

AC/4.8.18/RS 1



College of Arts,  
Science &  
Commerce

**RISE WITH EDUCATION**  
**Sion (West), Mumbai – 400022**  
**(Autonomous)**

**Faculty: Science**

**Program: S.Y.B.Sc.**

**Subject: ZOOLOGY**

**Academic Year: 2018 – 2019**

**Credit Based Semester and Grading System approved  
by Board of Studies in Zoology to be brought into effect  
from June 2018**

**S. Y. B. Sc. Zoology Syllabus (Autonomous)**  
**Semester III and Semester IV**  
**(Credit Based Semester and Grading System, with effect from academic year 2018-19)**

***Preamble***

*“I cannot teach anybody anything, I can only make them think.”– Socrates*

*With the institution entitled for Academic Autonomy, thus entails for academic freedom. This opens an avenue to refashion and refine the curriculum, which is one of the hallmarks of academic excellence. This syllabus is an attempt to appreciate Zoology in its fundamental and applied forms. It is a syllabus designed to provide a must-have knowledge that will open the doors for scientific discovery in students.*

*Some of highlights of this syllabus include:*

- ✓ Economic Zoology that may inspire the entrepreneur in students.*
- ✓ Research methodology nurturing deep thinking, an inclination for scientific investigation and developing analytical skills. Also, acquainting students with the ethics in engaging science- related issues for the welfare of the society.*

*This syllabus is a collective and constructive effort of the professors of Zoology at SIES College, Sion (West) and other board members from outside the institution. It was approved by the Board of Studies (Ad hoc) in the meeting held on 16<sup>th</sup> June 2018 at the institution’s department of Zoology.*

*Through implementation of this syllabus, we expect students to recognize the links between the various aspects/ topics of the subject that is crucial in gaining a better understanding and in application of the subject. In conclusion, we hope this syllabus will encourage and maximize learning among students to develop open, inquiring minds.*

*Dr. Satish Sarfare*  
*Chairman,*  
*Board of Studies in the subject of Zoology*

**S. Y. B. Sc. Zoology Syllabus (Autonomous)**  
**Credit Based Semester and Grading System**  
**(With effect from academic year 2018-19)**  
**Grid of Syllabus – Semester III**

<b>Theory</b>				
<b>Paper Code</b>	<b>Unit No.</b>	<b>Unit Name</b>	<b>Credits</b>	<b>Lectures/week</b>
<b>SIUSZO31</b>	1	Fundamentals of Genetics	2	1
	2	Chromosomes and Heredity		1
	3	Nucleic acids		1
<b>SIUSZO32</b>	1	Nutrition and Excretion	2	1
	2	Respiration and Circulation		1
	3	Control and Coordination, Locomotion and Reproduction		1
<b>SIUSZO33</b>	1	Ethology	2	1
	2	Parasitology		1
	3	Economic Zoology		1
<b>Practical</b>				
<b>SIUSZOP31</b>	Based on SIUSZO31 (Practical I)		1	3
<b>SIUSZOP32</b>	Based on SIUSZO32 (Practical II)		1	3
<b>SIUSZOP33</b>	Based on SIUSZO33 (Practical III)		1	3
<b>Total</b>			<b>9</b>	<b>18</b>

**S. Y. B. Sc. Zoology Syllabus (Autonomous)**  
**Credit Based Semester and Grading System**  
**(With effect from academic year 2018-19)**  
**Grid of Syllabus – Semester IV**

<b>Theory</b>				
<b>Paper Code</b>	<b>Unit No.</b>	<b>Unit Name</b>	<b>Credits</b>	<b>Lectures/week</b>
<b>SIUSZO41</b>	1	Origin and Evolution of Life	2	1
	2	Population Genetics and Evolution		1
	3	Scientific Attitude methodology, writing and ethics		1
<b>SIUSZO42</b>	1	Cell Biology	2	1
	2	Endomembrane System		1
	3	Biomolecules		1
<b>SIUSZO43</b>	1	Comparative Embryology	2	1
	2	Aspects of Human Reproduction		1
	3	Pollution and its effects on organisms		1
<b>Practical</b>				
<b>SIUSZOP41</b>	Based on SIUSZO41 (Practical I)		1	3
<b>SIUSZOP42</b>	Based on SIUSZO42 (Practical II)		1	3
<b>SIUSZOP43</b>	Based on SIUSZO43 (Practical III)		1	3
<b>Total</b>			<b>9</b>	<b>18</b>

## Semester III – Theory

### Paper Code: SIUSZO31

### Fundamentals of Genetics, Chromosomes and Heredity, Nucleic acids

#### *Learning Objectives*

- *To conceptualize the science of Genetics through Mendel's work and its extension.*
- *To understand the physical basis of genetic information – the chromosomes, and the role of genetics in sex determination and sex-linked inheritance.*
- *To unfold the beauty and wonder of DNA – the master molecule in cells encoding heritable information, and RNA – the molecular bridge between this information and proteins.*

#### **Unit 1: Fundamentals of Genetics**

**Lectures 15**

##### **1.1: Introduction to Genetics**

1.1.1: Definition, scope and importance of Genetics

1.1.2: Classical and Modern Concept of Gene (cistron, muton and recon)

1.1.3: Terms in Genetics: Allele, wild type and mutant allele, locus, dominant and recessive traits, homozygous and heterozygous, genotype and phenotype, genome

##### **1.2: Mendelian Genetics**

1.2.1: Mendelian Genetics: Monohybrid cross, dihybrid cross, test cross, back cross; Mendel's Laws of Inheritance; Mendelian traits in man

1.2.2: Exceptions to Mendelian Inheritance: Incomplete dominance, co-dominance, lethal alleles, epistasis –recessive, double recessive, dominant and double dominant

1.2.3: Chromosomal Theory of Inheritance

1.2.4: Pedigree Analysis: Autosomal dominant and autosomal recessive, X-linked dominant and X-linked recessive inheritance

##### **1.3: Multiple Alleles and Multiple Genes**

1.3.1: Concept of multiple alleles, coat colour in rabbit, ABO and Rh blood group systems

1.3.2: Polygenic inheritance with reference to skin colour and eye colour in man

1.3.3: Concept of Pleiotropy

##### **1.4: Linkage and Crossing Over**

1.4.1: Linkage and crossing over, types of crossing over, cytological basis of crossing over

#### **Unit 2: Chromosomes and Heredity**

**Lectures 15**

##### **2.1: Chromosomes**

2.1.1: Types of chromosomes: Autosomes and sex chromosomes (heterosomes)

2.1.2: Chromosome structure: Heterochromatin and euchromatin

2.1.3: Chromosome classification based on position of centromere

2.1.4: Concept of endomitosis; Giant chromosomes – Polytene and Lampbrush

chromosomes, and significance of Balbiani rings

## **2.2: Sex determination**

- 2.2.1: Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW
- 2.2.2: Sex determination in honey bees: Haplodiploidy
- 2.2.3: Sex determination in *Drosophila*: Genic balance theory, intersex, gynandromorphs
- 2.2.4: Parthenogenesis
- 2.2.5: Hormonal influence on sex determination: Freemartin and sex reversal
- 2.2.6: Role of environmental factors in sex determination in *Bonellia* and reptiles
- 2.2.7: Barr body and Lyon hypothesis

## **2.3: Sex-linked, Sex-influenced and Sex-limited Inheritance**

- 2.3.1: X-linked inheritance: Colourblindness, Haemophilia
- 2.3.2: Y-linked inheritance: Hypertrichosis
- 2.3.3: Sex-influenced genes
- 2.3.4: Sex-limited genes

## **Unit3: Nucleic acids**

## **Lectures 15**

### **3.1: Genetic material**

- 3.1.1: Griffith's experiment; Avery, Macleod and McCarty experiment; Hershey-Chase experiment
- 3.1.2: Chemical composition and structure of nucleic acids
- 3.1.3: Double helix nature of DNA; Solenoid model of DNA
- 3.1.4: Types of DNA: A, B, Z and H forms
- 3.1.5: DNA in Prokaryotes: Chromosomal and plasmid
- 3.1.6: Extranuclear DNA: Mitochondrial and chloroplast
- 3.1.7: RNA as a genetic material in viruses
- 3.1.8: Types of RNA: Structure and function

### **3.2: Flow of genetic information in eukaryotic cell**

- 3.2.1: DNA Replication
- 3.2.2: Transcription
- 3.2.3: Translation
- 3.2.4: Genetic code

### **3.3: Gene Expression and Regulation**

- 3.3.1: One gene-one enzyme hypothesis/ One gene-one polypeptide hypothesis
- 3.3.2: Concept of operon
- 3.3.3: Lac operon

## REFERENCES

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- Concepts of Genetics. Klug, W.S., Cummings M.R., Spencer, C.A. Benjamin Cummings.
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- Introduction to Genetic Analysis. Griffiths, A.J.F., Wessler. S.R., Lewontin, R.C. and Carroll, S.B. W. H. Freeman and Co.
- Cell Biology Genetics , Molecular Biology Evolution and Ecology Verma P.S. and Agrawal P.K., 9<sup>th</sup>PP edition, S. Chand Publication, New Delhi.
- Principles of Genetics – Eight edition- Eldon John Gardner, Michael J. Simmons, D. Peter Snustad
- Genetics- Weaver, Hedrick, third edition, Mc Graw Hill Education
- Genetics A Mendelian approach; Peter J.Russel, Pearson Benjamin Cummings
- Genetics A conceptual approach, Benjamin A. Pierce, Southwestern University, W.H. Freeman and company, New York
- Genetics, Third Edition, Monroe W. Strickberger
- Genetics from gene to genome, third edition, Leeland H. Hartwell, Leeroy Hood, Michael 7. L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education

## Semester III – Theory

Paper Code: SIUSZO32

### Nutrition and Excretion; Respiration and Circulation; Control and Coordination, Locomotion and Reproduction

#### *Learning Objective*

- *To elaborate on the physiological processes intricately involved in the sustenance of life; to appreciate how animals have modified themselves to enable these life processes for their survival.*

#### **Unit1: Nutrition and Excretion**

**Lectures 15**

##### **1.1:**

Comparative study of nutritional apparatus (structure and function): *Amoeba*, *Hydra*, Earthworm, Cockroach, Bivalve, Amphioxus, Pigeon, Ruminant

##### **1.2:**

Physiology of digestion in man

##### **1.3: Comparative study of excretory and osmoregulatory structures**

- Amoeba*: Contractile vacuoles
- Planaria*: Flame cells
- Earthworm: Nephridia
- Cockroach: Malpighian tubules and green gland
- Bivalve: Organ of Bojanus

##### **1.4:**

Categorization of animals based on principal nitrogenous excretory products

##### **1.5:**

Structure of kidneys, uriniferous tubules and physiology of urine formation in man

#### **Unit2: Respiration and Circulation**

**Lectures 15**

##### **2.1:**

Comparative study of respiratory organs (structure and function): Earthworm, Spider, Rohu, Frog, Pigeon

##### **2.2:**

Accessory respiratory structures: *Anabas* / *Clarias*

##### **2.3:**

Structure of lungs and physiology of respiration in man



**2.4:**

Comparative study of circulation: Open and closed type, single and double circulation

**2.5:**

Types of circulating fluids: Water, coelomic fluid, haemolymph, lymph and blood

**2.6:**

Comparative study of heart (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile, Pigeon

**2.7:**

Structure and mechanism of working of human heart

**Unit 3: Control and Coordination, Locomotion and Reproduction****Lectures 15****3.1: Control and Coordination**

3.1.1: Irritability in *Paramoecium*; nerve net in Hydra, nerve ring and nerve cord in Earthworm

3.1.2: Types of neurons on the basis of structure and function

3.1.3: Conduction of nerve impulse: Resting potential, action potential and refractory period

3.1.4: Synaptic transmission

3.1.5: Endocrine regulation: Hormones as chemical messengers; feedback mechanisms

**3.2: Movement and Locomotion**

3.2.1: Locomotor organs (structure and function):

a. Pseudopodia in *Amoeba* (Sol-gel theory), cilia in *Paramoecium*

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 the Sliding filament theory

**3.4: Reproduction**

3.4.1: Asexual reproduction: Fission, fragmentation, gemmule formation, budding

3.4.2: Sexual reproduction: Gametogenesis; structure of male and female gametes in human; types of fertilization; oviparity, viviparity and ovoviviparity

**REFERENCES**

- Vertebrate Zoology Volume I- Jordan and Verma , S. Chand and Co.
- Invertebrate Zoology Volume II- Jordan and Verma , S. Chand and Co.
- Invertebrate Zoology- Majupuria T. C., Nagin S.and Co.
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- Biological Science, Taylor D.J., Stout G.W., Green N.P.O, Soper R.,Cambridge University Press.
- Biology – A Global Approach; Tenth Edition (Global Edition); Campbell, Reece, Urry, Cain, Wasserman, Minorsky & Jackson; Pearson Education Ltd., England; 2015
- Biology; Seventh Edition; Neil A. Campbell & Jane B. Reece; Pearson Education, Inc.; 2005
- Biology; Student Edition; Kenneth R. Miller & Joseph S. Levine; Prentice Hall; 2007
- Biology: Eleventh Revised Edition; Sylvia S. Mader & Michael Windelspecht; McGraw-Hill Education; 2012
- Biology – Concepts & Applications; Sixth Edition; Cecie Starr; Brooks/ Cole; 2005

## Semester III – Theory

### Paper Code: SIUSZO33 Ethology, Parasitology, Economic Zoology

#### *Learning Objectives*

- *To appreciate the animal world around us through animal behavior studies, which is instrumental to understand the man-animal relationship much needed for coexistence.*
- *To give a snapshot of the world of parasites, organisms that have been a cause of distress to humans since ages, and the ways to effectively deal with them for a better, healthier life.*
- *To acquaint with Economic Zoology, an applied science that could allow to discover the commerce facet of students.*

#### **Unit 1: Ethology**

**Lectures 15**

##### **1.1: Introduction to Ethology**

1.1.1: Definition, history and scope of Ethology

1.1.2: Animal behaviour: Innate and learned behaviour

1.1.3: Types of learning: Habituation; Imprinting and types of imprinting – filial and sexual; Classical conditioning; Instrumental learning and Insight learning

##### **1.2: Aspects of Animal Behaviour**

1.2.1: Communication in bees and ants

1.2.2: Mimicry and colouration

1.2.3: Role of hormones and pheromones in sexual behaviour

1.2.4: Displacement activities; Ritualization

1.2.5: Migration in fish, schooling behaviour

1.2.6: Habitat selection, territorial behaviour, food selection and foraging behaviour in Indian ungulates

##### **1.3: Social Behaviour**

1.3.1: Social behaviour in primates: Hanuman langur

1.3.2: Elements of Socio-biology: Selfishness, cooperation, altruism, kinship and inclusive fitness

#### **Unit 2: Parasitology**

**Lectures 15**

##### **2.1: Introduction to Parasitology and types of Parasites**

2.1.1: Definitions: Parasitology, parasitism, host, parasite, vector (biological and mechanical)

2.1.2: Types of parasites: Ectoparasites and endoparasites; their subtypes

2.1.3: Parasitic adaptations in ectoparasites and endoparasites

2.1.4: Types of hosts: Definitive, intermediate and reservoir

##### **2.2: Host-parasite relationship: Host specificity**

2.2.1: Definition, structural specificity, physiological specificity and ecological specificity

### **2.3: Life cycle, Pathogenicity, Control measures and Treatment**

2.3.1: *Entamoeba histolytica*, *Fasciola hepatica*, *Taenia solium*, *Wuchereriabancrofti*

### **2.4: Morphology, Life cycle, Pathogenicity, Control measures and Treatment**

2.4.1: Head louse (*Pediculus humanus capitis*), Mite (*Sarcoptes scabiei*), Bed bug (*Cimex lectularis*)

### **2.5: Parasitological significance**

2.5.1: Zoonosis: Bird flu, Anthrax, Rabies and Toxoplasmosis

## **Unit 3: Economic Zoology**

**Lectures 15**

### **3.1: Apiculture**

3.1.1: Methods of bee keeping and management

3.1.2: An introduction to different species of honey bees used in apiculture

3.1.3: Selection of flora and bees for apiculture

3.1.4: Advantages and disadvantages of traditional and modern methods of apiculture

3.1.5: Pests and bee enemies: Wax moth, wasp, black ants, bee eaters and king crow; disease control

3.1.6: Bee keeping industry: Present status and recent advancements

3.1.7: Economic importance:

a. Honey: Production, chemical composition and uses

b. Bees wax: Chemical composition and uses

c. Role of honey bee in pollination

### **3.2: Vermiculture**

3.2.1: An introduction to different species of earthworms used in vermiculture

3.2.2: Methods of vermiculture

3.2.3: Maintenance and harvesting

3.2.4: Vermicompost

3.2.5: Economic importance: Advantages of vermiculture, demand for worms, market for vermicompost and entrepreneurship

### **3.3: Dairy Science**

3.3.1: Dairy development in India: Role of dairy development in rural economy and Employment opportunities

3.3.2: Dairy Processing: Filtration, cooling, chilling, clarification, pasteurization, freezing

3.3.3: Milk and milk products:

a. Composition of milk

b. Types of milk: Recombined milk, soft curd milk, skimmed and toned milk, artificial milk

c. Milk products

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- Bee and Bee Keeping- Roger A. Morse, Cornell University Press London
- Vermiculture Technology - Clive A. Edwards, Norman Q. Arancon and Rhonda Sherman
- Parasitology- Chatterjee K.D., Chatterjee Medical Publishers
- Medical Parasitology- Arora
- Textbook of Medical Parasitology-. C.K Jayaram Paniker, Jaypee Brothers
- A text book of Parasitology- Kochhar S.K. Dominant Pub. & Dis, New Delhi
- Essentials of Parasitology- Gerald and Schmidt: Universal Bookstall, New Delhi
- Parasitology- Sharma P.N. and Ratnu L.N., Chand S & Co. Pvt. Ltd.
- Introduction to Parasitology- Chandler and Read John Wiley & Sons
- Economic Zoology- Biostatistics and Animal behaviour – S. Mathur, Rastogi Publications
- Economic Zoology- Shukla G.S. & Upadhyay V.B., Rastogi Publications
- A handbook on Economic Zoology, S. Chand & Co.

### *ADDITIONAL READING:*

- World Encyclopedia of Animals; English language edition; Elena Marcon & Manuel Mongini; Orbis Publishing Limited; 1984

## **Semester III – Practical (SIUSZOP31)**

### **Practical I based on SIUSZO31**

1. Extraction and detection of DNA.
2. Extraction and detection of RNA.
3. Mounting of Barr bodies.
4. Study of Polytene chromosomes.
5. Study of Mitosis in onion root tip cells by polyploidy induction with colchicine, in comparison to normal cells.
6. Detection of blood groups and Rh factor.
7. Problems in Genetics
  - a. Monohybrid/ Dihybrid cross
  - b. X-linked Inheritance
  - c. Multiple alleles
8. Study of chromosome morphology: Metaphase spreadsheet (photograph to be provided).
9. Pedigree analysis
10. Problems on Molecular Biology

### Semester III – Practical (SIUSZOP32)

#### Practical II based on SIUSZO32

1. Urine analysis: Normal and abnormal constituents of urine.
2. Detection of ammonia in water excreted by fish.
3. Detection of uric acid from excreta of bird.
4. Study of striated and non-striated muscle fibres.
5. Study of nutritional apparatus in *Amoeba*, *Hydra*, Earthworm, Pigeon and Ruminant.
6. Study of respiratory structures:
  - a. Gills of bony fish and cartilaginous fish
  - b. Lungs of Frog
  - c. Lungs of mammal
  - d. Accessory respiratory structure in *Anabas*: Labyrinthine organ
  - e. Air sacs of Pigeon
7. Study of locomotor organs in *Amoeba*, *Unio*, Cockroach, Starfish, fish and bird.
8. Study of hearts in Cockroach, Shark, Frog, *Calotes*, Crocodile and mammal.
9. Reproduction: Study of permanent slides:
  - a. Sponge gemmules
  - b. *Hydra* budding
  - c. T.S. of mammalian testis
  - d. T.S. of mammalian ovary

## Semester III – Practical (SIUSZOP33)

### Practical III based on SIUSZO33

1. Extraction of casein from milk and its qualitative detection.
2. Preparation of paneer from milk.
3. Measurement of density of different milk samples by using lactometer.
4. Study of Honey bee:
  - a. Life cycle and structure of bee hive
  - b. Mouthparts
  - c. Legs
  - d. Sting apparatus
5. Study of ethological aspects:
  - a. Warning colouration
  - b. Instincts
  - c. Imprinting
  - d. Communication in animals: Chemical signals and sound signals
  - e. Displacement activities in animals: Courtship and mating behaviour, and ritualization
6. Study of Protozoan parasites:
  - a. *Trypanosoma gambiense*
  - b. *Giardia intestinalis*
7. Study of Helminth parasites:
  - a. *Ancylostoma duodenale*
  - b. *Dracunculus medinensis*
8. Parasitic adaptations: Scolex and mature proglottid of Tapeworm
9. Study of Ectoparasites:
  - a. Leech
  - b. Tick
  - c. Mite
10. Project based on suggested topics in Economic Zoology (Apiculture/ Sericulture/ Lac culture/ Vermicompost technique/ Construction of artificial beehives/Animal husbandry/Aquaculture, etc.)



## Semester IV – Theory

Paper Code: SIUSZO41

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

#### *Learning Objectives*

- *To study evolutionary aspects to appreciate the phenomenon of how life made its way through the apparently lifeless conditions existing on the primitive earth, and to understand the importance of natural forces that have given a form and function to the present living world.*
- *To instil the spark for inquiry-based learning through introducing Research methodology.*

#### **Unit 1: Origin and Evolution of Life**

**Lectures 15**

##### **1.1: Introduction**

1.1.1: Origin of universe

1.1.2: Chemical evolution: Miller-Urey experiment, Haldane and Oparin theory

1.1.3: Origin of life

1.1.4: Origin of eukaryotic  
cell

##### **1.2: Evidences in favour of Organic evolution**

1.2.1: Evidences from Geographical distribution, Paleontology, Anatomy, Embryology, Physiology and Genetics

##### **1.3: Theories of Organic evolution**

1.3.1: Theory of Lamarck

1.3.2: Theory of Darwin and Neo-Darwinism

1.3.3: Mutation Theory

1.3.4: Modern Synthetic theory

1.3.5: Weismann's Germ Plasm theory

1.3.6: Neutral theory of Molecular evolution

#### **Unit 2: Population Genetics and Evolution**

**Lectures 15**

##### **2.1: Introduction to Population Genetics**

2.1.1: Terms in Population Genetics: Population, gene pool, allele frequency, genotype frequency, phenotype frequency, microevolution

##### **2.2: Population Genetics**

2.2.1: Hardy-Weinberg Law

2.2.2: Factors that disrupt Hardy-Weinberg equilibrium:

a. Mutation

b. Migration (Gene flow)

- c. Non-random mating (Inbreeding, Inbreeding depression, Assortative mating – Positive and Negative, Disassortative mating)
- d. Genetic drift (Sampling error, Fixation, Bottleneck effect and Founder effect)
- e. Natural Selection
- 2.2.3: Patterns of Natural Selection
  - a. Stabilizing selection
  - b. Directional Selection (Examples: Peppered moth, Antibiotic resistance in bacteria, Pesticide resistance)
  - c. Disruptive selection

### **2.3: Evolutionary Genetics**

- 2.3.1: Genetic variation: Genetic basis of variation: Mutations and Recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random union of gametes during fertilization)
- 2.3.2: Nature of Genetic variations: Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism – Heterozygote advantage and frequency dependent selection
- 2.3.3: Neutral variations
- 2.3.4: Geographic variation (Cline)

### **2.4: Species Concept**

- 2.4.1: Biological species concept and evolutionary species concept

### **2.5: Speciation and Isolating mechanisms**

- 2.5.1: Definition and Modes of speciation (Allopatric, Sympatric, Parapatric and Peripatric)
- 2.5.2: Geographical isolation
- 2.5.3: Reproductive isolation and its isolating mechanisms (Prezygotic and Postzygotic)

### **2.6: Macroevolution and Megaevolution**

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

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

**Lectures 15**

### **3.1: Process of Science: A dynamic approach to investigation**

- 3.1.1: The Scientific method: Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery
- 3.1.2: Scientific Research: Definition, difference between method and methodology characteristics, types
- 3.1.3: 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
- 3.1.4: Dissemination of data: Reporting results to scientific community (Publication in peer-

reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation)  
3.1.5: Application of knowledge: Basic research, Applied research, Translational research  
3.1.6: Patent

### **3.2: Scientific writing**

3.2.1: Structure and components of a research paper (Preparation of manuscript for publication of research paper):

Title, Authors and their affiliations, Abstract, Keywords and Abbreviations, Introduction, Materials and Methods, Results, Discussion, Conclusions, Acknowledgement, Bibliography, Figures, Tables and their legends

### **3.3: Writing a review paper**

3.3.1: Structure and components of research report: Report writing, Types of report

3.3.2: Computer application: Plotting of graphs, Statistical analysis of data; Internet and its application in research – Literature survey, online submission of manuscript for publication

### **3.4: Ethics**

3.4.1: Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Institutional Animal Ethics Committee

3.4.2: Ethics in clinical research: Approval from Clinical Research Ethics Committee; Informed consent

3.4.3: Approval from concerned/ appropriate authorities:

- a. National Biodiversity Authority (National Board for Wildlife [NBWL])
- b. State Biodiversity Board (State Wildlife Advisory Board)
- c. Forest Department (Forest Advisory Committee [FAC])

3.4.4: Conflict of interest

### **3.5:**

Plagiarism

## **REFERENCES**

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- Evolution - Strickberger, CBS publication
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## Semester IV – Theory

### Paper Code: SIUSZO42

### Cell Biology, Endomembrane System and Biomolecules

#### *Learning Objectives*

- *To consider complexity of the architecture of life at the minuscule level of the cell – the structural and functional unit of life through a glimpse of Cell Biology.*
- *To appreciate the significance of lifeless chemicals – the biomolecules, in the expression of life energy.*

#### **Unit 1: Cell Biology**

**Lectures 15**

##### **1.1: Introduction to Cell Biology**

1.1.1: Definition and scope

1.1.2: Cell theory

1.1.3: Generalized prokaryotic and eukaryotic cell: size, shape and structure

##### **1.2: Nucleus**

1.2.1: Size, shape, number and position

1.2.2: Structure and functions of interphase nucleus

1.2.3: Ultrastructure of nuclear membrane and pore complex

1.2.4: Nucleolus: General organization, chemical composition and functions

1.2.5: Nuclear sap/ nuclear matrix

1.2.6: Nucleocytoplasmic interactions

##### **1.3: Plasma membrane**

1.3.1: Fluid Mosaic Model

1.3.2: Junctional complexes

1.3.3: Membrane receptors

1.3.4: Modifications: Microvilli, Desmosomes and Plasmodesmata

##### **1.4: Transport across membrane**

1.4.1: Diffusion and Osmosis

1.4.2: Transport: Passive and Active

1.4.3: Endocytosis and Exocytosis

##### **1.5: Cytoskeletal structures**

1.5.1: Microtubules: Composition and functions

1.5.2: Microfilaments: Composition and functions

## **Unit 2: Endomembrane System**

**Lectures 15**

### **2.1: Endoplasmic reticulum**

- 2.1.1: Discovery, occurrence and types
- 2.1.2: Ultrastructure and functions

### **2.2: Golgi complex**

- 2.2.1: Origin, occurrence and morphology
- 2.2.2: Ultrastructure and functions

### **2.3: Lysosomes**

- 2.3.1: Origin, occurrence and polymorphism
- 2.3.2: Ultrastructure and functions

### **2.4: Mitochondria**

- 2.4.1: Origin, occurrence and morphology
- 2.4.2: Ultrastructure and functions
- 2.4.3: Marker enzymes, Mitochondrial biogenesis, Semi-autonomous nature of mitochondria

## **Unit 3: Biomolecules**

**Lectures 15**

### **3.1: Biomolecules**

- 3.1.1: Concept of Micromolecules and Macromolecules

### **3.2: Carbohydrates**

- 3.2.1: Definition, Classification, Properties and Isomerism; Glycosidic bond
- 3.2.2: Structure of:
  - a. Monosaccharides – Glucose and Fructose
  - b. Disaccharides – Lactose and Sucrose
  - c. Polysaccharides – Cellulose, Starch, Glycogen and Chitin
- 3.2.3: Biological role and clinical significance

### **3.3: Amino Acids and Proteins**

- 3.3.1: Basic structure of amino acids, classification of amino acids; Essential and Non-essential amino acids; Peptide bond
- 3.3.2: Protein conformation: Primary, Secondary, Tertiary, Quaternary
- 3.3.3: Types of proteins – Structural (Keratin, Collagen) and functional proteins (Hemoglobin)
- 3.3.4: Biological role and clinical significance

### **3.4: Lipids**

- 3.4.1: Definition, classification of lipids with examples; Ester linkage
- 3.4.2: Physical and chemical properties of lipids
- 3.4.3: Saturated and unsaturated fatty acids; Essential fatty acids
- 3.4.4: Triacylglycerols, Phospholipids (Lecithin and Cephalin) and Steroids (Cholesterol)
- 3.4.5: Biological role and clinical significance

### 3.5: Vitamins

3.5.1: Water soluble vitamins (Vitamin C, Vitamin B<sub>12</sub>)

3.5.2: Lipid soluble vitamins (Vitamin A, Vitamin D)

3.5.3: Biological role and clinical significance

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## Semester IV – Theory

### Paper Code: SIUSZO43

## Comparative Embryology; Aspects of Human Reproduction; Pollution and its effect on organisms

### *Learning Objectives*

- *To admire how the first cell of a multicellular life progresses on its path towards shaping itself into a full-fledged organism through the study of Embryology.*
- *To draw attention to the aspects of human reproduction and care/ treatment employed for the inadequacies encountered in procreation, for a better social life.*
- *To make aware of the adulteration man has done in his own natural home – the earth, and to understand and take measures for its reversing effects on him, through environmental pollution study.*

### **Unit 1: Comparative Embryology**

**Lectures 15**

#### **1.1:**

Types of Eggs – Based on amount and distribution of yolk

#### **1.2:**

Structure and types of sperm

#### **1.3:**

Types of Cleavage – Holoblastic and Meroblastic

#### **1.4:**

Types of Blastulae

#### **1.5:**

Gastrulation

#### **1.6:**

Coelom – Formation and types

#### **1.7:**

1.7.1: Extra embryonic membranes

1.7.2: Types of Placentae –Based on histology, morphology and implantation

### **Unit 2: Aspects of Human Reproduction**

**Lectures 15**

#### **2.1: Human Reproductive system and Hormonal regulation**

2.1.1: Anatomy of human male and female reproductive system

2.1.2: Hormonal regulation of Reproduction and Impact of age on reproduction – Menopause and Andropause

## **2.2: Contraception and birth control**

2.2.1: Difference between contraception and birth control

2.2.2: Natural Methods: Abstinence, Rhythm method, Temperature method, cervical mucus or Billings method, Coitus interruptus, Lactation amenorrhea

2.2.3: Artificial methods: Barrier methods, Hormonal methods, Intrauterine contraceptives, Sterilization, Termination, Abortion

## **2.3: Infertility**

2.3.1: Female infertility:

a. Causes: Failure to ovulate; production of infertile eggs; damage to oviducts (oviduct scarring and PID or Pelvic inflammatory disease, TB of oviduct), Uterus (TB of uterus and cervix)

b. Infertility associated disorders: Endometriosis, Polycystic Ovarian syndrome (PCOS), Primary ovarian failure (POF), STDs (Gonorrhea, Chlamydia, Syphilis and Genital Herpes); Antibodies to sperm; Genetic causes – Recurrent abortions; Role of endocrine disruptors

2.3.2: 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**

2.5.1: Removal/ reduction of causative environmental factors

2.5.2: Surgical treatment

2.5.3: Hormonal treatment – Fertility drugs

2.5.4: Assisted Reproductive Technology

2.5.5: Sperm banks, cryopreservation of gametes and embryos

2.5.6: Surrogacy

## **2.6: Techniques and Ethical considerations of ART**

2.6.1: *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)

## **Unit3: Pollution and its effects on organisms**

## **Lectures 15**

### **3.1: Air Pollution**

3.1.1: Types and sources of air pollutants

3.1.2: Effects and control measures

### **3.2: Water Pollution**

3.2.1: Types and sources of water pollutants

3.2.2: Effects and control measures



### **3.3: Soil Pollution**

3.3.1: Types and sources of soil pollutants

3.3.2: Effects and control  
measures

### **3.4: Noise pollution**

3.4.1: Different means of noise pollution

3.4.2: Effects and control measures

### **3.5:**

Radioactive pollution

### **3.6: Solid waste pollution**

3.6.1: Types and sources

3.6.2: Effects and control  
measures

### **3.7:**

Pollution: Climate change and Global  
warming

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- Environmental Chemistry, A.K. De, New Age International
- A Text Book of Environmental Studies, Gurdeep R. Chatwal, Harish Sharma, Madhu Arora, Himalaya

## Semester IV – Practical (SIUSZOP41)

### Practical I based on SIUSZO41

1. Study of population density by Line transect method and Quadrant method and calculate different diversity indices:
  - a. Index of Dominance
  - b. Index of frequency
  - c. Rarity Index
  - d. Shannon Index
  - e. Index of Species diversity(Can be done on field OR data on minimum two habitats to be given for comparison and analysis. Also, analysis of data can be done on excel sheet.)
2. Study of Prokaryotic cells (bacteria) by Crystal violet staining technique.  
(A mixture of bacteria and yeast cells to be given as sample).
3. Study of Eukaryotic cells (WBCs) from blood smear by Leishman's stain.
4. Identification and study of fossils:
  - a. Arthropod: Trilobite
  - b. Mollusc: Ammonite
  - c. Aves: Archaeopteryx
5. Identification of:
  - a. Allopatric speciation (*Cyprinodon* species)
  - b. Sympatric speciation (Hawthorn fly and Apple maggot fly)
  - c. Parapatric speciation (Snail)
6. Bibliography/ Abstract writing
7. Preparation of Power point presentation

## **Semester IV – Practical (SIUSZOP42)**

### **Practical II based on SIUSZO42**

1. Study of permeability of cell membrane: Effect of Glucose and different concentrations of Sodium chloride on osmosis in blood cells.
2. Measurement of cell diameter by oculometer (by using permanent slides).
3. Qualitative tests for carbohydrates (Molisch's test, Benedict's test, Barfoed's test, Anthrone test)
4. Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)
5. Qualitative test for lipids (Solubility test, Sudan III test)
6. Study of rancidity of lipid by titrimetric method.
7. Study of ultrastructure 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 carbohydrate, protein and lipid imbalance (photograph to be provided; significance to be given and disorder to be identified):
  - a. Hyperglycemia, Hypoglycemia
  - b. Thalassemia, Kwashiorkor
  - c. Obesity, Atherosclerosis

## **Semester IV – Practical (SIUSZOP43)**

### **Practical III based on SIUSZO43**

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

**Practical Examination Question Paper Pattern  
Semester III – Practical (SIUSZOP31)**

**Practical I based on SIUSZO31**

<b>Time: 2 hours</b>	<b>Marks: 50</b>
<b>Major Question</b>	<b>15</b>
Q.1 Extraction and detection of DNA.	
<b>OR</b>	
Q.1 Extraction and detection of RNA.	
<b>Minor Question</b>	<b>07</b>
Q.2 Mounting of Barr bodies.	
<b>OR</b>	
Q.2 Study of Mitosis – Temporary squash preparation of onion root tip.	
<b>OR</b>	
Q.2 Detection of blood groups and Rh factor.	
Q.3 Problems on Genetics and Molecular biology (Transcription/ Genetic code) (One problem each)	<b>10</b>
<b>Q.4 Identification</b>	<b>08</b>
a. Chromosome morphology	
b. Pedigree analysis	
Q.5 Viva and journal	<b>10</b>

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**Semester III–Practical (SIUSZOP32)**

**Practical II based on SIUSZO32**

**Time: 2 hours**

**Marks: 50**

**Major Question**

**15**

**Q.1** Urine analysis – Detection of normal and abnormal urine constituents.

**Minor Question**

**10**

**Q.2** Detection of ammonia in water excreted by fish.

**OR**

**Q.2** Detection of uric acid from excreta of bird.

**Q.3 Identification**

**15**

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

**Q.4** Viva

**05**

**Q.5** Journal

**05**

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**Semester III–Practical (SIUSZOP33)**

**Practical III based on SIUSZO33**

**Time: 2 hours**

**Marks: 50**

**Major Question**

**12**

**Q.1** Extraction of casein from milk and its qualitative detection.

**OR**

**Q.1** Preparation of paneer from milk sample.

**OR**

**Q.1** Measurement of density of milk using different samples by lactometer.

**Minor Question**

**08**

**Q.2** Life cycle of Honey Bee and bee hive

**OR**

**Q.2** Mouthparts of Honey Bee

**OR**

**Q.2** Legs of Honey Bee

**OR**

**Q.2** Sting Apparatus of Honey Bee

**Q.3 Identification**

**15**

a. Ethology

b. Protozoan parasite

c. Helminth parasite

d. Ectoparasite

e. Parasitic adaptations

**Q.4** Project submission (based on visit to local fish market/ fish landing centre) and viva based on the project.

**10**

**Q.5** Journal

**05**

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**Practical Examination Question Paper Pattern  
Semester IV–Practical (SIUSZOP41)**

**Practical I based on SIUSZO41**

**Time: 2 hours**

**Marks: 50**

**Major Question**

**12**

**Q.1** Determination of population density by Line transect or Quadrant method and calculation of biodiversity indices (any 2).

**Minor Question**

**08**

**Q.2** Prepare a smear to show prokaryotic cell.

**OR**

**Q.2** Prepare a smear to show eukaryotic cell.

**Q.3 Identification**

**08**

a. Fossil

b. Speciation

**Q.4** From the given article prepare bibliography/ abstract.

**06**

**Q.5** Power point presentation

**06**

**Q.6** Viva and journal

**10**

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**Semester IV–Practical (SIUSZOP42)**

**Practical II based on SIUSZO42**

**Time: 2 hours**

**Marks: 50**

**Major Question**

**15**

**Q.1** Study of permeability of cell through plasma membrane (Osmosis in blood cells).

**OR**

**Q.1** Measurement of cell diameter by oculometer (by using permanent slide).

**Minor Question**

**10**

**Q.2** Qualitative tests for carbohydrates (Molisch's test, Benedict's test, Barfoed's test, Anthrone test)

**OR**

**Q.2** Qualitative tests for proteins (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)

**OR**

**Q.2** Qualitative test for lipids (Solubility test, Sudan III test)

**OR**

**Q.2** Study of rancidity of lipids by titrimetric method.

**Q.3 Identification**

**15**

a. Ultrastructure of cell organelles (a, b and c)

b. Clinical disorders (d and e)

**Q.4** Viva

**05**

**Q.5** Journal

**05**

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**Semester IV–Practical (SIUSZOP43)**

**Practical III based on SIUSZO43**

**Time: 2 hours**

**Marks: 50**

**Major Question**

**Q.1** Estimation of dissolved oxygen from water sample provided.

**12**

**OR**

**Q.1** Detection of creatinine in urine.

**OR**

**Q.1** Determination of blood sugar by GOD and POD method.

**Minor Question**

**08**

**Q.2** Estimation of salinity by refractometer from water sample provided.

**OR**

**Q.2** Estimation of conductivity by conductometer from water sample provided.

**OR**

**Q.2** Determination of blood pressure by using sphygmomanometer.

**OR**

**Q.2** Study of bleeding time and clotting time.

**Q.3 Identification**

**15**

a. Permanent slides (a and b)

b. Fishery (c, d and e)

**Q.4** Field report and viva based on it.

**10**

**Q.5** Journal

**05**

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**S. Y. B. Sc. Zoology Syllabus (Autonomous)  
Credit Based Semester and Grading System  
(With effect from academic year 2018-19)**

**Scheme of Examination**

The performance of learners will be evaluated in two parts for the Theory component of the Course:

1. Internal Assessment with 40% marks
2. Semester End Examination (written) with 60% marks

The Practical component of the Course will be evaluated by conducting Semester End Practical Examination of 50 marks.

**Internal Assessment Theory (40%)**

It is the assessment of learners on the basis of continuous evaluation as envisaged in the Credit Based System by way of participation of learners in various academic and correlated activities in the given semester of the program.

**Marks: 40**

1. Class test (Centralized Examination): **20 Marks**
2. At the departmental level evaluation will be conducted on the basis of Seminar given by the student on any topic chosen by him/ her: **20 Marks**

**Semester End Assessment Theory (60%)**

**Marks: 60**

**Duration: 2 hours**

**Theory question paper pattern:**

- There shall be four questions of 15 marks each. On each unit there will be one question and the 4<sup>th</sup> question will be based on the entire syllabus.

**OR**

There shall be three questions of 20 marks each, each question based on one unit.

- All questions are compulsory with internal choice within the questions.
- Questions may be subdivided and the allocation of marks depends on the weightage of the topic.

**Semester End Assessment Practical**

**Marks: 50**

**Duration: 2 hours**

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