Academic Council dated 20th May, 2021 as per Item Number: 2.03

DOMBIVLI SHIKSHAN PRASARAK MANDAL’S,
K.V. PENDHARKAR COLLEGE OF ARTS, SCIENCE AND COMMERCE, (AUTONOMOUS)
DOMBIVLI (EAST), DIST. THANE
(Affiliated to University of Mumbai)

Faculty of Science
DEPARTMENT OF ZOOLOGY
(Programme: Bachelor of Science: B.Sc.)

SYLLABUS FOR
F. Y. B.Sc. Zoology(Semester I and II)
Choice Based Credit System (CBCS)

(with effect from the Academic Year: 2021-2022)
## SYLLABUS F.Y.B.Sc. ZOOLOGY
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# Syllabus for F. Y. B.Sc.
## Course – ZOOLOGY

To be implemented from Academic year 2021-22

### SEMESTER - I

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OBJECTIVES:
1. To make the learners aware of the animals around them and to develop in their interest the study of animal world.
2. To orient learners about rich heritage of biodiversity of India and make them understand significance of its conservation.

COURSE OUT COME:
1. Learners would develop an interest in the fascinating world of animals.
2. Learners would appreciate treasure of Biodiversity, its importance and hence would contribute their best for its conservation

Unit 1: Wonders of Animal World (15 L)

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 Egg fly and Common Crow, Common Palm fly 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**:
1.9.1: Pisces - Ovo-viviparous (Black Molly/Guppy), Mouth brooders (Tilapia), Brood pouches (Seahorse)
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)

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.


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

Unit 3: Study of Vertebrates (15 L)

3.1: Introduction: Overview of Invertebrates Classification

   3.1.1 Unicellarity to Multicellularity- Cells, Tissues, Organs and System Grade Body

   3.1.2 Symmetry: Asymmetry, Radial Symmetry and Bilateral Symmetry

   3.1.3 Body wall: Diploblastic to Triploblastic Condition

   3.1.4 Coelom: Acoelom, Pseudocoelom and True Coelom Condition

3.2: Study of General Organization of the vertebrate classes

   3.2.1: Class: Ostracodermi (Extinct), Example- Cephalaspis

   3.2.2: Class: Cyclostomata Example- Petromyzon

   3.2.3: Class: Placodermi Example- climatius
3.2.4: Class: - Chondrichthyes Example- *Shark*

3.2.5: Class: - Osteichthyes Example-*Exocetus*

3.2.6: Class: - Amphibia Example- *Frog*

3.2.7: Class: - Reptilia Example- *Crocodile*

3.2.8: Class: - Aves Example- *Duck, Heron*

3.2.9: Class: - Mammals Example- *Squirrel, Monkey*

3.3: Economic importance of Fishes, Amphibians, Reptiles and Mammals.

(PUSZO121-162)

**PAPER-II: Instrumentation and Biotechnology**

**OBJECTIVES:**

1. 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.

2. To acquaint learners with the modern developments and concepts of Zoology and their role in human welfare.

**COURSE OUTCOME:**

1. Learners would work safely in the laboratory and avoid occurrence of accidents (mishaps) which will boost their scholastic performance.

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

3. Students will be skilled to select and operate suitable instruments for the studies they would undertake.

**Unit 1: Laboratory safety, Units and Measurement**

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 (15L)

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 (15L)

3.1: Microscopy- 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.

3.4: Centrifuge - Principle and applications (clinical and ultracentrifuges).

3.5: Chromatography - Principle and applications (Partition and Adsorption)
3.6: Electrophoresis - Principle and applications (AGE and PAGE)

LEARNERS SPACE:
1. Some of the marine fishes generate electric current. Study it's mechanism by using any search engine from internet. Comment on its Biological significance.
2. What is meant by captive breeding? Where is it practiced?
3. Study the unique features of Ammocoetus larva and Axolotl larva in vertebrates.
4. What are Bionanomaterials? What would be the size of nanomaterials used in Nanotechnology?
5. How do you obtain distilled water and Deionised water in the laboratory? Give its significance in the laboratory work.
6. What are the properties of potable water?
7. Refer the principles and applications of GLC and TLC.

Paper I and Paper II

REFERENCES AND ADDITIONAL READING
3. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition
5. Modern Textbook of Zoology, Invertebrates, R. L.Kotpal
7. Biodiversity- S.V.S Rana- Prentice Hall Publications
8. Biology of Mollusca- D. R.Khanna
Publications


18. Biotechnology –Glick and Pasternak


22. Biological instruments and methodology – Dr. P. K. Bajpai, S. Chand company Ltd.

23. Dr.Parvish Pandya- A talk on Animal Behaviour
   https://youtu.be/hFSBx9F-fwg

24. Biodiversity in Konkan and Western Ghats
   https://youtu.be/mfSuc6C2mb0

   Gel Electrophoresis MITK12 Videos
   Transgenic mice You Tube Shomu’s Biology
   Microscope? You Tube Amoeba Sisters
   Application of Biotechnology You Tube Kaye B
   Adsorption Chromatography. You Tube Shomu’s Biology
SEMESTER I: Practical I (PUSZOI21-P161)

1. Mounting of foraminiferan shells from sand (any 3)
2. Study of types of Corals – Brain coral, Organ pipe, Stag Horn, Mushroom coral.
3. Study of six fish species with respect to their habitat. (Tilapia, Catfish, Catla, Pomfret, Eel, Sting ray)
4. Mounting of scales of fish (placoid, cycloid and ctenoid)
5. Breeding and parental care in Amphibia- Rhacophorus, Midwife toad, Darwin’s frog, Caecilian.
7. Identification and differentiation of venomous and non-venomous snakes (Scales, Fangs, Bite marks, etc.).
8. Study of types of beaks and claws in birds (Beaks-Nectar feeding, Insect catching, fruit eating, scavenging), (Claws-perching, wading, swimming, climbing)
9. Identification of birds - Coppersmith Barbet, Bulbul, Rose ringed Parakeet, Magpie Robin, two local birds
10. Identification of Mammals on the basis of feeding habit- Rabbit, Elephant, Dog, Tiger, Rat, Monkey.

Field Report – Observation of fauna.
To be done in a group of ten students (submission of written / type report preferably along with photographs/ tables/graphs

Suggested topics for field observation: Butterflies/ Fishes/ Migratory birds of local area.
*Note - The practicals 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 regulations of the relevant monitoring bodies. Specimens, however, shall be procured for the purpose of conducting practicals mention here-in-above. #There shall be at least one excursion/field trip

SEMESTER I: Practical II (PUSZOI21-P162)

1. Interpretation of safety symbols (toxic, corrosive, explosive, flammable, skin irritant, oxidizing agent, compressed gases, aspiration hazards and Bio hazardous infectious material.)
2. Preparation of Molar solutions of any three chemicals.
3. Study of central tendencies and plotting of bar diagram, histogram and pie diagram.

4. Identification of transgenic fish (Trout and Salmon) / cloned animals (Dolly sheep, cc cat and Snuppy dog) from photograph.

5. a) Study of pH meter
   b) Calculation of pH of three different samples (one and neutral) using pH each acidic, alkaline paper/Universal Indicator and confirming the result with pH meter

6. a) Demonstration of Electrophoretic technique.
   b) Application of DNA Fingerprinting in criminology (photograph of electrophoretic pattern to be given for interpretation by the students)

7. a) Study of parts of microscope and their functions.
   b) Technique of focusing a permanent slide under 10x and 45x (objectives).

8. a) Study of Colorimeter. Dilution of given sample and estimation of OD by using colorimeter.
   b) Calculation of concentration from the given OD using formula.

9. a) Separation of amino acids from the mixture by paper chromatography.
   b) Calculation of Rf value of separated pigments/amino acids from given chromatogram and their identification from standard chart.

10. a) Separation of pigments by adsorption chromatography using chalk.
   b) Separation of lipids by TLC,

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Websites referred to change the syllabus

1. www.sgbau.ac.in Sant Gadgebaba Amravati University, Amravati, (M.S.)
2. bhu.ac.in Banaras Hindu University, Varanasi (U.P.)
3. nmu.ac.in Kavyatri Bahinabai North Maharashtra University, Jagaon(M.S.)
4. msubaroda.ac.in The Maharaja Sayajirao University, Vadodara (Gujrat)
OBJECTIVES:

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

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

3. 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 bio piracy.

COURSE OUTCOME:

1. This study would allow the learner to know about nature of animal Population, specific factors affecting specific factor affecting its growth and its impact on the population of other life forms.

2. Learners will grasp the concept of interdependence and interaction of physical, chemical and biological factors in the environment.

3. Learners would be inspired to choose career options in the field of wildlife conservation, research, photography and ecotourism.

Unit 1: Population ecology:

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  

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 Grassland).
   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  


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

3.3: Ecotourism

3.4: Biopiracy
OBJECTIVES:

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

2. 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.

3. To understand causes and ill effects of atmospheric pollution.

COURSE OUT COME:

1. 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.

2. Learners will understand the importance of water conservation and personal hygiene.

3. Learners will be more thoughtful in using the natural resources and may also guide their peers for the same.

Unit 1: Nutrition and Health (15 L)

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, Kwashiorkar (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), BMI calculation and its significance.

1.5 : Importance of fibres infood.

1.6 : Significance of breastfeeding.

1.7 : Swine flu (cause, symptoms, precaution and remedy).

1.8 : Covid-19(cause, symptoms, prevention and precaution)

Unit: 2 Public Health and Hygiene (15L)
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: Blood bank – Concept and significance

Unit: 3. Pollution (15L)

3.1: Introduction
3.2: Causes, effects and control measures of pollution
   3.2.1: Air Pollution
   3.2.2: Water Pollution
   3.2.3: Soil Pollution
   3.2.4: Solid waste pollution
   3.2.5: Noise pollution

3.3: Case studies on pollution:
   Bhopal Gas Tragedy, The Minamata disaster, Effect of air pollution on Taj Mahal, Acidification of Great Barrier reef, Diclofenac as a threat to Indian vultures

LEARNERS SPACE:
1. To protect wildlife from extinction now a day Satellite Technology is used in Sanctuaries and National Parks. How do they obtain images of their behaviour by using a way of modern wildlife
techniques?

2. Find ecological significance of every species of animal world.

3. What is meant by captive breeding? Where is it practiced?

4. What is Nephelometry? What is its use?

5. As a Nutritionist prepare guidelines to maintain physical fitness of your age.

6. Compare demography of any one developing and developed Nations,

PAPER: I and II
REFERENCES AND ADDITIONAL READING


2. Ecology - Mohan P. Arora, Himalaya Publishing House


13. Parasitology (Protozoology and Helminthology) - K. D. Chatterjee, Chatterjee Medical Publishers.
21. Food Nutrition and Health - Dr. Shashi Goyal, Pooja Gupta, S. Chand Publications.
23. Western Ghats https://youtu.be/mfSuc6C2mb0
24. Yoga at Home Yoga at Family for physical fitness https://youtu.be/2IXMHR07_A8
25. Human Nutrition and Health - You Tube: University of Surrey
SEMESTER II: Practical I (PSZOII21-P261)

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 and food webs chains.

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).

10. Study of sanctuaries, national parks, biosphere reserves in India with respect to its brand fauna as listed in theory)
1. Qualitative test of heavy metals iron and lead.
2. Water Analysis- Physical properties
3. Milk adulterants (starch and glucose), methylene blue reduction Test (MBRT).
5. Study of Common medicines.
6. Study of causes and symptoms of anemia, acidity, obesity, constipation and goiter and kwashiorkor diseases
7. Study of Human parasites.
   1. Endoparasites - Protozoans (Entamoeba, Plasmodium), Helminths (Ascaris, Wuchereria), Ectoparasites (Head louse, tick) and Exoparasites (Bed bug, Mosquito).
8. Screening of anaemic/non-anaemic persons using CuSO4 method.
9. First Aid – Demonstration Practical Training for teachers and students to be conducted by the experts from Red cross, 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.

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

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2. bhu.ac.in Banaras Hindu University, Varanasi (U.P.)
3. nmu.ac.in Kavyatri Bahinabai North Maharashtra University, Jagaon(M.S.)
4. msubaroda.ac.in The Maharaja Sayajirao University, Vadodara (Gujrat)
Pedagogy

As F.Y.B.Sc 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 has been 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 student 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 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. It is advisable to share topic related internet links to see videos on you tubes. Population ecology needs to be explained in context with sensors to enlighten pupils about the effect of diversity and dynamism of human population on socio-economic status of India. Expert 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 may be engaged to educate students regarding myth, precautionary measures, immunization dries of common diseases, ill-effects of self-medication and stress, significance of BMI through series of programs. 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 first-aid technics for teachers and students both with the help of organizations like Red cross society, Health department of civic bodies, civil defense department and local self-government etc. They should be also made realize that healthy air, water and soil quality is important for existence of life on the earth.
SCHEME OF EXAMINATION (THEORY)

(a) Internal assessment of forty (40) marks per course per semester will be conducted according to the format given below.

(b) External assessment of sixty (60) marks per course per semester will be conducted as per the following skeleton question paper pattern.

(c) One practical examination of fifty (50) marks per course each will 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: 60

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Type of Questions</th>
<th>Weightage</th>
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<tr>
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<td>Answer in one or two sentences each/Definition/Give reason/Justify the statements</td>
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<td>Short answer questions</td>
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<td>Preparations, Presentation, Observation, Analysis, Results, Excursion / Survey, Viva and Journal</td>
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<td>Theory Internal (40%)</td>
<td>One Class test (Objective/ Multiple Choice).</td>
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<td>Assignment/ Project/ Presentation/ Field Experience/Book or Research Paper Review.</td>
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<td>Active Participation, Level of Understanding of Students.</td>
<td>12.5%</td>
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</table>
SEMESTER I: PAPER 1
Skeleton - Practical Examination Question Paper Pattern

Time: 2hrs
Marks: 50

Q.1. From the given sample mount foraminiferan shells (three types) (06 Marks)

OR
Mounting of scales (placoid and cycloid/ctenoid) from fishes.

Q.2. Identify the fish species and comment on their habitat (a and b) (06 Marks)

Q.3. Identification (one specimen each) (15 Marks)
   i. Types of corals
   ii. Amphibians-breeding and parental care
   iii. Adaptive radiation in reptiles
   iv. Venomous and non-venomous snake
   v. Types of beaks/claws in birds

Q.4. Identify the mammal and comment on their feeding habits (a and b, c out of syllabus) (09 Marks)

Q.5. Field study report (Biodiversity) and viva on it. (09 Marks)

Q.6. Journal (05 Marks)

-----------------------------
SEMESTER I: PAPER II

Skeleton - Practical Examination Question Paper Pattern

**Time:** 2hrs  **Marks:** 50

**Q. 1**

a) Dilute the given sample and estimate the OD using colorimeter. (four dilutions)  (10 Marks)

b) Calculate concentration from given OD by formula. (three concentrations)  (05 Marks)

**OR**

a) Prepare molar solutions (three)  (10 Marks)

b) Find pH of water samples (three) and comment on their chemical nature.  (05 Marks)

**Q. 2.** Perform experiment for separation of pigments by adsorption chromatography.  (08 Marks)

**OR**

Perform experiment for separation of mixture of amino acids by paper chromatography

**OR**

Focus the given slide under 10 X and 45 X and show it to examiner.

**OR**

Perform Thin Layer Chromatography (TLC) for separation of lipids.

**Q. 3.** Prepare a frequency distribution table / Plot histogram / Pie diagram / from the given data.  (06 Marks)

**Q. 4.** Identification  (12 Marks)

(Safety Symbols (two), parts of compound microscope, instrument (any one), transgenic animals, DNA fingerprinting)

**Q. 5.** Viva  (04 Marks)

**Q. 6.** Journal  (05 Marks)

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Semester II Practical I

Practical Examination Question Paper Pattern
Q.1. Estimate Hardness from given water samples and compare the results. (15 Marks)

OR
Estimate Free CO2 from given samples and compares the results.

Q.2. Solve the given problems (using statistical approach wherever possible) based on (Any two) (10 Marks)
- 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 Practical II
Skeleton - Practical Examination Question Paper Pattern

Time: 2hrs 
Marks: 50

Q.1. Analyse the given water sample and comment on its quality. (10Marks)

OR

Detect the presence of heavy metals in the given water sample.

Q.2. Analyse the given food sample and identify food adulterants (any 2 samples). (10Marks)

OR

Detect adulterants present in the given milk sample (any two).

Q.3 Evaluate milk quality by Methylene Blue Reduction Test (MBRT). (10Marks)

OR

Comment on the medicinal use of the given sample (two samples).

OR

Determine whether given blood sample is from anaemic/non-anaemic person using CuSO4 Method and suggest the appropriate diet (05Marks)

Q.4 Identification (10Marks)

a) One specimen of Protozoan Parasites.
b) One specimen of Helminth Parasites.
c) One specimen from Ectoparasite
d) One specimen from Endoparasite
e) One specimen from Exoparasite

Q.5 Submission of report of Survey of nutritional diseases / Sound Pollution in their area / report of field visit and viva based on it. (10Marks)

Q.6. Journal. (05 Marks)

*****************************************************************************
DOMBIVLI SHIKSHAN PRASARAK MANDAL’S,
K.V. PENDHARKAR COLLEGE OF ARTS, SCIENCE AND COMMERCE,
(AUTONOMOUS) DOMBIVLI (EAST), DIST. THANE

(Affiliated to University of Mumbai)

Faculty of Science

DEPARTMENT OF ZOOLOGY

(Programme: Bachelor of Science: B.Sc.)

SYLLABUS FOR

S. Y. B.Sc. Zoology (Semester III and IV)
Choice Based Credit System (CBCS)

(With effect from the Academic Year: 2022-2023)
# Syllabus for S.Y.B.Sc.

**Subject:** ZOOLOGY

**SEMESTER – III**

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<thead>
<tr>
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<th>TOPIC</th>
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<td>PUSZOIII22-361</td>
<td>I</td>
<td>Fundamentals of Genetics,</td>
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<td></td>
<td>II</td>
<td>Chromosomes and Heredity,</td>
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<td>III</td>
<td>Nucleic acids</td>
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<td>PUSZOIII22-362</td>
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<td>II</td>
<td>Study Respiration and circulation,</td>
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<td>III</td>
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Syllabus for S.Y. B. Sc
Course – ZOOLOGY

1. Syllabus Semester III & IV (Theory and Practical)

2. References and Additional Reading

3. Scheme of Examination and Paper Pattern (Theory and Practical)

4. Model Question bank
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### S.Y.B.Sc SYLLABUS
#### SEMESTER- III

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<td>Unit 1: Fundamentals of Genetics</td>
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**Objectives:**
- To Introduce basic terms of genetics
- To study Mendelian principles of inheritance and other forms pattern of inheritance

**Desired outcomes:**
- Understand and apply the principles of inheritance.
- Understand the concept of multiple alleles, linkage and crossingover.

#### 1.1 Introduction to genetics
- Definition, scope and importance of genetics.
- Classical and Modern concept of Gene (Cistron, muton, recon).
- Brief explanation of the following terms: Allele, wild type and mutant alleles, locus, dominant and recessive traits, homozygous and heterozygous, genotype and phenotype, genome.

#### 1.2 Mendelian Genetics
- Mendelian Genetics: Monohybrid cross, Dihybrid cross, test cross, backcross, Mendel’s laws of Inheritance, Mendelian traits in man.
- Chromosome theory of inheritance.
- Pedigree analysis-Autosomal dominant and autosomal recessive, X-linked dominant, and X-linked recessive

#### 1.3 Multiple Alleles and Multiple Genes
- Concept of multiple alleles, Coat colour in rabbit, ABO and Rh blood group systems
- Polygenetic inheritance with reference to skin colour and eye colour
1.4 **Linkage and Crossing Over**  
Linkage and crossing over, types of crossing over, cytological basis of crossing over.

**Unit: 2: Chromosomes and Heredity**

<table>
<thead>
<tr>
<th>Learning objectives:</th>
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<tbody>
<tr>
<td>To familiarize the learners with the structure, types and classification of chromosomes.</td>
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<tr>
<td>To introduce the concept of sex determination and its types, sex influenced and sex limited genes.</td>
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</table>

**Desired Outcomes:**
- Learners would understand the structure and types of chromosomes.
- Learners would understand mechanisms of sex determination.
- Learners would be able to correlate the disorders linked to a particular sex chromosome.

2.1 **Chromosomes**
- Types of chromosomes—Autosomes and Sex chromosomes
- Chromosome structure - Heterochromatin, Euchromatin
- Classification based on the position of centromere
- Endomitosis, Giant chromosomes- Polytene and Lamp brush chromosomes and significance of Balbiani rings.

2.2 **Sex- determination**
- Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW.
- Sex determination in honey bees- Haplodiploidy,
- Sex determination in *Drosophila*-Genic balance theory, intersex, gynandromorphs.
- Parthenogenesis.
- Hormonal influence on sex determination-Freemartin and sexreversal.
- Role of environmental factors- Bonellia and Crocodile
- Barr bodies and Lyon hypothesis
2.3 **Sex linked, sex influenced and sex limited inheritance.**

- X-Linked: Colourblindness, Haemophilia
- Y-linked: Hypertrichosis
- Sex-influenced genes
- Sex limited genes

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<th>Unit: 3</th>
<th>Nucleic acids</th>
<th>15 L</th>
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**Objectives:**
- To introduce to the learners the classical experiments proving DNA as the genetic material.
- To make the learner understand the structure of nucleic acids and the concept of central dogma of molecular biology.
- To familiarize the learner with the concept of gene regulation.

**Desired Outcomes:**
- Learner would understand the importance of nucleic acids as a genetic material.
- The learners would understand and appreciate the regulation of gene expressions.

3.1 **Genetic material**

- Griffith’s transformation experiments, Avery-Macleod and McCarty, Hershey Chase experiment of Bacteriophage infection
- Chemical composition and structure of nucleic acids.
- Double helix nature of DNA, Solenoid model of DNA.
- Types of DNA – A, B, Z & H forms.
- DNA in Prokaryotes - chromosomal and plasmid.
- Extra nuclear DNA - mitochondria and chloroplast.
- RNA as a genetic material in viruses.
- Types of RNA: Structure and function.

3.2 **Flow of genetic information in a Eukaryotic cell**

- DNA Replication
- Transcription of mRNA
- Translation
- Genetic code
3.3 Gene Expressions and regulation
- One gene-one enzyme hypothesis / one polypeptide hypothesis
- Concept of operon
- Lac operon

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<th>PUSZ0III22-362 COURSE-VI</th>
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<tbody>
<tr>
<td>1.1</td>
<td>Comparative study of Nutritional Apparatus (structure and function): Amoeba, Hydra, Earthworm, Cockroach, Bivalve, Amphioxus, Pigeon, Ruminants.</td>
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<tr>
<td>1.2</td>
<td>Physiology of digestion in man</td>
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</table>
| 1.3    | Comparative study of Excretory and Osmoregulatory structures and function  
a. Amoeba - contractile vacuoles  
b. Planaria - Flame cells  
c. Earthworm - Nephridia  
d. Cockroach - Malphigian tubules and green gland  
e. Bivalve - Organ of Bojanus | 5L |
### Unit: 2 Life Processes - II

**Objective:**
- To introduce the concepts of physiology of respiration and circulation
- To expose the learners to various respiratory and circulatory structures in different classes of organisms.

**Desired Outcome:**
- Learners would understand the increasing complexity of respiratory and circulatory physiology in evolutionary hierarchy.
- Learners would be able to correlate the habit and habitat with respiratory and circulatory structures.

#### 2.1 Comparative study of Respiratory organs (structure and function)
- Earthworm, Spider, Rohu, Frog and Pigeon.

#### 2.2 Accessory respiratory structures: Anabas /Clarius

#### 2.3 Structure of lungs and physiology of respiration in man

#### 2.4 Comparative study of circulation: Open and closed - single and double

#### 2.5 Types of circulating fluids- Water, coelomic fluid, haemolymph, lymph and blood.

#### 2.6 Comparative study of Hearts (Structure and function)
- Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon.

#### 2.7 Structure and mechanism of working of heart in man

### Unit: 3 Life Processes - III

**Objective:**
- To introduce the concepts of physiology of control and coordination and locomotion and reproduction
- To expose the learners to various locomotory and reproductive structures in different classes of organisms
**Desired Outcome:**
- Learners would understand the process of control and coordination by nervous and endocrine regulation.
- Learners would be fascinated by various locomotory structures found in the animal kingdom.
- Learners would be acquainted with various reproductive strategies present in animals.

### 3.1 Control and coordination
- Irritability – Paramaecium, Nerve net in Hydra, Nerve ring and nerve cord in earthworm
- Types of neurons on the basis of structure and function
- Conduction of nerve impulse: Resting potential, action potential and refractory period
- Synaptic transmission
- Endocrine regulation: Hormones as chemical messengers, feedback mechanisms

### 3.2 Movement and Locomotion
- Locomotory organs - structures and functions
  a. Pseudopodia in Amoeba (sol gel theory), Cilia in Paramecium
  b. Wings and legs in Cockroach
  c. Tube feet in Starfish
  d. Fins of fish

### 3.3 Structure of Striated muscle fibre in human and Sliding filament theory

### 3.4 Reproduction
- Asexual Reproduction - Fission, fragmentation, gemmule formation, budding
- Sexual reproduction
  i. Gametogenesis
  ii. Structure of male and female gametes in human
  iii. Types of fertilization
  iv. Oviparity, viviparity, ovi-viviparity
### UNIT 1: Common Human Diseases and Common Drugs (15L)

**Objective:**
- To educate learners about causes, symptoms and impact of stress related disorders and infectious diseases.
- To understand the chemical nature of various drugs

**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.
- Learners would be able to acquire knowledge of cause, symptoms and precautions of infectious diseases.
- Learners would be understand chemical nature of drug with action against the specific clinical condition.

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
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</thead>
</table>
| 1.1 | Stress related disorders  
1.1.1: Anxiety, insomnia, migraine, depression (cause, symptoms, precaution and remedy)  
4L |
| 1.2 | Communicable and non-communicable diseases and their common drugs  
1.2.1: Typhoid, Hepatitis (A and B), AIDS,  
6L |
| 1.2.2 | Diseases of respiratory system- Causes, symptoms precautions & remedy of respiratory diseases- Asthma, Bronchitis, n-COVID-19, Prognosis for diseases. |
| 1.2.3 | Oral Cancer  
(Discuss cause/causative agents, symptoms, diagnostics, precaution /prevention and remedy) |
| 1.3 | Introduction to some common drugs and their routes of administrations  
Definition and sources of drugs, Antibiotics and Antivirals and Antimalaria, Antiamoebic, Anti-helminthic and Antifungal drugs  
5L |

**Unit: 2 Parasitology** 15L
Objective:
- To acquaint learners with the concepts of parasitism, their relationship with environment.
- To make learners aware about the modes of transmission of parasites.

Desired Outcome:
- Learners would understand the general epidemiological aspects of parasites that affect humans and apply simple preventive measures for the same.
- Learners would comprehend the life cycle of specific parasites, the symptoms of the disease and its treatment.

2.1 Introduction to Parasitology and types of parasites
- Definitions: parasitism, host, parasite, vector-biological and mechanical
- Types of parasites- Ectoparasites, Endoparasite and their subtypes
- Parasitic adaptations in Ectoparasites and Endoparasites
- Types of hosts: intermediate and definitive, reservoir

2.2 Host-parasite relationship-Host specificity
- Definition, structural specificity, physiological specificity and ecological specificity.

2.3 Life cycle, pathogenicity, control measures and treatment
- Entamoeba histolytica, Fasciola hepatica, Taenia solium, Wuchereria bancrofti

2.4 Morphology, life cycle, pathogenicity, control measures and treatment
- Head louse (Pediculus humanus capitis), Mite (Sarcoptes scabei), Bed bug (Cimex lectularis)

2.5 Parasitological significance
- Zoonosis- Bird flu, Anthrax, Rabies and Toxoplasmosis

Unit 3 Economic Zoology
- Objective:
  - To disseminate information on economic aspects of zoology like apiculture, vermiculture, dairy science.
  - To encourage young learners for self-employment.
- Desired Outcome:
  - Learners would gain knowledge on animals useful to mankind and the
means to make the most of it.

- Learners would learn the modern techniques in animal husbandry.
- Learners would be pursuing entrepreneurship as careers

<table>
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<th>3.1</th>
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<th>5L</th>
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<tbody>
<tr>
<td><strong>3.1.1</strong> Methods of bee keeping and management</td>
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<tr>
<td>➢ An introduction to different species of honey bees used in apiculture.</td>
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</tr>
<tr>
<td>➢ Selection of flora and bees for apiculture.</td>
<td></td>
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</tr>
<tr>
<td>➢ Advantages and disadvantages of traditional and modern methods of apiculture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Pests and Bee enemies- Wax moth, wasp, black ants, bee eaters, king crow and disease control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bee keeping industry- Present status and recent efforts to improve and boost the industry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **3.1.2** Economic importance | | |
| ➢ Honey- Production, Chemical composition and economic importance | | |
| ➢ Bees wax- Economic importance. | | |
| Role of honey bees in pollination. | | |

<table>
<thead>
<tr>
<th>3.2</th>
<th>VERMICULTURE</th>
<th>4L</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.2.1</strong> Rearing methods, management and economic importance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ An introduction to different species of earthworms used in vermiculture.</td>
<td></td>
<td></td>
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<tr>
<td>➢ Methods of vermiculture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Maintenance and harvesting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic importance: advantages of vermiculture, demands for worms; market for vermicompost and entrepreneurship.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.3</th>
<th>DAIRY SCIENCE</th>
<th>6L</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.3.1</strong> Dairy development in India</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Role of dairy development in rural economy, employment opportunities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 3.3.2 | Dairy Processing | | |
|-------|------------------|----|
| Filtration, cooling, chilling, clarification, pasteurization, freezing | | |

| **3.3.3** Milk and milk products | | |
- Composition of milk
- Types of milk:
  - Recombined milk
  - Soft curd milk
  - Skimmed and toned milk
  - Artificial milk
- Milk products
<table>
<thead>
<tr>
<th></th>
<th>SEMESTER III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Practical PUSZ0III22-P361 (Course V)</strong></td>
</tr>
<tr>
<td>1</td>
<td>Extraction and detection of DNA</td>
</tr>
<tr>
<td>2</td>
<td>Extraction and detection of RNA.</td>
</tr>
<tr>
<td>3</td>
<td>Mounting of Barr bodies.</td>
</tr>
<tr>
<td>4</td>
<td>Study of polytene chromosome.</td>
</tr>
<tr>
<td>5</td>
<td>Study of mitosis- temporary squash preparation of Onion root tip</td>
</tr>
<tr>
<td>6</td>
<td>Detection of blood groups and Rh factor.</td>
</tr>
<tr>
<td>7</td>
<td>Problems in genetics</td>
</tr>
<tr>
<td></td>
<td>a. Monohybrid/ Dihybrid cross</td>
</tr>
<tr>
<td></td>
<td>b. X- linked inheritance</td>
</tr>
<tr>
<td></td>
<td>c. Multiple alleles</td>
</tr>
<tr>
<td>8</td>
<td>Chromosome morphology: Metaphase spreadsheet (photograph to be provided)</td>
</tr>
<tr>
<td>9</td>
<td>Problems based on Pedigree analysis</td>
</tr>
<tr>
<td>10</td>
<td>Problems on molecular biology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Practical PUSZ0III22-P362 (Course VI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Urine analysis—Normal and abnormal constituents</td>
</tr>
<tr>
<td>2</td>
<td>Detection of ammonia in water excreted by fish</td>
</tr>
<tr>
<td>3</td>
<td>Detection of uric acid from excreta of Birds</td>
</tr>
<tr>
<td>4</td>
<td>Study of striated and non- striated muscle fibre</td>
</tr>
<tr>
<td>5</td>
<td>Study of nutritional Apparatus  (Amoeba, Hydra, Earthworm, Pigeon, Ruminant stomach)</td>
</tr>
<tr>
<td>6</td>
<td>Study of respiratory structures:</td>
</tr>
<tr>
<td></td>
<td>a. Gills of Bony fish and Cartilaginous fish.</td>
</tr>
<tr>
<td></td>
<td>b. Lungs of Frog</td>
</tr>
<tr>
<td></td>
<td>c. Lungs of Mammal.</td>
</tr>
<tr>
<td></td>
<td>d. Accessory respiratory structure in Anabas (Labyrinthine organ )</td>
</tr>
<tr>
<td></td>
<td>e. Air sacs of Pigeon.</td>
</tr>
<tr>
<td>7</td>
<td>Study of locomotory organs (<em>Amoeba, Unio, Cockroach, Starfish, Fish, and Birds</em>)</td>
</tr>
<tr>
<td>8</td>
<td>Study of hearts (Cockroach, Shark, Frog, <em>Calotes</em>, Crocodile, Mammal)</td>
</tr>
<tr>
<td>9</td>
<td>Study of permanent slides on topic of Reproduction</td>
</tr>
<tr>
<td></td>
<td>a. Sponge gemmules</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>b.</td>
<td>Hydra budding</td>
</tr>
<tr>
<td>c.</td>
<td>T.S. of mammalian testis</td>
</tr>
<tr>
<td>d.</td>
<td>T.S. of mammalian ovary</td>
</tr>
<tr>
<td></td>
<td>Practical PUSZ011122-P363 (Course VII)</td>
</tr>
<tr>
<td>1</td>
<td>Extraction of Casein from Milk and its qualitative estimation</td>
</tr>
</tbody>
</table>
| 2 | Study of Protozoan parasites:  
|   | a. Trypanosoma gambiense  
|   | b. Giardia intestinalis  
|   | c. Entamoeba histolytica, |
| 3 | Study of Helminth parasites:  
|   | a) Ancylostoma duodenale  
|   | b) Dracunculus medenensis  
|   | c) Fasciola hepatica, |
| 4 | Parasitic adaptations: Scolex and mature proglottid of Tapeworm |
| 5 | Study of Ectoparasites:  
|   | a. Leech  
|   | b. Tick  
|   | c. Mite |
| 7 | First-aid: Demonstration practical training for teachers and students to be conducted by the experts from red cross, civil defense, civic authorities by Individual institutes or cluster colleges in rotation. |
| 8 | Anxiety test – Coglab software/ C A (Comprehensive anxiety by Sharma Bhardwaj and Bhargava, Mapan, Agra) Test |
| 9 | Project- Suggested topics on economic zoology (e.g Apiculture, sericulture/ lac culture /vermicompost Technique / Construction of artificial beehives /Animal husbandry/ aquaculture etc) |

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.

**Justification:**

Paper-III Unit-I- Common Diseases and some common drugs:

It is essential for awareness to introduce Human diseases and certain drugs at UG level. Epidemic and pandemic spread of diseases becomes one of the reasons to setback economic growth of Nation.

Marks for Practical viva and certified Journal are given with separate weightage of 5 marks.

**Learner’s Space:**

1. Prepare slogans on human parasites and control and treatment against parasitic diseases in English/Marathi/Hindi or in your mother tongue.
2. What are pandemic diseases?
3. What is the legislation implemented in checking pandemic condition. Explain it with suitable example.
4. Prepare a chart of types of various Human parasites, mode of infection, pathogenicity and precautionary measures.
5. Enlist the various parasites transmitted from pets. What are the precautions to be taken to avoid such infections?
6. Locate natural hive of Honeybees in wild habitat or in your vicinity using binocular from the safe distance. Identify the type of Honey bees depending on size and position of honey comb.
7. Prepare feasibility report of any one cattle farm as a guideline to emerging small scale cattle farmer.
   Define Lac-culture and Sericulture. Give its scope in various states of India.
8. Learn to prepare any other dairy products of your interest other than yogurt at your home. Give its constituents.
10. What is ringworm infection? Find the prospective prognosis for the same.
11. If both parents have blood group ‘A’ what will be the possible blood group of their children.
12. Observe Drosophila and study various eye colours and wing patterns.
13. Conduct a survey in your class for the following traits and determine how many students in the class exhibit the phenotype:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Trait</th>
<th>Do you have the trait (Yes/No)</th>
<th>Percentage of students showing similar traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tongue Rolling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Attached earlobe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Hitchhiker's thumb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Curly hair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Widow’s peak</td>
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</tbody>
</table>

14. Arrange all the chromosomes of a normal person to prepared ideogram.
15. Compare the chromosomes in man and chimpanzees and note the identical chromosomes.
16. Organize a group activity of role played to understand protein synthesis by assigning the roles of DNA, mRNA, rRNA, tRNA, amino acids and peptide bonds.
17. Find out about more operon systems in human body.
18. Elucidate the causes and types of nephrolithiasis.
19. Review symbiotic digestion in animals other than ruminants.
20. Describe the role gastrointestinal hormones in the regulation of the secretions of the digestive glands and their role in digestion.
21. Discuss the disorders caused due to nutritional deficiencies.
22. Discuss the causes and general effects of the major respiratory disorders and diseases.
23. Review the three general pathway to generate ATP from food.
24. Study a standard ECG and identify what cardiac function corresponds to each peak.
25. Find out the difference of the working of heart in space and earth.

**Job oriented/Entrepreneurship development topics:**
1. Common Human diseases and some common drugs: Medical Transcription.
2. Economic Zoology: Apiculture, Dairy industry and Vermiculture as self-employment programs.

**Semester –III**

**REFERENCE BOOKS AND ADDITIONAL READING**
COURSE-V (PUSZOIII22-361)

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

COURSE-VI (PUSZOIII22-362)

2. Invertebrate Zoology Volume II- Jordan and Verma, S. Chand and Co.
5. Invertebrate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.

COURSE-VII (PUSZOIII22-363)

3. Bee and Bee Keeping- Roger A. Morse, Conell University Press London
6. Medical Parasitology- Arora
11. Introduction to Parasitology- Chandler and Read John Wiley & Sons

ICT Backup:

1. Google search engine.
2. Yahoo search engine
3. YouTube videos and animations
4. Department e-book library and video gallery

Pedagogy:

1. Awareness Wall
e.g. Cut-outs regarding the developments in the field of Wildlife, Environment, Social health etc. will be displayed.

2. **Teaching through Surveys:** Population surveys to study genetic traits (Widow’s Peak, Free/Attached Earlobes, Curly Hair, Roller/Non-roller), BMI studies, Seasonal occurrence of diverse insects and avian fauna.

3. While taking lesson of drugs, it is expected that teachers shall emphasize upon avoidance of self-medication even though students are aware of the chemical nature & mode of action of drugs

**MOOC units:**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
<th>Topic</th>
<th>MOOC unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PUSZ0I122-361</td>
<td>Genetics</td>
<td>a. Useful genetic part –I: How our genes shape us?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Useful genetic part –II: Genes and genetics</td>
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<td></td>
<td>c. Inheritance</td>
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<td></td>
<td>d. AP Biology part II: Genetics.</td>
</tr>
<tr>
<td>2.</td>
<td>PUSZ0I122-362</td>
<td>Life Processes</td>
<td>a. Anatomy: Cardiovascular, Urinary and respiratory system</td>
</tr>
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<td></td>
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<td></td>
<td>b. Anatomy: Human Neuroanatomy</td>
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<td></td>
<td>c. Anatomy: Gastrointestinal, Reproductive and endocrine system</td>
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<td></td>
<td>d. Human reproduction</td>
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<td></td>
<td>e. Respiration in the human body</td>
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<tr>
<td></td>
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<td></td>
<td>f. Sex and Human reproduction</td>
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</tbody>
</table>
SCHEME OF EXAMINATION (THEORY)

(a) Internal assessment of forty (40) marks per course per semester will be conducted according to the format given below.

(b) External assessment of sixty (60) marks per course per semester will be conducted as per the following skeleton question paper pattern.

(c) One practical examination of fifty (50) marks per course each will 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

<table>
<thead>
<tr>
<th>EVALUATION PATTERN</th>
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<tbody>
<tr>
<td>Evaluation</td>
</tr>
<tr>
<td>Theory External (60%)</td>
</tr>
<tr>
<td>Short answer questions</td>
</tr>
<tr>
<td>Long answer questions</td>
</tr>
<tr>
<td>Practical (I/II/III)</td>
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<tr>
<td>Theory Internal (40%)</td>
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</table>

**Passing Standard:** 40% (Theory and Practical courses are separate areas of passing)
PRACTICAL
PUSZ0III22-361 (Course V)
Skeleton-Practical Examination Question Paper
Pattern

Time: 2 hrs
Marks: 50

Major Question

Q1. Extraction and detection of DNA
    OR
Q1. Extraction and detection of RNA

Minor Question

Q2. Mounting of Barr bodies
    OR
Q2. Study of mitosis-Temporary squash preparation of Onion root
    tipOR
Q2. Detection of blood groups and Rh factor

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

Q4. Identification
    a. Chromosome morphology (2 Photograph)
    b. Pedigree analysis

Q5. Viva
    05 marks

Q6. Journal
    05 marks
PRACTICAL
PUSZ0III22-362 (Course VI)
Skeleton-Practical Examination Question Paper
Pattern

Time: 2 hrs

Marks: 50

Major Question

Q1. Urine analysis—Normal and abnormal constituents

Minor Question

Q2. Detection of ammonia in water excreted by fish

OR

Q2. Detection of uric acid from excreta of Birds

Q3. Identification

i. Nutritional apparatus

ii. Respiratory structures

iii. Locomotory organs

iv. Types of hearts

v. Permanent slides on reproduction

Q4. Viva

05 marks

Q5. Journal

05 marks
PRACTICAL
PUSZOIII22-
363 (Course VII)
Skeleton - Practical Examination Question Paper
Pattern

Time: 2 hrs

Marks: 50

Major Question

Q1. Extraction of Casein from Milk and its qualitative estimation

OR

Q1. Preparation of paneer from the given milk sample.

OR

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

Minor Question

Q2. Life Cycle of Honey Bee and Bee Hive

OR

Q2. Mouthparts of Honey Bee

OR

Q2. Legs of Honey Bee

OR

Q2. Sting Apparatus of Honey Bee

Q3. Identify and describe as per instructions

a. Disorder/ First aid

b. Protozoan parasites

c. Helminth parasites

d. Ectoparasites

e. Parasitic adaptations

Q4. Project submission and Viva based on project
Q5. Journal 05 marks
# Origin and evolution of Life, Population genetics, Scientific Research methodology

## Unit 1: Origin and evolution of Life

### Objective:
- To impart scientific knowledge to the learner about how life originated and evolved on our planet.

### Desired Outcomes:
- Learner will gain insight about origin of life.
- Learner will know about the different theories of evolution.

#### 1.1 Introduction.
- Origin of universe
- Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory
- Origin of life
- Origin of eukaryotic cell.

#### 1.2 Evidences in favour of organic evolution
- Evidences from: Geographical distribution, Paleontology Anatomy, Embryology, Physiology and Genetics

#### 1.3 Theories of organic evolution
- Theory of Lamarck.
- Theory of Darwin and Neo Darwinism
- Mutation Theory
- Modern Synthetic theory
- Weismans germplasm theory
- Neutral theory of molecular evolution

---

## Unit 2: Population genetics and evolution

### Objective:
- To develop learner's knowledge and understanding of genetic variability within a population and how the change in the genepool leads to
### Desired Outcomes:
- Learner would understand the forces that cause evolutionary changes in natural populations.
- Learner would comprehend the mechanisms of speciation.
- Learner will be able to distinguish between microevolution, macroevolution and megaevolution.

<table>
<thead>
<tr>
<th>2.1</th>
<th><strong>Introduction to population genetics</strong></th>
<th>1L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definition</td>
<td></td>
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<tr>
<td>2.1.1</td>
<td><strong>Brief explanation of the following terms:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Population, gene pool, Allele frequency, genotype frequency, phenotype frequency, microevolution</td>
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</table>

<table>
<thead>
<tr>
<th>2.2</th>
<th><strong>Population genetics</strong></th>
<th>6L</th>
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</thead>
<tbody>
<tr>
<td>2.2.1</td>
<td>Hardy-Weinberg Law</td>
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<tr>
<td>2.2.2</td>
<td>Factors that disrupt Hardy Weinberg equilibrium-</td>
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<tr>
<td></td>
<td>Mutation,</td>
<td></td>
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<tr>
<td></td>
<td>Migration (Gene flow),</td>
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<td></td>
<td>Non-random mating (Inbreeding, inbreeding depression, Assortative mating-Positive and Negative, Disassortativemating),</td>
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<tr>
<td></td>
<td>Genetic drift (Sampling error, fixation, Bottleneck effect and Founder effect)</td>
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<tr>
<td></td>
<td>Natural Selection.</td>
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</tbody>
</table>

| 2.2.3 | **Patterns of Natural Selection** |    |
|   | Stabilizing selection, |    |
|   | Directional Selection (Examples: Peppered moth, Antibiotic resistance in bacteria, Pesticide resistance) |    |
|   | Disruptive selection |    |

<table>
<thead>
<tr>
<th>2.3</th>
<th><strong>Evolutionary genetics</strong></th>
<th>8L</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>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).</td>
<td></td>
</tr>
</tbody>
</table>
- Nature of genetic variations- Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism- Heterozygote advantage and frequency dependent selection,
- Neutral variations.
- Geographic variation (Cline).

2.3.1 **Species Concept:** Biological species concept and evolutionary species concept

2.3.2 **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)

2.3.3 **Macroevolution and Megaevolution :**
- Concept and Patterns of macroevolution (Stasis, Preadaptation/Exaptation, Mass extinctions, Adaptive radiation and Coevolution), Megaevolution

### Unit 3: Scientific Attitude, Research methodology , writing and ethics

**Objective:**
*To inculcate scientific temperament in the learner.*

**Desired outcome:**
- The learner will develop qualities such as critical thinking and analysis.
- The learner will develop the skills of scientific communication.
- Learner will understand the ethical aspects of research

#### 3.1 Process of science: A dynamic approach to investigation

**The Scientific method**
- Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery

**Scientific Research**
- Definition, difference between method and methodologycharacteristics, types

**Steps in the Scientific Method**
<table>
<thead>
<tr>
<th>Identification of research problem, Formulation of research hypothesis, Testing the hypothesis using experiments or surveys, Preparing research/study design including methodology and execution (Appropriate controls, sample size, technically sound, free from bias, repeat experiments for consistency), Documentation of data, Data analysis and interpretation, Results and Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dissemination of data</strong></td>
</tr>
<tr>
<td>➢ Reporting results to scientific community (Publication in peer-reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation)</td>
</tr>
<tr>
<td><strong>Application of knowledge</strong></td>
</tr>
<tr>
<td>Basic research, Applied research, Translational research, Patent</td>
</tr>
<tr>
<td><strong>3.2 Scientific writing</strong></td>
</tr>
<tr>
<td><strong>Structure and components of a research paper</strong></td>
</tr>
<tr>
<td>➢ (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</td>
</tr>
<tr>
<td><strong>3.3 Writing a review paper</strong></td>
</tr>
<tr>
<td><strong>Structure and components of research report:</strong></td>
</tr>
<tr>
<td>Report writing, Types of report</td>
</tr>
<tr>
<td><strong>Computer application</strong></td>
</tr>
<tr>
<td>➢ Plotting of graphs, Statistical analysis of data. Internet and its application in research-Literature survey, Online submission of manuscript for publication</td>
</tr>
<tr>
<td><strong>3.4 Ethics</strong></td>
</tr>
<tr>
<td><strong>Ethics in animal research</strong></td>
</tr>
<tr>
<td>The ethical and sensitive care and use of animals in research, teaching and testing, Approval from Institutional animal ethics Committee</td>
</tr>
<tr>
<td><strong>Ethics in clinical research</strong></td>
</tr>
<tr>
<td>➢ Approval from Clinical Research Ethics Committee</td>
</tr>
<tr>
<td><strong>Informed consent</strong></td>
</tr>
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</tr>
<tr>
<td><strong>Approval from concerned/appropriate authorities:</strong></td>
</tr>
<tr>
<td>➢ National Biodiversity Authority</td>
</tr>
<tr>
<td>➢ State Biodiversity Board</td>
</tr>
<tr>
<td>➢ Forest Department</td>
</tr>
<tr>
<td><strong>Conflict of interest</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>3.5</th>
<th><strong>Plagiarism</strong></th>
<th>1L</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th><strong>PUSZOIV22-462 COURSE-IX</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cell Biology &amp; Histology and Biomolecules</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Unit 1: Cell Biology and Histology</strong></td>
<td>15L</td>
</tr>
<tr>
<td><strong>Objective:</strong></td>
<td></td>
</tr>
<tr>
<td>➢ <em>To study the structural and functional organization of cell with an emphasis on nucleus, plasma membrane and cytoskeleton.</em></td>
<td></td>
</tr>
<tr>
<td><strong>Desired outcome:</strong></td>
<td></td>
</tr>
<tr>
<td><em>Learner would acquire insight of transport mechanisms for maintenance and composition of cell</em></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>1.1 Introduction to cell biology</strong></th>
<th>2L</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Definition and scope</td>
<td></td>
</tr>
<tr>
<td>➢ Cell theory</td>
<td></td>
</tr>
<tr>
<td>Generalized prokaryotic, eukaryotic cell: size, shape and structure</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>1.2 Nucleus</strong></th>
<th>4L</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Size, shape, number and position</td>
<td></td>
</tr>
<tr>
<td>➢ Structure and functions of interphase nucleus</td>
<td></td>
</tr>
<tr>
<td>➢ Ultrastructure of nuclear membrane and pore complex</td>
<td></td>
</tr>
<tr>
<td>➢ Nucleolus: general organization, chemical composition and functions</td>
<td></td>
</tr>
<tr>
<td>➢ Nuclear sap/nuclear matrix</td>
<td></td>
</tr>
<tr>
<td>➢ Nucleocytoplasmic interactions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>1.3 Plasma membrane</strong></th>
<th>4L</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Fluid Mosaic Model</td>
<td></td>
</tr>
<tr>
<td>b. Junctional complexes</td>
<td></td>
</tr>
</tbody>
</table>
c. Membrane receptors  
d. Modifications: Microvilli, Desmosomes and Plasmodesmata

1.4 **Transport across membrane**  
a. Diffusion and Osmosis  
b. Transport: Passive and Active  
c. Endocytosis and Exocytosis

1.5 **Histology: Overview of animal tissues, Vertical section of Skin**

Unit 2 Endomembrane System

**Objective**:  
*To acquaint the learner with Ultrastructure of cell organelles and their functions.*

**Desired outcome**:  
- Learner would appreciate the intricacy of endomembranesystem.  
- Learner would understand the interlinking of endomembrane System for functioning of cell.

2.1 **Endoplasmic reticulum**  
- Discovery, occurrence and Types  
  Ultrastructure and Functions

2.2 **Golgi complex**  
- Origin, occurrence and morphology  
  Ultra structure and functions

2.3 **Lysosomes**  
- Origin, occurrence and polymorphism  
  Ultrastructure and Functions

2.4 **Mitochondria**  
- Origin, occurrence and morphology  
- Ultrastructure and functions  
- Marker enzymes, Mitochondrial biogenesis, Semiautonomous nature of mitochondria

Unit 3: Biomolecules

**Objective**:  

To give learner insight into the structure of biomolecules, and their role in sustenance of life.

**Desired outcome:**
- The learner will realize the importance of biomolecules and their clinical significance.

### 3.1 Biomolecules
Concept of Micromolecules and Macromolecules.

### 3.2 Carbohydrates
- Definition Classification, Properties and Isomerism, Glycosidic bond
- Structure of
  - a. Monosaccharides - Glucose and Fructose
  - b. Disaccharides - Lactose and Sucrose
  - c. Polysaccharides - Cellulose, Starch, Glycogen and Chitin

Biological role and their Clinical significance

### 3.3 Amino Acids and Proteins
- Basic structure of amino acid, classification of amino acids, Essential and Non-essential amino acids, Peptide bond
- Protein conformation: Primary, Secondary, Tertiary, Quaternary
- Types of proteins – Structural (Keratin, Collagen) and functional proteins (Hemoglobin)

Biological role and their Clinical significance

### 3.4 Lipids
- Definition, classification of lipids with examples, Ester linkage
- Physical and Chemical properties of lipids
- Saturated and Unsaturated fatty acids, Essential fatty acids
- Triacylglycerols, Phospholipids (Lecithin and Cephalin) and Steroids (Cholesterol).

Biological role and their Clinical significance

---

**PUSZOIV22-463 COURSE-X**

Comparative Embryology, Aspects of Human Reproduction, Ethology
**UNIT 1: Comparative Embryology**

<table>
<thead>
<tr>
<th><strong>Objective:</strong></th>
<th>15L</th>
</tr>
</thead>
<tbody>
<tr>
<td>To acquaint the learner with key concepts of embryology.</td>
<td></td>
</tr>
</tbody>
</table>

**Desired Outcomes:**
- Learner will be able to understand and compare the different pre-embryonic stages
- Learner will be able to appreciate the functional aspects of extra embryonic membranes and classify the different types of placentae.

| **1.1** Types of Eggs - Based on amount and distribution of yolk | 2L |
| **1.2** Structure and Types of Sperms | 1L |
| **1.3** Types of Cleavages - Holoblastic and Meroblastic | 1L |
| **1.4** Types of Blastulae | 1L |
| **1.5** Gastrulation | 2L |
| **1.6** Coelom - Formation and types | 2L |
| **1.7** Extra embryonic membranes | 6L |
| Types of Placentae - Based on histology, morphology and implantation | |

**UNIT 2: Aspects of Human Reproduction**

<table>
<thead>
<tr>
<th><strong>Objectives:</strong></th>
<th>15L</th>
</tr>
</thead>
<tbody>
<tr>
<td>To acquaint the learners with different aspects of human reproduction.</td>
<td></td>
</tr>
<tr>
<td>To make them aware of the causes of infertility, techniques</td>
<td></td>
</tr>
<tr>
<td>To overcome infertility and the concept of birth control</td>
<td></td>
</tr>
</tbody>
</table>

**Desired Outcome:**
- Learners will able to understand human reproductive physiology
- Learners will become familiar with advances in ART and Related ethical issues.

| **2.1** Human Reproductive system and Hormonal regulation | 2L |
| Anatomy of human male and female reproductive system | |
| Hormonal regulation of Reproduction and Impact of age on reproduction - Menopause and Andropause | |

| **2.2** Contraception & birth control | 2L |
### 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

### 2.3 Infertility
#### Female infertility
- **Causes:** Failure to ovulate; production of infertile eggs; damage to oviducts (oviduct scarring and PID or Pelvic inflammatory disease, TB of oviduct), Uterus (T. B. of uterus and cervix)
- **Infertility associated disorders:** (Endometriosis, Polycystic Ovarian syndrome (PCOS), POF (Primary ovarian failure) STDs (Gonorrhea, Chlamydia, Syphilis and Genital Herpes); Antibodies to sperm; Genetic causes- Recurrent abortions; Role of endocrine disruptors

#### Male infertility
- **Causes:** Testicular failure, infections of epididymis, seminal vesicles or prostate, hypogonadism, cryptorchidism, congenital abnormalities, Varicocele, Blockage, Azoospermia, Oligospermia, abnormal sperms, autoimmunity, ejaculatory disorders and Idiopathic infertility.

### 2.5 Treatment of Infertility
- Removal / reduction of causative environmental factors
- Surgical treatment
- Hormonal treatment - Fertility drugs
- Assisted Reproductive Technology
- Sperm banks, cryopreservation of gametes and embryos
- Surrogacy

### 2.6 Techniques and Ethical considerations of ART
- In vitro fertilization, Embryo transfer (ET), Intra-fallopian transfer (IFT), Intrauterine transfer (IUT), Gamete intra-fallopian transfer (GIFT), intra-zygote transfer (ZIFT), Intracytoplasmic sperm injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsies – Testicular sperm extraction (TESE), Pronuclear stage transfer (PROST).
<table>
<thead>
<tr>
<th><strong>Unit : 3 Ethology</strong></th>
<th>15L</th>
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</thead>
</table>

**Objective:**
- To equip learners with a sound knowledge of how animals interact with one another and their environment.
- To enable the learners to understand different behavioural patterns.

**Desired Outcome:**
- Learners would gain an insight into different types of animal behaviour and their role in biological adaptations.
- Learners would be sensitized to the feelings instrumental in social behavior.

3.1 **Introduction to Ethology**
- Definition, History and Scope of Ethology
- Animal behaviour - Innate and Learned behaviour

3.2 **Aspects of animal behaviour**
- Communication in Bees and Ants
- Mimicry and colouration
- Role of hormones and pheromones in sexual behaviour
- Displacement activities, Ritualization
- Migration in fish, schooling behaviour
- Habitat selection, territorial behaviour, food selection and foraging behaviour in African ungulates

3.3 **Social behaviour**
- Social behaviour in primates - Hanuman langur
- Elements of Socio-biology: Selfishness, cooperation, altruism, kinship and inclusive fitness

4L

6L

5L
<table>
<thead>
<tr>
<th></th>
<th>SEMESTER IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Practical PUSZOIV22-461 (Course VIII)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Study of population density by Line transect method &amp; Quadrant method and calculate different diversity indices.</td>
</tr>
<tr>
<td></td>
<td>a) Index of Dominance.</td>
</tr>
<tr>
<td></td>
<td>b) Index of frequency.</td>
</tr>
<tr>
<td></td>
<td>c) Rarity Index.</td>
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<tr>
<td></td>
<td>d) Shannon Index.</td>
</tr>
<tr>
<td></td>
<td>e) Index of species diversity</td>
</tr>
<tr>
<td>2</td>
<td>Study of Prokaryotic cells (bacteria) by Crystal violet staining technique.</td>
</tr>
<tr>
<td>3</td>
<td>Study of Eukaryotic cells (WBCs) from blood smear by Leishman’s stain.</td>
</tr>
<tr>
<td>4</td>
<td>Identification and study of fossils</td>
</tr>
<tr>
<td></td>
<td>a. Arthropods: Trilobite</td>
</tr>
<tr>
<td></td>
<td>b. Mollusca: Ammonite</td>
</tr>
<tr>
<td></td>
<td>c. Aves: Archaeopteryx</td>
</tr>
<tr>
<td>5</td>
<td>Identification of</td>
</tr>
<tr>
<td></td>
<td>a) Allopatric speciation (Cyprinodon species)</td>
</tr>
<tr>
<td></td>
<td>b) Sympatric speciation. (hawthorn fly and apple maggot fly)</td>
</tr>
<tr>
<td></td>
<td>c) Parapatric speciation. (Snail)</td>
</tr>
<tr>
<td>6</td>
<td>Bibliography/Abstract writing.</td>
</tr>
<tr>
<td>7</td>
<td>Preparation of Power point presentation (Research Project &amp; its presentation For interested students</td>
</tr>
<tr>
<td><strong>Practical PUSZOIV22-462 (Course IX)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Study of permeability of cell through plasma membrane (Osmosis in blood cells).</td>
</tr>
<tr>
<td>2</td>
<td>Measurement of cell diameter by occulometer (by using permanent slide)</td>
</tr>
<tr>
<td>3</td>
<td>Qualitative tests for carbohydrates (Molisch’s test, Benedicts test, Barfoed’s test, Anthrone test)</td>
</tr>
<tr>
<td>4</td>
<td>Qualitative tests for protein (Ninhydrin test, Biuret test, Millon’s test, Xanthoproteic test)</td>
</tr>
<tr>
<td>5</td>
<td>Qualitative test for lipids (Solubility test, Sudan III test)</td>
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<tr>
<td><strong>6</strong></td>
<td>Study of rancidity of lipid by titrimetric method.</td>
</tr>
</tbody>
</table>
| **7** | Ultra structure of cell organelles – (Electron micrographs)  
  a. Nucleus  
  b. Endoplasmic reticulum (Smooth and rough)  
  c. Mitochondria.  
  d. Golgi apparatus  
  e. Lysosomes |
| **8** | Study of clinical disorders due to carbohydrates, proteins and lipids imbalance. (photograph to be provided / significance to given and disorder to be identified)  
  a. Hyperglycemia, Hypoglycemia.  
  b. Thalassemia, Kwashiorkor  
  c. Obesity, Atherosclerosis |
| **9** | Study of mammalian histology: T.S. of Liver, Stomach and Intestine. V.S. of Tooth, Tongue and V.S. of skin |

**Practical PUSZOIV22-463 (Course X)**

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Determination of blood pressure by Sphygmomanometer.</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Detection of Creatinine in urine.</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Determination of blood sugar by GOD and POD method</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Study of bleeding time and clotting time.</td>
</tr>
</tbody>
</table>
| **5** | Study of the following permanent slides, museum specimens and materials.  
  a. Mammalian sperm and ovum.  
  b. Egg types – Fish eggs, Frog eggs, Hen's egg.  
  c. Cleavage, blastula and gastrula (Amphioxus, Frog and Bird). |
| **6** | Detection of pregnancy from given sample of urine using test-kit. |
| **7** | Study of birth control measures applicable to humans- IUD, Condoms and hormonal pills |
| **8** | Review writing based on programmes telecast by Doordarshan, Gyandarshan, UGC programmes. |
| **9** | Study of ethological aspects:  
  a) Warning Colouration  
    a) Instincts  
    b) Imprinting |
c) Communication in animals: Chemical signals and sound signals
Displacement activities in animals: Courtship and mating behavior in animals and ritualization

| 10 | Study of natural ecosystem and field report of the visit |

Note - The practicals may be conducted by using specimens authorized 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

**Justification:**

Paper-II Unit-I- Cell Biology and Histology:
Histology is also given weightage to understand the aspects of tissue differentiation. As it is SYBSc topic, students will prepare better in TYBSc to study histological techniques like histopathology, histochemistry, Zoopharmacognosy and Micro techniques etc.

P-II Unit-III- Ethology
Study of Biodiversity and wild life has been covered in FYBSc class so in continuation with that behavioural study and it's techniques can be easily understood.
Marks for Practical viva and certified Journal are given with separate weightage of 5 marks.
In practical question of identification of spots, marks are justified with the number of sub-questions and it's explanation.
Titles of courses are modified suitably wherever possible to provide more specific titles.

**Learner’s Space:**

1. Study about precocial and altricial animals with suitable examples.
2. Observe any one pet in your area to learn about classical conditioning.
3. Find or record the any two examples using auditory signals used by animals as a means of communication.

4. Study anyone insect behaviour and present it in the class on overhead projector.

5. Explain territorial behaviour in Cats?

6. Visit the museums that have collection of various evidences of evolution like fossils, relics etc.

7. Study the latest trends in evolutionary evidences that are mentioned in the research journals.

8. Construct models to explain the origin of eukaryotic cells from prokaryotic cells.

9. Conduct general survey with reference to various genetic characters in your vicinity and confirm their distribution in the population.

10. Visit any ecosystem and enlist animals observed to – a) Put them in an appropriate schedule as per their ecological status. b) Prepare evolutionary tree

11. Describe various theories explaining formation of continents as they appear today.

12. Refer case studies of plagiarism and conflicts of interest in research.

13. Visit sites of INSA, ICMR, etc. to further understand ethical issues in animal and human trials.

14. Conduct a simple research survey and write a report.

15. Surf the internet to find out the details of research institutions in India and abroad.

16. Is nucleolus indispensible for the cell?

17. List examples of diffusion in our daily life.

18. Study the Na-K pump in detail.

19. Describes different types of sensory receptors found in our sensory organs with the help of electron micrograph.

20. Enlist the disorders caused due to defective cell organelles.

21. Draw chart diagrams to explain vesicle formation from Golgi apparatus.

22. Enlist the examples of Monosaccharides, disaccharides, oligosaccharides and Polysaccharides (atleast 10 examples of each)

23. What are different respiratory pigments other than Haemoglobin found in various animals?

24. D and L amino acid ratio is often used to determine the age of a person. Give reasons.

25. What will happen to you if you eat L-Glucose? Justify your answer.

26. Find out structure of steroids of plant origin and compare with that of animals

27. Enlist names of enzymes you have studied that require a vitamin as coenzyme.

28. Study eggs of different sizes and comment on their yolk contents.

29. Procure the half way incubated hen’s eggs from hatcheries and open it to observe the blastodisc, yolk content and developmental stages of embryo with the help of your teachers.

30. What is fate map of the frog or chick embryo?
31. Among mammals only primates menstruate. Which fertility/reproductive cycle is seen in non-primate mammals? How is it different from the menstrual cycle?

32. Endocrine disrupting chemicals can seriously affect the health, including the reproductive abilities of Humans. Give examples of adverse effects of EDs on wild life.

Job oriented/Entrepreneurship development topics for Sem IV:

1. Population genetics and evolution: Health industry and population studies for socio-economic development.
2. Cell Biology and histology, Biomolecules: Introduction to Pathology and Histopathology courses.
4. Ethology: Animal care and preservation of animals in captivity or training or conservation programs.
Semester IV

REFERENCE AND ADDITIONAL READING

COURSE-VIII (PUSZOIV22-461)

2. Evolution - Strickberger, CBS publication
3. Evolution- P.S.Verma and Agarwal
4. Introduction to Evolution by Moody
   Cengage learning International Edition
7. Research Methodology, Methods and Techniques- by C.R. Kothari, WileyEastern Ltd. Mumbai
8. Practical research planning and design 2nd edition- Paul D Leedy, MacmilanPublication

COURSE-IX (PUSZOIV22-462)

1. Cell Biology by Singh and Tomoir Rastogi Publication..
2. Cell and molecular Biology E.D.P De Robertis and E.M.R Robertis ,CBS Publishersand Distributors
3. The cell A molecular Approach Goeffrey M.Coper ASM Press Washington D.C.
6. Cell Biology Pawar C.B. Himalaya publication
7. Molecular Biology of the cell (6th ed) by the Insertus
8. Campbell Biology (9th Ed.)
   Rodwell V.M. Hall international USA
16. Inderbir Singh’S Textbook Of Human Histology With Colour Atlas And Practical
   Guide by Pushpalatha K (Author), Deepa Bhat (Author), Pushpa NB (Author), Jaypee
   Brothers Medical Publishers
17. Bailey's textbook of histology, Williams & Wilkins; 17th edition

COURSE-X (PUSZOIV22-463)

5. Chick Embryology- Bradley M. Pattern.
7. Chordate Embryology- Dalela,Verma and Tyagi
8. Human Anatomy and Physiology. E. L. Marieb, Pearson Education Low Price
   Edition
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. Pragati Prakasan, Meerut
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., Pragati Prakasan, 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, Himalaya
25. Animal Behaviour- David Mc Farland
26. Animal Behaviour- Mohan Arora
27. Animal Behaviour- Reena Mathur
28. An introduction to Animal Behaviour- Dawkins
29. Animal Behaviour-Agarwal
30. Animal Behaviour- Tinberge

ICT Backup:
1. Google search engine.
2. Yahoo search engine
3. Youtube videos and animations
4. Department e-book library and video gallery
5. NCBI, EMBI, Pubmed, BLAST, FASTA,etc.

Pedagogy:
1. Awareness Wall
   e.g. Cut-outs regarding the developments in the field of Wildlife, Environment, Social health etc. will be displayed.
2. Teaching through Surveys: Population surveys to study genetic traits (Widow’s Peak, Free/Attached Earlobes, Curly Hair, Roller/Non-roller), BMI studies, Seasonal occurrence of diverse insects and avian fauna.
3. **QR codes:** Are used for conveying syllabus related material with more convenience.

**MOOC units:**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
<th>Topic</th>
<th>MOOC unit</th>
</tr>
</thead>
</table>
| 1.      | PUSZOIV22-461 | Origin and Evolution of Life | a. AP Biology- part 3: Evolution and Diversity  
b. Introduction to Human evolution |
| 2.      | PUSZOIV22-462 | Cell Biology, Biomolecules | a. Essential Human biology cells and Tissues  
b. The cells Biology: Cytoskeleton and cell cycle  
c. The cells Biology: Signaling  
d. The cells Biology: Cell transport  
e. AP Biology- part1: The Cell |
| 3.      | PUSZOIV22-463 | Animal Behaviour | a. Introduction to animal behaviour |
SCHEME OF EXAMINATION (THEORY)

(d) Internal assessment of forty (40) marks per course per semester will be conducted according to the format given below.

(e) External assessment of sixty (60) marks per course per semester will be conducted as per the following skeleton question paper pattern.

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

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

All Questions are compulsory Figures to the right indicate full marks

Time: 2.5 hours

Total marks: 60

<table>
<thead>
<tr>
<th>EVALUATION PATTERN</th>
</tr>
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<tbody>
<tr>
<td><strong>Evaluation</strong></td>
</tr>
<tr>
<td>Theory External (60%)</td>
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<td></td>
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<tr>
<td>Practical (I/II/III)</td>
</tr>
<tr>
<td>Theory Internal (40%)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>One Class test (Objective/ Multiple Choice).</td>
</tr>
<tr>
<td>Active Participation, Level of Understanding of Students.</td>
</tr>
</tbody>
</table>

**Passing Standard:** 40% (Theory and Practical courses are separate areas of passing)
# PRACTICAL
PUSZOIV22-
461 (Course VIII)

Skeleton - Practical Examination Question Paper Pattern

<table>
<thead>
<tr>
<th>Time: 2 hrs</th>
<th>Marks: 50</th>
</tr>
</thead>
</table>

**Major Question**

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. Study Population density by Line transect or Quadrant method and calculate biodiversity indices (any 2)</td>
<td>12 marks</td>
</tr>
</tbody>
</table>

**Minor Question**

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2. Prepare a smear to show prokaryotic cell.</td>
<td>8 marks</td>
</tr>
</tbody>
</table>

**OR**

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2. Prepare a smear to show eukaryotic cell.</td>
<td>8 marks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3. Identify and describe as per instructions</td>
<td>8 marks</td>
</tr>
<tr>
<td>a. Fossils</td>
<td></td>
</tr>
<tr>
<td>b. Speciation</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4. From the given article prepare the bibliography/abstract</td>
<td>6 marks</td>
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<td>Q7. Journal</td>
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PRACTICAL
PUSZOIV22-462 (Course IX)
Skeleton - Practical Examination Question Paper
Pattern

Time: 2 hrs
Marks: 50

Major Question

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

OR

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

Minor Question

Q2. Qualitative tests for carbohydrates (Molisch’s test, Benedict’s test, Barfoed’s test, Anthrone test)

OR

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

OR

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

OR

Q2. Study of rancidity of lipids by titrimetric method

Q3. Identify and describe as per instructions

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

Q4. Viva

Q5. Journal
PRACTICAL
PUSZOIV22-464 (Course X)
Skeleton - Practical Examination Question Paper
Pattern

Time: 2 hrs                                                        Marks: 50
Major Question                                                  12 marks

Q1. Detection of Creatinine in urine

OR

Q1. Determination of blood sugar by GOD and POD method

Minor Question                                                 08 marks

Q2. Detection of pregnancy using given sample of urine

OR

Q2. Determination of blood pressure by usingspyghmomanometer

OR

Q2. Study of bleeding time and clotting time

Q3. Identify and describe as per instructions                  15 marks
    1. Permanent slides/ Photographs (Embryology) (a,b)
    2. Ethology (c,d)
    3. Birth control device (e)

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

Q5. Journal                                                   05 marks

*****************************************************************************

END OF S.Y.B.Sc. SYLLABUS
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)

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**Total Number of Credits and Workload:** 16 32

**Research Project**

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**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

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| Total Credits and Workload | 16 | 32 |

**Research Project**

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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. Truemetamerism:
   i. Homonomous – Annelida e.g. Nereis
   ii. Heteronomous – Cephalization – Insecta e.g. Dragonfly
       Cephalothorax – Crustacean e.g. Lobster

1.4.3: Evolutionary significance of metamerism

1.5: Taxonomy
1.5.1: Basic concept, definition and objectives

1.5.2: Linnaean Hierarchy, Binomial Nomenclature

1.5.3: Six Kingdom classification:
   General characters of each Kingdom with examples:
   - Kingdom Archaebacteria
   - Kingdom Eubacteria
   - Kingdom Protista
   - Kingdom Fungi
   - Kingdom Plantae
   - Kingdom Animalia

1.6: Kingdom Protista: Animal like Protists: Protozoa
1.6.1: General characters of Protozoa

1.6.2: Classification of Protozoa with distinguishing features and suitable examples:
   - Phylum Sarcomastigophora
     ➢ Class Sarcodina e.g. Amoeba
     ➢ Class Mastigophora e.g. Trypanosoma
   - Phylum Ciliophora
     ➢ Class Ciliata e.g. Opalina
     ➢ Class Phyllopharyngea e.g. Dysteria
   - Phylum Sporozoa
     ➢ Class Aconoidasida e.g. Plasmodium
     ➢ Class Conoidasida e.g. Toxoplasma

Unit II: Kingdom Animalia I

(15L)

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

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

2.1: Phylum Porifera
   a. General characters
   b. Classification up to class with distinguishing features and suitable examples:
      - Class Calcarea e.g. Leucosolenia (Branched sponge)
• Class Hexactinellida e.g. Hyalonema (Glass-robe sponge)
• Class Demospongia e.g. Euspongia (Bath sponge)

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

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

2.4: Phylum Nematoda
   a. General characters
   b. Classification up to class with distinguishing features and examples
      • Class: Aphasida / Adenophorea e.g. Trichinella (Trichina worm)
      • Class: Phasmida / Secernentea e.g. Ascaris (Roundworm)

Unit III: Kingdom Animalia II

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

Desired outcome:
• Learners will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects.

3.1: Phylum Annelida
3.1.1: General characters

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

3.2: Phylum Arthropoda
3.2.1: General characters
3.2.2: Classification up to class with distinguishing features and examples
   • Subphylum Chelicerata
     • Class Arachnida e.g. Hottentotta (Scorpion)
     • Class Merostomata e.g. Limulus (Horse-shoe crab)
     • Class Pycnogonida e.g. Nymphon (Sea spider)
Subphylum Crustacea
- Class Malacostraca e.g. Scylla (Crab)
- Class Maxillipoda e.g. Balanus (Barnacle)

Subphylum Uniramia
- Class Chilopoda e.g. Scolopendra (Centipede)
- Class Diplopoda e.g. Xenobolus (Millipede)
- Class Insecta e.g. Attacus (Moth)

3.3: Phylum Mollusca
3.3.1: General characters of the Phylum

3.3.2: Classification up to class with distinguishing features and examples
- Class Aplacophora e.g. Chaetoderma (Gibson worm solenogaster)
- Class Polyplacophora e.g. Chiton (Coat-of-mail shells)
- Class Monoplacophora e.g. Neopilina
- Class Gastropoda e.g. Nerita (Nerit)
- Class Pelecypoda e.g. Solen (Razor clam)
- Class Scaphopoda e.g. Dentalium (Tusk shell)
- Class Cephalopoda e.g. Nautilus (Pearly nautilus)

3.4: Phylum Echinodermata
3.4.1 General characters

3.4.2 Classification up to class with distinguishing features and examples
- Class Asteroidea e.g. Protoreaster (Starfish)
- Class Ophiuroidea e.g. Ophiothrix (Brittle star)
- Class Echinoidea e.g. Clypeaster (Sand dollar)
- Class Holothuroidea e.g. Cucumaria (Sea cucumber)
- Class Crinoidea e.g. Antedon (Sealily)

3.5 Minor phyla
3.5.1: General characters along with examples of
- Phylum Acanthocephala e.g. Moniliformis
- Phylum Onychophora e.g. Peripatus (Velvet worm)
- Phylum Chaetognatha e.g. Sagitta (Arrow worm)

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

3.6 Phylum Hemichordata
3.6.1: General characters, classification with distinguishing features and examples
- Class Enteropneusta e.g. Balanoglossus (Acorn worm)
- Class Pterobranchia e.g. Rhabdopleura
- Class Planctosphaeroidea e.g. Planctosphaera

3.7 Basic concepts of phylogeny: Phylogenetic tree of invertebrates
Unit IV: Type study: Sepia

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

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: Immunelectrophoresis – 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: USZ0503:
Histology, Toxicology, Pathology and Biostatistics
Course 13

Unit I: Mammalian Histology (15L)

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

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

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

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

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

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

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

Unit II: Toxicology (15 L)

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

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

2.1: Basic toxicology
2.1.1: Introduction to toxicology – brief history, different areas of toxicology, principles and scope of toxicology

2.1.2: Toxins and Toxicants – Phytotoxins (caffeine, nicotine), Mycotoxins (aflatoxins),
Zootoxins (cnidarian toxin, bee venom, scorpion venom, snake venom)

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

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

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

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

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

2.1.8: Target organ toxicity:
  Hepatotoxicity: susceptibility of the liver, types of liver injury, examples of hepatotoxins;
  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

Objectives:
- To introduce the learner to basics of general pathology.
- To impart knowledge of regressive, 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: Regressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)
Course Code: USZO504:
Anatomy and Developmental Biology
Course 14

Unit I: Integumentary system and derivatives  (15L)

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

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

1.1: Basic structure of integument: Epidermis and dermis

1.2: Epidermal derivatives of Vertebrates
1.2.1: Hair, hoof, horn, claw, teeth, beak and epidermal scales (small scales, large scales, modified scales – spine)

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

1.2.3: Type of feathers

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

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

Unit II: Human Osteology  (15L)

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

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

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

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

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

2.2.4: Hyoid bone: Structure and function.

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

2.3.2: Pelvic girdle and bones of hind limbs

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

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

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

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

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

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

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

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

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

3.3.3: Muscles that move the ankle, foot and toes - Tibialis anterior, Extensor digitorum, Longus and Fibularis muscles
Unit IV: Developmental biology of Chick

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. Paramaecium
      • 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. Hyalonema (Glass-rope sponge)
      • Class Demospongia e.g. Spongila (Freshwater sponge)

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

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

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

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

   I. Phylum Arthropoda
      Subphylum Chelicereta
      • 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* (Bean clam or 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
Course code: USZOP05; Course 12

1. Enumeration of Erythrocytes – Total Count.
2. Enumeration of Leucocytes – Total Count.
4. Erythrocyte Sedimentation Rate by suitable method – Westergren or Wintrobe method.
5. Estimation of haemoglobin by Sahli’s acid haematin method.
7. Estimation of total serum/plasma proteins by Folin’s method.
10. Determination of bleeding and clotting time.

Course code: USZOP05; Course 13

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) & 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 and Vertebral column
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
6. Rectus femoris, Vastus lateralis, Vastus medialis, Hamstring group (Biceps femoris, Semimembranosus, Semitendinosus), Fibularis longus, Gastrocnemius
7. Tibialis anterior, Soleus, Extensor digitorum longus, Fibularis tertius
8. Study of ontogeny of chick embryo using permanent slides – 18 hours, 24 hours, 33 hours, 48 hours and 72 hours.
9. Prepare temporary mounting of chick embryo up to 48 hours of incubation.
References and Additional Reading for Semester V

Course 11:

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- Invertebrate Zoology: E.L. Jordan and P.S. Verma
- A manual of Zoology - Part I, Invertebrata; Ayyar, M. Ekambaranath
- Invertebrate Zoology – Volumes of different Phyla; Hyman L.H.
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- 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
- invertebrates by Richard C. Brusca et. al, 3rd edition 2016, publications Oxford

ADDITIONAL READING

- https://www.earthlife.net/inverts/an-phyla.html
- http://instructor2.mtsac.edu/mcooper/Biology%202/Labs/Protistalab1.pdf
- http://www.cvb.ns.ca/mchs/diversity/ProtozoansPage1.html
- http://bioweb.uwlax.edu/bio203/s2009/maiers_andr/Classification.htm
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http://www.fossilmuseum.net/Tree_of_Life/PhylumArthropoda.htm
http://www.geo.arizona.edu/geo3xx/geo308/FoldersOnServer/2003/3Mollusca.htm
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- Human Physiology - Volume 1; C.C. Chatterjee
- Essentials of Haematology; Shirish M. Kawthalkar; Jaypee Brothers
- Williams Hematology; Kenneth Kaushansky, Marshall A. Lichtman, E. Beuther, Thomas J. Kipps, Joseph Prchal, Uri Seligsohn
- Essential Haematology; Victor Hoffbrand, Paul Moss, John Pettit
- Rapid Review of Haematology; 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
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- Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014
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• Biology; Student Edition; Kenneth R. Miller & Joseph S. Levine; Prentice Hall; 2007
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- Comparative Anatomy of Vertebrates by S. K. Kulshrestha
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- Illustrations of Comparative Anatomy, Vertebrate and Invertebrate – For The Use of Students In The Museum Of Zoology And Comparative Anatomy
- 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
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- Dictionary of Developmental Biology and Embryology by Frank J. Dye
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 Ascidiae 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: 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
2.2.1: Division: Gnathostomata
   - Superclass: Pisces and Tetrapoda
   - Superclass – Pisces: Distinguishing characters
     - Class Placodermi e.g. *Clamatus*
     - Class Chondrichthytes e.g. *Rhinobatus* (*Guitar fish*)
     - Class Osteichthytes e.g. *Exocetus* (*Flying fish*)
Unit IV: Type study: Shark

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

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

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

2.2.3: 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

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

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 learners to chemical and molecular processes that affect genetic material.
- To make learners 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 learners 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 (same-sense), 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 Allopolyplodyy)

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

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-EBI, 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
Course Code: USZO604:
Environmental Biology and Zoopharmacognosy
Course 18

Unit I: Environment management

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, milli, 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
1.5.2: 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

2.3.3: 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 by self-medication by 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**

**Objectives:**
- To introduce learner to the geographic distribution (present and past) of animal species.
- To introduce learner to various ways by which animals distributed.

**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:** Patterns of animal distribution – continuous, discontinuous, isolation and bipolarity
- **4.2.2:** Barriers of distribution – Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habit (homing instinct).  
- **4.2.3:** 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
1. **Group Protochordata**
   - Subphylum Urochordata
     - Class Larvacea e.g. *Oikopleura* (Sea squirt)
     - Class Asciidiacea 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 Gnathiostomata**
   - Superclass Pisces:
     - Class Placodermi e.g. *Bothriolepis*
     - Class Chondrichthyes e.g. *Rhinobates* (Guitar fish), *Chimaera* (Rabbitfish or ghost shark)
     - Class Ostechthyes e.g. *Protopterus, Clarius* (Catfish)
   - Superclass Tetrapoda:
     - Class Amphibia e.g. *Alytes* (Midwife toad) and *Triton* (Salamander)
     - Class Reptilia e.g. *Varanus* (Monitor lizard) and *Crocodylus* (Crocodile)

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

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

5. **Study of Shark with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected.**
   a) Digestive system
   b) Heart and Aortic arches
   c) Urinogenital System
   d) Endoskeleton of shark:
      i. Axial – Skull and vertebral column
      ii. Appendicular – Pelvic and pectoral fins, pelvic and pectoral girdle

6. Visit to fish market / Aquarium / Zoo/ National Park / Local Gardens and available niche / Sanctuaries / and such other places in Maharashtra and / or India and / or abroad to observe chordates and prepare a report.
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
7. Instruments for tissue culture- Autoclave, Millipore filter, CO₂ incubator, Laminar air-flow. (Principle & 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.
5. Problems based on Restriction endonucleases.
6. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical &/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
8. Study of Zoopharmacognosy in ants, cats, elephants and dogs.
9. Indicate the distribution of fauna in the world map w.r.t. 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. Long Excursion (Study tour / Visit) to Zoo / Sanctuary / National park / Research institute and submit a report.
References and Additional Reading for Semester VI

Course 15
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- Fundamentals of Zoology, Dr. K. C. Ghosh and Dr. B. Manna, New Central book Agency (P) Ltd.
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- Practical Zoology: Vertebrate, by S. S. Lal, 2015
- 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

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- http://www.ucmp.berkeley.edu/chordata/chordata.html
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- http://www.nhptv.org/wild/chordata.asp
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- Biotechnology of Animal Tissues; Dr. P. R. Yadav and Dr. Rajiv Tyagi; Discovery Publishing House, New Delhi; 2006

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- Molecular Biology – Academic Cell Update; Update Edition; David Clark; Elsevier, Inc.; 2010
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- Ecological animal geography- Allee, Park and Schmidt
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- 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
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- Solid Waste Management by Subhash Anand
- Watershed Management by Vijay P. Singh and Ram Narayan Yadava
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• http://www.calmercreatures.co.uk/zoopharmacognosy-dogs/
• Zoopharmacognosy, The Self-Medication Behavior Of Animals by Eraldo Medeiros Costa-Neto
*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)**

<table>
<thead>
<tr>
<th>Time: 3 hours</th>
<th>Total marks: 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. Based on Unit 1</td>
<td>20 marks</td>
</tr>
<tr>
<td>Q.2. Based on Unit 2</td>
<td>20 marks</td>
</tr>
<tr>
<td>Q.3. Based on Unit 3</td>
<td>20 marks</td>
</tr>
<tr>
<td>Q.4. Based on Unit 4</td>
<td>20 marks</td>
</tr>
<tr>
<td>Q.5. Based on all four Units</td>
<td>20 marks</td>
</tr>
</tbody>
</table>

*Internal option scheme shall be followed from time to time as per university guidelines for T. Y. B. Sc.*
T. Y. B.Sc. Zoology: Semester V (Practical)  
Course Code: USZOP05: Course 11

Skeleton of Practical Examination Question Paper

Time: 9.30 am. To 2.30 pm.  
Total Marks: 50

Q.1  Sepia:  
Sketch and label ___________ system.  
(Digestive / Reproductive system / Nervous system)  
OR  
Identify and Describe: a, b & c  
(Jaws / Radula / Chromatophores / Spermatophores / Statocyst)  
OR  
Perform virtual dissection of ________________ system.

Q.2.  Identify and classify giving reasons:  
a) Protozoa / Porifera / Cnidaria  
b) Platyhelminthes / Nematoda  
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 phylum giving reasons.  
* A suitable animal which is not prescribed in the syllabus

Q.4  Field report – Submission and Discussion  

Q.5  Viva voce  

Q.6  Journal
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.  
    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.  
    OR
Q. 2 Estimate serum/plasma total triglycerides by Phosphovanillin method.

Q. 3 Estimate haemoglobin by Sahli’s acid haematin method.  
    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.  
    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 14

Skeleton Question Paper for Practical Examination

Time: 9.30 am. To 2.30 pm.                                      Total Marks: 50

Q.1 Make a temporary mounting of chick embryo (up to 48 hours)  10

Q.2 Identify and describe
   a) and b) Based on integumentary system
   c) and d) Based on forelimb muscle
   e) and f) Based on hindlimbs 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 / Ostachodermi / Cyclostomata
   b) Observe the animal* (photo/existing preserved specimen) and state
      its class giving reasons.
      * The animal should be other than prescribed in the syllabus
      06

Q.2 Identify, classify and describe
   a) Pisces
   b) Amphibia
   c) Reptilia
   d) Aves
   e) Mammalia
   15

Q.3 Study of shark with the help of Specimen / Photograph / Simulation
   (Digestive system / Urinogenital system / Heart and aortic arches)
   06

Q.4 Identify, sketch and label / Identify and describe marked portion in given
   diagram
   Skull or vertebra of shark / Fin of shark (Pectoral / Pelvic) / Girdle of
   shark (Pectoral / Pelvic)
   03

Q.5 Field report – Submission and Discussion
   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
a to d: Slides / Photographs of T.S of Pituitary, thyroid, parathyroid, pancreas, adrenal (any 4)
e: Any one instrument – Autoclave, Millipore filter, CO₂ incubator, Laminar air-flow.

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

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.1</td>
<td>Isolation &amp; Estimation of RNA by Orcinol method.</td>
<td>15</td>
</tr>
<tr>
<td>OR</td>
<td>Isolation &amp; Estimation of DNA by Diphenylamine method.</td>
<td></td>
</tr>
<tr>
<td>Q.2</td>
<td>Separation of Genomic DNA by Agarose gel electrophoresis.</td>
<td>09</td>
</tr>
<tr>
<td>OR</td>
<td>Colorimetric estimation of proteins from given sample by Folin’s method.</td>
<td></td>
</tr>
<tr>
<td>Q.3</td>
<td>Problems (two) based on Restriction endonucleases.</td>
<td>08</td>
</tr>
<tr>
<td>OR</td>
<td>Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.</td>
<td></td>
</tr>
<tr>
<td>Q.3a</td>
<td>Analyse the given syndrome and comment on numerical and/or structural variations in chromosomes.</td>
<td>04</td>
</tr>
<tr>
<td>Q.3b</td>
<td>Interpretation of a genetic formula.</td>
<td>04</td>
</tr>
<tr>
<td>Q.4</td>
<td>Demonstrate the use of bioinformatics tool:</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>BLAST for nucleotide sequence comparison.</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>Databases at NCBI for querying a nucleotide/protein sequence with the help of suitable operator.</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>PubMed for downloading a research paper of interest with the help of suitable operator.</td>
<td></td>
</tr>
<tr>
<td>Q.5</td>
<td>Viva voce</td>
<td>05</td>
</tr>
<tr>
<td>Q.6</td>
<td>Journal</td>
<td>05</td>
</tr>
</tbody>
</table>
T.Y. B.Sc. Zoology: Semester VI (Practical)
Course Code: USZOP06: Course 18

Skeleton Question Paper for Practical Examination

Time: 9.30 am. To 2.30 pm.                      Total Marks: 50

Q.1  Estimation of BOD / COD / nitrates from the given water sample  10

Q.2  Estimation of phosphates / acidity / alkalinity of sample water.  08

Q.3  Identification
    a) Based on bioprospecting (Sponge / Aloe ferox / Aloe vera)
    b) Zoopharmacognosy (any one – ants, cats, elephants and dogs)  06

Q.4  Identify the given animals (any 2) with respect to their realms and comment.  06

Q.5  Study tour Visit Report – Submission and Discussion.  10

Q.7  Journal  05

Q.6  Viva voce  05
Research Project (Optional)

There shall be a component of Research Project which will be optional, catering to the needs of advanced learners and the students desirous of perceiving higher studies and / or career in research. Since research component 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 student in the Research Project shall appear separately in the marksheet or shall be certified separately by the University in both the semesters viz. Semester V and Semester VI. These marks / GPA / grade points shall not be added to the total / grand total and shall not be considered for class / GPA / grade / merit / rank of the University. Research Project shall be evaluated at practical examination by the examiners in both the semesters, by dividing the candidates equally for each examiner irrespective of practicals based on Course 11, 12, 13, 14 / 15, 16, 17, 18. The students may seek guidance from a mentor who could be a teacher from his college or any other college or from the industry though it is not mandatory since Research Project done by the student independently shall also be assessed. Assessment will be based on file in Semester and hard bound dissertation in Semester VI submitted by the student and viva voce conducted by the examiner, details of which shall be as follows:

In semester V the students will submit an outline / scheme of the project proposal to be evaluated by the external examiner as per the following criteria:

<table>
<thead>
<tr>
<th>Title</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature Search / Survey</td>
<td>06 marks</td>
</tr>
<tr>
<td>Objectives, Purpose and Rationale</td>
<td>06 marks</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>06 marks</td>
</tr>
<tr>
<td>Expected outcome / Hypothesis</td>
<td>05 marks</td>
</tr>
<tr>
<td>Bibliography</td>
<td>05 marks</td>
</tr>
<tr>
<td>Work plan</td>
<td>06 marks</td>
</tr>
<tr>
<td>Relevance</td>
<td>06 marks</td>
</tr>
<tr>
<td>Viva voce based on the proposal</td>
<td>10 marks</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50 marks</strong></td>
</tr>
</tbody>
</table>

Actual execution / practical work of this project to be done only in semester VI. Evaluation of which will be done by any external examiner during practical examination for Semester VI. The external examiner will evaluate the ‘Dissertation’ carrying 30 marks as per the evaluation criteria given below:

<table>
<thead>
<tr>
<th>Title</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract / Synopsis</td>
<td>05 marks</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>05 marks</td>
</tr>
<tr>
<td>Observations</td>
<td>05 marks</td>
</tr>
<tr>
<td>Interpretation of Results</td>
<td>05 marks</td>
</tr>
<tr>
<td>Conclusion and Discussion</td>
<td>05 marks</td>
</tr>
<tr>
<td>Relevance of work</td>
<td>05 marks</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30 marks</strong></td>
</tr>
</tbody>
</table>

The external examiner will evaluate the ‘Power point presentation’ carrying 20 marks as per the evaluation criteria given below:
<table>
<thead>
<tr>
<th>Title</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content of the presentation</td>
<td>05 marks</td>
</tr>
<tr>
<td>Quality of the presentation</td>
<td>05 marks</td>
</tr>
<tr>
<td>Presentation skills</td>
<td>05 marks</td>
</tr>
<tr>
<td>Viva /Question- Answer session</td>
<td>05 marks</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30 marks</strong></td>
</tr>
</tbody>
</table>

The credits of Research Projects which are additional, may be transferred to other programs and post graduation program wherever applicable and permitted by the ordinances and if desired by the student.