvie now advised him to do M.Sc. by research along with his business. Gaurang got registered under his guide ship in SVKM's Mithibai College, with registration No. 39, dated 12.03.2012 in the subject of Zoology with title as "Value addition in *Penaeus monodon* through processed shelf – stable RTE Malvani prawn Pilaf in retort pouch". To begin with Gaurang did work with fresh water prawn as it is available fresh in Satara. Teachers from Hospitality Management colleges and chefs were interviewed for recipe. Blind product testing was done to establish authenticity of Malvani taste.

After a series of trial and error self-stable Prawn pulav was developed in retort packing with a guaranteed freshness for six months without refrigeration with no preservatives added. It was one of the very few fish products available in ready to eat series overcoming susceptibility of prawn to perish fast. This innovative product fetched attention of technocrats and Department of Science and Technology which under the scheme of Public Private Partnership granted an aid of Rs. 3.2 million. Gaurang obtained loan of Rs.5 million from Bank of India and after investing his own shares of Rs. 2.5 million established a unit of RTE at Satara of Maharashtra state.

Today Gaurang is a young food technologist, budding entrepreneur and owner of Trilok Foods India but still neither reached breakeven point in his business nor achieved post-graduation degree. He has established a food processing plant in half an acre of land with built up area of 5000 sq. feet at Satara district of Maharashtra. There are 10 employees at present and more will be employed in future. The Plant has retort sterilizer machine with capacity of 150 kg per batch and can process about one ton of raw material every day. He has produced about 24 different types of Ready to Eat products in having more than six months shelf-life without refrigeration.

The Plant is set up under public private partnership (PPP) model in collaboration with ICT with total cost is INR 11.5 million, out of which grant in aid received from DST is INR 3.2 million, subsidy of INR 1.3 million is expected from ministry of food processing industries, INR 5 million was loan sanctioned under collateral free scheme and INR 2.0 million is SME's investment. The plant was inaugurated by Padma vibhushan Shri Anil Kakodkar, Chairperson, of Rajeev Gandhi commission of Science and technology. Gaurang presented his incubation model at the global R & D 2016 event at Vigyan Bhavan, Delhi, in the presence of Hon. Union Cabinet Minister Shree Nitin Gadkari, where it was highly appreciated. His products are tested and approved also in international market and are being exported to UK, Canada and Gulf Countries.

Unfortunately as he started struggling to establish his business, he is not able to pay attention towards his education and is able to complete M.Sc. (By Research) for which he had registered in March 2012. Running a unit at Satara, developing innovative products and marketing globally makes it very difficult for Gaurang to meet his guide in Mithibai College and complete writing of Thesis though his experimental work is finished long before and has come out in the form of product which made him an entrepreneur.

Q.1. Gaurang today has neither reached breakeven point being in gestation period for about 3 years nor does he have post graduate degree, how would you analyze this case while agreeing or disagreeing with the series of decisions taken by him? (05)

Q.2.Which niche market should Gaurang focus on? (05)

Q.3.What strategies should Gaurang adopt to get an early break-even point? (05)

OR

CASE STUDY: Antarctica Expedition

Antarctica is an icy continent as large as India and China put together. It is said to have the world's largest oil and gas reserves and its seas are biologically most productive on earth.

The main reason that India sends any expedition to Antarctica almost as a ritual is to retain its 'coveted' status as a consultative member of the Antarctica Treaty. The treaty signed in 1959 by 12 countries including USA, USSR, UK and Antarctica was aimed at preserving Antarctica as an international research laboratory and to use it only for peaceful purposes.

Indian Antarctic expedition commenced in 1981. After operating from ship and temporary shelters for two years, the first permanent research station 'Dakshin Gangotri' was established in 1983 which was abandoned in 1990 as it got buried under snow. Research base Maitri became operational in 1988 and research base Bharati became operational in 2015. Since March 2012 India's expedition is launched annually where in about 100 to 120 members including scientist, engineers, doctors and tradesman are sent in batches between November to January. So far 35 scientific expeditions including a parallel Weddell expedition in 1989 were carried out to Antarctica. Geophysical, geochemical and glaciology as well as shadow bands on solar eclipse research is also carried out by Indian team.

Maitri station is functional round the year and is one of the Global Positioning Systems (GPS) stations contributing to the International database. It has revealed that recovery of ozone depletion does not take place as fast in Antarctica as in Arctic. India is one of the first country to take up magnetometer triangulation experiments at Antarctica, to study the presence and movement of small scale and aerosol current system. About 30 out of 240 new bacterial species discovered so far in Antarctica are by Indian Scientists. Two genes namely t-RNA modification GTPase and aspartate amino transferase have been identified by our biologist as genes required for survival of bacteria at low temperature. Many lipases and proteases useful to biotechnological industry are also identified from here.

The total amount of expenditure incurred both in establishing Dakshin Gangotri, Maitri and Bharati as well as sending periodic expeditions to Antarctica since its inception i.e. from 1981-82 to 2014-15 is Rs. 1473.39 crores.

The sad part now is that when various travel agencies are conducting cruise of about five weeks to Antarctica and fifth Indian Antarctica expedition is set to sail in December, many of the top research institutions have second thoughts about participating in it. NIO Goa, the country's premier oceanographic research organisation is thinking of withdrawing itself from all future Antarctica expedition.

Q. Is it worth spending about 1500 crores on Antarctica expedition by a developing country like India where large amounts of resources are needed for infrastructure development,

socio-economical upliftment, education etc.– (15)

Note: Questions of the model question paper are not exhaustive, but suggestive, and teachers have liberty to reframe, modify and add other questions as deemed fit.

MODEL QUESTION PAPER USACMSC601

Duration:
2.5 Hrs.

Marks
75

N.B.

1. Question no.1 is compulsory.
2. Attempt any **four** questions from question no.2 to 9.
3. Draw neat labeled diagrams wherever necessary.

- Q.1** Write short notes on: Any five of the following (Mixed questions from all units) **15**
- a) Protein concentrate as value added product
 - b) Fish maws as value added product
 - c) Any two challenges of shrimp culture
 - d) Any two challenges of *Lates calcarifer* culture
 - e) Any two methods to test freshness and quality of fish
 - f) Any two methods to test freshness and quality of prawn
 - g) Name the disease, symptoms of fish caused by protozoan
 - h) Name the disease, symptoms of fish caused by fungus
 - i) Name to sea weeds and there distributions
 - j) To bioactive compounds and their importance
 - k) Any two government schemes for financing fishery
 - l) Role of NABARD in fishery financing
 - m) Micro marketing
 - n) Rules for export of fishes
 - (from open unit, if opted)
 - p) ----- (from open unit, if opted)

- Q.2** Describe marine prawn culture (*Litopenaeus vannamei*) **15**
(Unit 1)

OR

- Q.2** a Give an account of cage farming of Cobia. **08**
(Unit 1) b Describe marine culture with reference to *Lates calcarifer*. **07**

- Q.3** Explain fish protein concentrate and isinglass as value added product. **15**
(Unit 2)

OR

- Q.3** a Give an account of chitosan. **07**
(Unit 2) b Give an account of surimi. **08**

- Q.4** Describe different characters of fish freshness and its quality. **15**
(Unit 3)

OR

Q.4 (Unit 3)	a Give an account on prawn freshness and its quality.	07
	b Explain the methods of spoilage: hyperemia and rigor mortis.	08
Q.5 (Unit 4)	Describe fish disease caused by protozoans and comment on modes of infection symptoms and treatment.	15
	OR	
Q.5 (Unit 4)	a Describe fish disease caused by fungi and comment on its symptoms and treatment.	07
	b Describe fish diseases caused by crustaceans and comment on its symptoms and treatment.	08
Q.6 (Unit 5)	Explain types of sea weeds and their properties.	15
	OR	
Q.6 (Unit 5)	a Explain important properties of bioactive compounds.	08
	b Give an account on commercial applications of sea weeds.	07
Q.7 (Unit 6)	Name financial institutions and funding agencies and describe their schemes as well as basic subsidies for fishery.	15
	OR	
Q.7 (Unit 6)	a Prepare feasibility report of cage farming of Cobia.	08
	b Explain costing, budgeting of establishing fish farm.	07
Q.8 (Unit 7)	Give an account of traditional marketing with reference to Satpati model.	15
	OR	
Q.8 (Unit 7)	a Give an account of micro marketing.	08
	b Explain different export and import procedure of fish.	07
Q.9 (Unit 8)	Question based on Open unit, if opted	15
	OR	
Q.9 (Unit 8)	a	08
	b	07

Note: Questions of the model question paper are not exhaustive, but suggestive, and teachers have liberty to reframe, modify and add other questions as deemed fit.