AC/4.8.18/RS 1

SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

(*Affiliated to University of Mumbai*)

Faculty: Science

Program: F.Y.B.Sc

Subject: ZOOLOGY

Academic Year: 2018 – 2019

Revised Syllabus in Zoology
under Choice Based Credit System (CBCS)
Approved by the Board of Studies in Zoology
Effective from academic year 2018 – 2019

F. Y. B. Sc. Zoology Syllabus (Autonomous)

Semester I and Semester II

(Choice Based Credit System with effect from academic year 2018-19)

Preamble

"To educate means to draw out. Knowledge has to be drawn out of you, nobody can give it to you."

Academic Autonomy brings forth the freedom of restructuring and refining the curriculum, which is pivotal in shaping the educational outcomes of an academic institution. Thus, a modest attempt has been made to design an effective syllabus for the subject of Zoology that will preserve the essence of the subject and also suit the contemporary education system, allowing critical thinking and developing attitudes necessary for scientific inquiry.

Some features of this syllabus are:

- ✓ *Taxonomical studies of animals, the core of Classical Zoology.*
- ✓ *Molecular basis of life, elaborating the relation between lifeless molecules and life.*
- ✓ *Animal behaviour study, signifying the importance of animals as part of the same world to which humans belong.*
- ✓ *Biodiversity, to sensitize about the biowealth nature has bestowed on humans, and to treat this natural resource with humane and responsible attitude in this era of global warming.*
- ✓ *Introduction to Biotechnology, an aspect inclined to benefit mankind through available biological resources with the aid of technology.*

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 whose suggestions and expertise were so valuable in conceptualizing this syllabus. It was approved by the Board of Studies (Ad hoc) in the meeting held on 16th June 2018 at the institution's department of Zoology.

As students have a boundless potential for searching, we hope this syllabus will allow them to reach out beyond the borders of the subject. This syllabus is an approach made to help sustain enthusiasm among students about the subject, that could be a stepping-stone in the career of some willing to explore the territories of Zoology.

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

Members of the Board of Studies in the subject of Zoology

- ✓ *Dr. Meenakshi Sundaresan – Head and Associate Professor, Department of Zoology, D.G. Ruparel College, Mumbai (Ad-hoc, Vice Chancellor's Nominee)*
- ✓ *Professor (Dr.) Manoj Mahimkar – Principal Investigator, Cancer Research Institute, ACTREC, Kharghar, Navi Mumbai; (Subject expert from outside the Parent University to be nominated by the Academic Council)*
- ✓ *Dr. Sasikumar Menon – Director, Institute for Advanced Training & Research in Interdisciplinary Sciences (IATRIS), (Therapeutic Drug Monitoring Lab), Sion, Mumbai; Faculty, Pharma Analytical Sciences, Ruia College, Mumbai (Subject Expert from outside college/Industry expert)*
- ✓ *Mr. Kedar Gore – Director, The Corbett Foundation (Non-profit Organization), Mumbai, (Subject expert from outside college / Representative from Corporate sector / Allied area)*
- ✓ *Ms. Uma Bandekar – Clinical Team Manager with ICON plc (Postgraduate Meritorious Alumnus)*
- ✓ *Dr. Satish Sarfare – Head and Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Mr. Pushparaj Shetty – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Rupali Vaity – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Madhavan Gopalan – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Aditya Akerkar – Faculty, Department of Zoology, SIES College, Mumbai*

Syllabus Committee

- ✓ *Dr. Satish Sarfare – Head and Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Mr. Pushparaj Shetty – Faculty, Department of Zoology, SIES College, Mumbai*
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- ✓ *Mr. Avadhesh Ram – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Mr. Dinesh Saroj – Faculty, Department of Zoology, SIES College, Mumbai*

F. Y. B. Sc. Zoology Syllabus (Autonomous)
Choice Based Credit System
(With effect from academic year 2018-19)
Grid of Syllabus – Semester I

Theory				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
SIUSZO11	1	Diversity of Animal Kingdom - I	2	1
	2	Life Processes - I		1
	3	Ecology		1
SIUSZO12	1	Molecular basis of life - I	2	1
	2	Biotechnology - I		1
	3	Genetics		1
Practical				
SIUSZOP11	Based on SIUSZO11 (Practical I)		1	3
SIUSZOP12	Based on SIUSZO12 (Practical II)		1	3
Total			**6**	**12**

F. Y. B. Sc. Zoology Syllabus (Autonomous)
Choice Based Credit System

(With effect from academic year 2018-19)
Grid of Syllabus – Semester II

Theory				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
SIUSZO21	1	Diversity of Animal Kingdom - II	2	1
	2	Life Processes - II		1
	3	Ethology		1
SIUSZO22	1	Molecular basis of life - II	2	1
	2	Biotechnology - II		1
	3	Evolution and Biodiversity		1
Practical				
SIUSZOP21	Based on SIUSZO21 (Practical I)		1	3
SIUSZOP22	Based on SIUSZO22 (Practical II)		1	3
Total			**6**	**12**

Programme: Bachelor of Science, B.Sc. – Zoology

"I cannot teach anybody anything, I can only make them think" - Socrates

The characteristic graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science graduate in the subject of Zoology are as follows:

Note the list of abbreviations:

PO: Programme Outcome, PSO: Programme Specific Outcome, CO: Course Outcome
Cognitive Levels:- R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Serial Number	**Details of Programme Outcomes (POs)**
PO1 *(Skill Level)*	Problem Solving Ability *(U, Ap)* • Apply the knowledge of various courses learned under a program to break down complex problems into simple components. • Adopt and assimilate problem-based learning models and apply one's learning to solve real life problem situations.
PO2 *(Skill Level)*	Critical Thinking *(U, An, E)* • Develop critical thinking based on a rationale to identify assumptions, verifying the accuracy and validity of assumptions, and making informed decisions. • Inculcate the ability of logical reasoning to question the rationale behind concepts, ideas, and perspectives.
PO3 *(Skill Level)*	Effective Communication Skills *(Ap, C)* • Improve written and oral communication skills so as to express thoughts and ideas effectively. • Demonstrate the ability to listen carefully and imbibe soft skills to convey and receive instructions clearly. • Develop presentation skills to present complex information in a clear, lucid and concise manner.
PO4 *(Skill Level)*	Proficiency with Information and Communication Technology *(U, An, E)* • Demonstrate ability to access, evaluate and use a variety of relevant information resources inclusive of internet and electronic media for the purpose of collating and analysing data. • Understand the scope and limitations of tools or software's used in Information and Communication Technology.
PO5 *(Skill Level)*	Leadership Skills and Team Work *(U, Ap, An, C)* • Demonstrate leadership skills formulating an inspiring vision, thereby building a team, motivating and inspiring team members to engage and achieve that vision. • Develop management skills to guide people in taking tasks to their logical conclusion. • Inculcate the ability to facilitate coordinated effort as a group or team in the interests of common cause and recognise the contribution of team members.
PO6 *(Attitude Level)*	Self-directed and Lifelong Learning *(U, Ap, An)* • Demonstrate the ability to work independently and take responsibility for one's actions. • Acquire the ability to explore and evolve by becoming self-sufficient and self-reliant. • Adapt lifelong learning approaches to broaden one's horizons for personal growth and development.

PO7 *(Attitude Level)*	Ethical Values and Environmental Concerns *(U, Ap, E)* • Embrace moral or ethical values in conducting one's life and implement ethical practices in all aspects of life. • Create awareness and concern for environmental and sustainability issues. • Understand and realize the significance and relevance of co-habitation and co-evolution in attaining the needs of sustainable development.
PO8 *(Attitude Level)*	Gender Sensitization and Community Service *(U, Ap, An)* • Respect gender sensitivity, gender equity and gender justice. • Encourage mutual understanding and express empathetic social concern towards different value systems and different strata of society. • Engage in community service through Institutional Social Responsibility.

Serial Number	**Details of Programme Specific Outcomes (PSOs)**
PSO1	Conceptual Understanding and Emerging Applications *(R, U, Ap, An)* • Inculcate conceptual and coherent understanding of zoology, and demonstrate a broad understanding of animal diversity, including fundamental and systematic knowledge of the scientific classification, taxonomy and evolutionary relationships of major groups of animals. • Understand the nature and basic concepts of cell biology, biochemistry, animal physiology, molecular biology, ecology among other topics, so as to recognize the relationships between structure and functions at different levels of biological organization for the major groups of animals. • Demonstrate interest in different areas of zoology so as to analyse the scope of emerging applications of biological sciences in medicine, genetics, wildlife, etc and apply appropriate methodologies with cutting edge tools/techniques in biological sciences to seek solutions to emerging problems faced by mankind. • Demonstrate the relevance of the procedural subject knowledge that creates different types of professionals related to the disciplinary/subject area of zoology, including professionals engaged in research and development, teaching and government/public service.
PSO2	Analytical reasoning and Scientific Inquiry *(U, An, E)* • Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions. • Encourage the ability to analyse, interpret and draw conclusions from qualitative/quantitative data and critically evaluate ideas, experiences, theories and concepts by following scientific approach to knowledge development from an open minded and reasoned perspective. • Develop analytical skills involving paying attention to detail and imbibe the ability to construct logical arguments using correct technical language related to the relevant subject. • Analyse and interpret data/information collected or related to experiments or investigations, using appropriate methods involving Biostatistics, Bioinformatics among others and report accurately the findings of the experiment/investigations while relating the conclusions/ findings to relevant theories of zoology.
PSO3	Laboratory Skills and Fieldwork *(R, U, E, C)* • Understand and apply standard operating procedures as per Good Laboratory Practices so as to develop laboratory skills and qualities required for successful career in teaching, research, industry, etc. • Demonstrate awareness regarding animal ethics, human ethics, conservation of flora and fauna, so as to promote safe environment and ecosystem, in the pursuit of disciplinary knowledge.

	• Develop instrumentation handling skills and laboratory techniques relevant to academia and industry, integrate knowledge, skills with technical competency, so as to create solutions for issues and problems related to biological sciences. • Demonstrate leadership qualities, command trust and respect, thereby, motivating and inspiring team members to work effectively in diverse teams during excursions or study tours. Realise the relevance of participation in field studies in the context of teamwork as well as life on the outdoors.
PSO4	Research Aptitude and Interdisciplinary Approach *(Ap, An, E, C)* • Inculcate and adapt to research aptitude and culture, integrate research-based knowledge in an interdisciplinary framework, and realise the relevance of choosing research as an alternative career option. • Demonstrate the awareness regarding compliance with research ethics, awareness about conflicts of interests and Intellectual Property Rights, and avoiding unethical behaviour such as fabricating, falsifying or misrepresenting data or to committing plagiarism. • Inculcate the ability to recognise cause and effect relationships, formulate hypothesis, reporting the results of an experiment or investigation, and application of research tools for analysis and interpretation of data. • Inculcate an interdisciplinary approach, to understand and consolidate fundamental concepts through inquiry based curriculum, develop critical thinking and problem solving ability required to solve different types of biology related problems with well-defined solutions, and tackle open-ended problems that may cross disciplinary-area boundaries.

Course Outcomes for FYBSc

At the root of all (science) education (Core Learning Outcome):

"The imaginative and original mind need not be overawed by the imposing body of present knowledge or by the complex and costly paraphernalia which today surround much of scientific activity. The great shortage in science now is not opportunity, manpower, money, or laboratory space. What is really needed is more of that healthy scepticism which generates the key idea – the liberating concept." *– P.H. Abelson*

Purity of mind leads to clarity in thought and action for creation of an original archaic work.
As well, to consciously attempt the basic pursuit of understanding human existence.

Semester I – Theory

Course Code: SIUSZO11
Course Name: Diversity of Animal Kingdom - I, Life Processes - I and Ecology
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Diversity of Animal Kingdom - I	**CO1:** Understand animal diversity – variation in animal life, at elementary level to attempt an explanation of the experience of the animal world around. Spark the sensitive curiosity of zoology student for furthering in animal studies.	*R, U*	*PO1, PO2, PO6, PO7* *PSO1, PSO3, PSO4*
Unit 2: Life Processes - I	**CO2:** Elucidate the interplay between structure and function in animal biology which has survival value. Facilitate clarity on the working of human machine through analysis of animal physiology (physiological processes – inner working of animals). Account for the bodily processes as movement and	*R, U*	*PO1, PO2* *PSO1, PSO2*

	locomotion, nutrition, respiration and circulation.		
Unit 3: Ecology	**CO3:** Outline concepts of ecology – a study of where (place) and how (interaction) organisms live on earth, and realise that any imbalances in the delicate ecological networking of organisms could lead to problems of global environmental concern. Recognise that living things transform energy.	*R, U*	*PO1, PO2, PO7* *PSO1, PSO3, PSO4*

Course Code: SIUSZO12
Course Name: Molecular basis of life - I, Biotechnology - I and Genetics
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Molecular basis of life - I	**CO1:** Account for the underlying chemistry that both makes possible and sustains life, by a discussion onbiomolecules (here, focusing on proteins and carbohydrates). Apply this basic knowledge for advancing in varied fields of biological sciences having social relevance.	*R, U*	*PO1, PO2,PO8* *PSO1, PSO2, PSO3, PSO4*
Unit 2: Biotechnology - I	**CO2:** Introduction to biotechnology – a field of endeavour and a frontier open for invention by application of technological advancements to biological systems for human benefit. Insight on some tools and techniques of biotechnology, and account for applications in food and enzyme technology.	*R, U, Ap*	*PO2, PO7* *PSO1, PSO2, PSO3, PSO4*
Unit 3: Genetics	**CO3:** Build a conceptual framework of the science of inheritance – genetics, through discussion on mendelian inheritance, cytoplasmic inheritance and touching on human genetics. Acknowledge the lasting contribution of Gregor Mendel and his methodology demonstrating his scientific and perseverant traits.	*R, U, Ap, An*	*PO1, PO2,PO8* *PSO1, PSO2, PSO4*

Semester II – Theory

Course Code: SIUSZO21
Course Name: Diversity of Animal Kingdom - II, Life Processes - II and Ethology
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Diversity of Animal Kingdom - II	**CO1:** Expand the understanding of diversity of animal life by an account of animals with more complex levels of organization (Mollusca to Chordata); an understanding that may aid a healthy man-animal coexistence.	*R, U*	*PO1, PO2, PO6, PO7* *PSO1, PSO3, PSO4*

	Develop interest in specific animal groups for an uncharted exploration and specialization in them.		
Unit 2: Life Processes - II	**CO2:** Elucidate the interplay between structure and function in animal biology which has survival value. Facilitate clarity on the working of human machine through analysis of animal physiology (physiological processes – inner working of animals). Account for the bodily processes as excretion and osmoregulation, control and coordination, and reproduction.	*R, U*	*PO1, PO2* *PSO1, PSO2*
Unit 3: Ethology	**CO3:** Understand "nature versus nurture" concept in development of animal behaviour, and an insight into the various experiments and original observations to explain animal learning. Deepen knowledge to apply for a career in zookeeping.	*R, U*	*PO2, PO7* *PSO1, PSO3, PSO4*

Course Code: SIUSZO22
Course Name: Molecular basis of life - II, Biotechnology - II, and Evolution and Biodiversity
The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: Molecular basis of life - II	**CO1:** Extend the account for the underlying chemistry that both makes possible and sustains life, by a discussion on biomolecules (here, focusing on lipids and nucleic acids). Apply this basic knowledge for advancing in varied fields of biological sciences having social relevance.	*R, U*	*PO1, PO2,PO8* *PSO1, PSO2*
Unit 2: Biotechnology - II	**CO2:** Introduction to biotechnology – a field of endeavour and a frontier open for invention by application of technological advancements to biological systems for human benefit. Insight into transgenesis, animal cloning, gene therapy for benefit of mankind, and application for environmental concerns.	*R, U, An*	*PO2, PO7* *PSO1, PSO2, PSO3, PSO4*
Unit 3: Evolution and Biodiversity	**CO3:** Introduction to evolution for understanding of events and processes that have shaped, reshaped theliving world on planet earth. Insight into the wealth of living forms on earth for wise and sustainable usage of these natural resources for man's livelihood as well as recreational activity.	*R, U, An*	*PO2, PO7* *PSO1, PSO2, PSO3, PSO4*

PRACTICAL

"*Study nature not books.*" – An old dictum.

The practical course in Zoology is designed for first hand study of animal life through observation of preserved specimens, *in situ* organ systems, microscopic examination of permanent slides, etc. as well as to perform experiments to strengthen the concept base.

It is an effort to invigorate a thought process that can analyse and reason for the sake of awareness, hence to reach a valid answer.

Semester I – Practical

Course Code: SIUSZOP11
Course Name: Practical I based on SIUSZO11

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	• Discuss levels of organization in animal kingdom on which animal body plans are made. • Elaborate on animal diversity (Protozoa to Arthropoda) and inquire into the relatedness of taxa in animal kingdom by direct observation preserved specimens/ permanent slides of chosen representatives from each phylum. • Explain essential life processes as digestion, excretion-osmoregulation and movement-locomotion by microscopic examination of one-celled animalcule, *Paramoecium*. • Account for functional morphology in animals by examining (preserved/ fresh, wherever applicable) nutritional apparatus, respiratory structures, hearts and blood smears of selected animals. • Emphasize the role of factors like pH and temperature for enzyme functioning by testing amylase activity, under physiology of digestion. • Examine a beating heart under light microscope and determine its rate by using crustacean arthropod *Daphnia*. • Explain coexistence and coevolution of animal forms through animal interaction study.	*R, U, Ap, An, E*	*PO1, PO2,PO6, PO7* *PSO1, PSO2, PSO3, PSO4*

Course Code: SIUSZOP12
Course Name: Practical II based on SIUSZO12

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	• Analyze the importance of laboratory safety practices and safety symbols, for awareness regarding conduct as a science student. • Describe the handling and use/ function	*R, U, Ap, An, E*	*PO1, PO2,PO3, PO5,PO6, PO8*

	of basic laboratory equipments/ instruments in an undergraduate course laboratory. • Comprehend the significance of aseptic techniques in biological experiments. • Demonstrate/show chromatography as a separation technique in biology by performing paper chromatography. • Insight into the chemistry of biomolecules – proteins and carbohydrates by their qualitative detection. • Test the feasibility of immobilization technique in laboratory and discuss its applications in industry. • Explain fermentation, an age-old process known to mankind and meat tenderization, both with applications in food industry for consumer satisfaction. • Compare and discuss modes of inheritance of genetic traits in humans by solving problems based on pedigree analysis of humans.		*PSO1, PSO2, PSO3, PSO4*

Semester II – Practical

Course Code: SIUSZOP21
Course Name: Practical I based on SIUSZO21

Course Outcome (CO)	**Details**	**Cognitive Level**	**Affinity with PO/ PSO**
	• Identify, describe and classify animal representatives of different phyla (Mollusca to Chordata) as well as analyse the evolutionary connect between them. • Discuss vital life processes – digestion, excretion, nervous control and reproduction, through observation of structures/ organs in different animal specimens (preserved or fresh) and permanent slides, and clarify their possession by these animals. • Observe under light microscope the structure of an excretory organ – septal nephridium present in an invertebrate – earthworm, and compare and contrast it with nephron of mammalian kidney. • Describe irritability, a kind of response shown by the microscopic animalcule – *Paramoecium*, demonstrating sensitivity/ ability to sense the environment, a basic feature of life. • Explain behavioural ecology with examples of mimicry in the animal world.	*R, U, Ap, An*	*PO1, PO2,PO7* *PSO1, PSO2, PSO3, PSO4*

Course Code: SIUSZOP22
Course Name: Practical II based on SIUSZO22

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	• Realise the ease of carrying out chromatography in college laboratory, a separation technique with wide applications; and explain the underlying principle of Thin layer chromatography (TLC) and adsorption chromatography. • Detect presence of lipids, one of the biomolecules, by their physical and chemical properties. Also perform extraction/ removal of another biomolecule – nucleic acids (DNA and RNA) and confirm their presence by specific chemical tests. • Describe the different methodologies for transgenesis; recognise the use of technological advancements on biological systems, and realise about the expertise and patience required to attain these transformations, for human welfare. • Differentiate between the two broad categories of bacteria using Gram staining, a method that can serve as preliminary diagnostic test for bacterial infection disease. • Discuss and perform a simple method to evaluate the quality of milk sample by checking its bacterial load, which has a direct impact on fitness of milk for human consumption and hence on commercial value of milk. Understand the International Organization for Standardization (ISO) criteria for milk quality. • Conclude the reality of evolution by explaining analogy, homology and by a mention of fossils (invertebrate fauna fossils).	*R, U, Ap, An, E*	*PO1, PO2,PO5, PO6,PO7, PO8* *PSO1, PSO2, PSO3, PSO4*

Semester I – Theory

Paper Code: SIUSZO11
Diversity of Animal Kingdom - I, Life Processes - I and Ecology

Learning Objectives

- *To do an introductory survey of the diversity of animal life to understand that part of the world around us composed of animals. Also, to gain an insight on the evolutionary sequence of life from simpler to more complex ones, to which man himself belongs.*
- *To attempt an inquiry into the vital processes that make life possible through an understanding of the adaptations animals have evolved that best suit the milieu in which they thrive.*
- *To understand the relation between organisms and their environment through Ecology i.e., the study of "life at home".*

Unit 1: Diversity of Animal Kingdom - I **Lectures 15**

1.1: Levels of Organization
1.1.1 : Unicellularity vs Multicellularity; formation of colonies
1.1.2 : Organization of germ layers and fate of ectoderm, mesoderm and endoderm; Diploblastic and triploblastic condition; Division of labour and organization of tissues
1.1.3 : Development of Coelom; Acoelomate, pseudocoelomate and coelomate organization
1.1.4: Radial and bilateral symmetry
1.1.5: Segmentation and cephalization

Salient features with examples of Phyla, Subphyla and Classes mentioned below:
1.2 : Unicellular and Multicellular Organization
1.2.1 : Unicellular organization: Phylum Protozoa
1.2.2 : Multicellular organization: Colonization level – Phylum Porifera
1.2.3 : Multicellular organization: Division of labour (Cell differentiation) – Phylum Cnidaria/ Coelenterata

1.3 : Triploblastic Acoelomate and Pseudocoelomate Organization
1.3.1 : Acoelomate organization – Phylum Platyhelminthes
1.3.2 : Pseudocoelomate organization – Phylum Nemathelminthes

1.4 : Triploblastic Coelomate Organization
1.4.1 : Animals with metameric segmentation – Phylum Annelida
1.4.2: Animals with jointed appendages – Phylum Arthropoda

Unit 2: Life Processes - I **Lectures 15**

2.1 : Movement and Locomotion
2.1.1 : Amoeboid movement
2.1.2 : Ultrastructure of cilia and ciliary movements
2.1.3: Action of muscles (Role of muscles in movement)

2.2 : Nutrition
2.2.1 : Types of nutrition: Autotrophic and heterotrophic
2.2.2: Apparatus for nutrition:
a. Food vacuole: Animals without alimentary canal, ex. *Amoeba*
b. Animals with incomplete alimentary canal, ex. *Hydra*
c. Animals with complete alimentary canal, ex. bird
2.2.3: Physiology of digestion in vertebrates and symbiotic digestion in ruminants

2.3 : Respiration
2.3.1 : Types of respiratory surfaces:
a. General body surface: Cell membrane, ex. *Amoeba*; Skin, ex. earthworm and frog
b. Specialized respiratory structures: Trachea and spiracles, gills of fish, lungs of frog and human, air sacs of bird
2.3.2 : External respiration and cellular respiration with reference to human

2.4 : Circulation
2.4.1 : Types of circulating fluids: Water, coelomic fluid, lymph and blood
2.4.2 : Types of circulation: Protoplasmic streaming, open and closed circulation, single and double circulation
2.4.3 : Hearts: Heart in *Daphnia,* cockroach and chordates (one, two, three and four-chambered hearts)
2.4.4 : Structure of cardiac muscle

Unit 3: Ecology **Lectures 15**

3.1:
Concept of Ecosystem

3.2:
Concepts of energy flow, food chain and food web

3.3 : Biogeochemical cycles
3.3.1 : Carbon cycle, oxygen cycle, nitrogen cycle, phosphorus cycle and water cycle
3.3.2: Human activities affecting biogeochemical cycles

3.4 : Animal interactions
Symbiosis: Mutualism, commensalism, parasitism, predation and antibiosis

Semester I – Theory

Paper Code: SIUSZO12
Molecular basis of life - I, Biotechnology - I and Genetics

Learning Objectives

- *To develop an interest to learn the chemical language of life i.e., the molecular basis of life.*
- *To keep pace with technology that merges biological concepts, for its application for the betterment of human life through the study of Biotechnology.*
- *To improve our understanding of the genetic information – the molecular code of life, through Mendelism and to better understand the human race through a genetic perspective.*

Unit 1: Molecular basis of life - I **Lectures 15**

1.1: Biological micromolecules and macromolecules
1.1.1: Monomeric constituents; Polymers
1.1.2: Significance of Carbon

1.2: Proteins
1.2.1 : Amino acids: Types based on carboxylic, amino and aromatic groups
1.2.2: Peptide bond
1.2.3: Structure of proteins: Primary, secondary, tertiary and quaternary
1.2.4: Classification of proteins based on structure and function
1.2.5: Biological role of proteins

1.3: Carbohydrates
1.3.1 : Nomenclature, isomerism and classification
1.3.2: Glycosidic bond
1.3.3: Types of carbohydrates:
a. Monosaccharides: Glucose, fructose, galactose
b. Disaccharides: Maltose, sucrose, lactose
c. Polysaccharides: Starch, glycogen, cellulose, chitin, heparin
1.3.4: Biological role of carbohydrates

Unit 2: Biotechnology - I **Lectures 15**

2.1: Concept of Biotechnology
2.1.1 : Definition
2.1.2 : An overview of achievements and scope

2.2: Fundamentals of laboratory techniques in Biotechnology
2.2.1 : Safe handling of equipments

2.2.2 : Sterilization techniques

2.2.3 : Molecular separation techniques
Principle and applications: Paper chromatography, Thin Layer Chromatography (TLC) and Electrophoresis – Agarose gel electrophoresis (AGE) and Polyacrylamide gel electrophoresis (PAGE)

2.3 : Food Biotechnology
2.3.1 : Applications of biotechnology in making bread, beer, wine, yogurt and cheese

2.4 : Enzyme Technology
2.4.1 : Enzymes as meat tenderizers
2.4.2: Biodetergents
2.4.3: Concept of enzyme immobilization

Unit 3: Genetics **Lectures 15**

3.1:
Definition of gene; concept of genetics vs heritability; concept of mutation vs polymorphism

3.2 : Mendelian Inheritance
3.2.1 : Monohybrid and dihybrid cross
3.2.2: Concept of dominance
3.2.3: Exceptions to Mendelian Inheritance:
Incomplete dominance; Co-dominance; Interaction of genes – Epistasis: recessive, dominant, double recessive and double dominant epistasis; Lethal genes

3.3 : Cytoplasmic Inheritance
3.3.1 : Kappa particles in *Paramoecium*; Sigma factor in *Drosophila* and shell coiling in *Limnaea*

3.4:
Effect of environment on heredity

3.5 : Introduction to Human Genetics
3.5.1 : Mendelian phenotypic traits in humans: Dominant, recessive and X-linked characters (two examples of each)
3.5.2 : Pedigree analysis: Dominant, recessive and X-linked traits
3.5.3: Genetic counselling
a. Risk of recurrence of hereditary diseases (thalassemia, haemophilia) in a family
b. Risk of inheriting a disease from consanguineous marriage
c. Risk of acquiring common hereditary diseases

Semester I – Practical (SIUSZOP11)

Practical I based on SIUSZO11

1. Levels of Organization in Animal Kingdom
a. Symmetry:
1. Asymmetric organization: *Amoeba*
2. Radial symmetry: Sea anemone, *Aurelia*
3. Bilateral symmetry: *Planaria*/ liver fluke

b. Coelom condition:
1. Acoelomate: T.S. of *Planaria*/ liver fluke
2. Pseudocoelomate: T.S. of *Ascaris*
3. Coelomate: T.S. of earthworm

c. Metamerism: Earthworm

d. Specialization of body parts for division of labour: Insect – Head, thorax and abdomen

e. Cephalization:
1. Cockroach – Head
2. Prawn/ crab – Cephalothorax

2. Animal Diversity
a. Phylum Protozoa: *Amoeba, Paramoecium, Euglena, Plasmodium*
b. Phylum Porifera: *Leucosolenia,* Bath sponge
c. Phylum Cnidaria/ Coelenterata: *Hydra, Obelia colony, Aurelia,* Sea anemone and any one coral
d. Phylum Platyhelminthes: *Planaria*, liver fluke and tapeworm
e. Phylum Nemathelminthes: *Ascaris* (male and female)
f. Phylum Annelida: *Nereis*, earthworm and leech
g. Phylum Arthropoda: Crab, lobster, *Lepisma*, beetle, dragonfly, butterfly, moth, spider, centipede, millipede

3. Study of *Paramoecium* culture to observe food vacuole, contractile vacuole and ciliary movement.

4. Study of nutritional apparatus: *Amoeba*, L.S. of *Hydra* and *Planaria*, digestive system of cockroach and earthworm.

5. Study of activity of digestive enzymes from the gut of cockroach (from dead/ narcotized specimen).

6. Study of effect of pH and temperature on the activity of enzyme amylase/ trypsin.

7. Mounting of trachea and spiracles of cockroach (from dead/ narcotized specimen); study of gills of fish, lungs of frog and mammal; rate of oxygen consumption by cockroach (demonstration only).

8. Study of heart of cockroach; study of whole mount and L.S. of following hearts: fish (two-chambered), frog (three-chambered), mammal (four-chambered).

9. Determination of rate of heartbeat in Daphnia.

10. Study of permanent slides of blood smear of frog and mammal.

11. Study of Animal interactions:
a. Mutualism: Termite and *Trichonympha*
b. Antibiosis: Effect of antibiotics on bacterial growth in a petriplate
c. Parasitism: 1. Ectoparasite – Head louse and bed bug
2. Endoparasite – *Trichinella spiralis*
d. Predation: Praying mantis and spider

12. Determination of population density (*Daphnia* or any suitable organism) by subsampling method.

Semester I – Practical (SIUSZOP12)

Practical II based on SIUSZO12

1. Introduction to basic laboratory safety:
Safety rules and precautions; safety practices w.r.t. accidents which may occur while working in a laboratory (chemical spillage, burns, etc.); principle, working and use of fire extinguishers.

2. Handling of common laboratory equipments/ instruments: Burner, microscope, centrifuge, colorimeter, balance, homogenizer.
Handling of glassware

3. Aseptic techniques:
a. Autoclaving and packaging of test tubes, pipettes, petri plates and conical flasks.
b. Aseptic transfer of liquids between burners.

4. Separation of amino acids by ascending paper chromatography and thin layer chromatography (TLC).

5. Qualitative tests for proteins and carbohydrates.

6. Preparation of beads of calcium alginate for immobilization of enzyme amylase/ yeast cells.

7. Assay of immobilized amylase/ invertase from immobilised yeast cells by DNSA method (visual observation for comparing the colour intensity in test tubes).

8. Demonstrate agarose gel electrophoresis for the separation of egg white proteins and compare with a protein ladder or standard protein sample.

9. To demonstrate fermentation of grape juice/ sugar cane juice or any fruit juice (Detection of alcohol generated during fermentation by benzoic acid).

10. Effect of Papain (raw papaya extract) as a meat tenderizer.

11. Human Pedigree analysis: Dominant, recessive and X-linked characters.

Semester II – Theory

Paper Code: SIUSZO21
Diversity of Animal Kingdom - II, Life Processes - II and Ethology

Learning Objectives

- *To do an introductory survey of the diversity of animal life to understand that part of the world around us composed of animals. Also, to gain an insight on the evolutionary sequence of life from simpler to more complex ones, to which man himself belongs.*
- *To attempt an inquiry into the vital processes that make life possible through an understanding of the adaptations animals have evolved that best suit the milieu in which they thrive.*
- *To appreciate the significance of animals as part of the same world in which humans exist, through ethological study.*

Unit 1: Diversity of Animal Kingdom - II **Lectures 15**

1.1: Triploblastic Coelomate Organization
1.1.1 : Animals with mantle: Phylum Mollusca
1.1.2 : Animals with enterocoel: Phylum Echinodermata

1.2 : Phylum Hemichordata

1.3 : Phylum Chordata
1.3.1 : Subphylum Urochordata
1.3.2 : Subphylum Cephalochordata
1.3.3 : Subphylum Vertebrata
a. Division: Agnatha –
Class Cyclostomata
b. Division: Gnathostomata –
1. Class Pisces (Cartilaginous and bony fish)
2. Class Amphibia
3. Class Reptilia
4. Class Aves
5. Class Mammalia

Unit 2: Life Processes - II **Lectures 15**

2.1 : Excretion and Osmoregulation
2.1.1 : Concepts of excretion and osmoregulation
2.1.2 : Categorization of animals on the basis of principal nitrogenous excretory products
2.1.3: Ornithine cycle, formation of urea; deamination and detoxification

2.2 : Control and Coordination
2.2.1 : Irritability
2.2.2 : Structure of neuron; sense organs – human eye and ear
2.2.3 : Conduction of nerve impulse: Resting potential, action potential and refractory period

2.2.4 : Synaptic transmission
2.2.5 : Endocrine regulation: Hormones as chemical messengers; feedback mechanisms

2.3 : Reproduction
2.3.1 : Gametogenesis; structure of egg and sperm of mammal
2.3.2: Fertilization in animals; *In vitro* fertilization
2.3.3: Oviparity, viviparity and ovoviviparity

Unit 3: Ethology **Lectures 15**

3.1 : Development of Behaviour
3.1.1 : Ontogeny of behaviour
3.1.2 : Environmental influence on behaviour
3.1.3 : Sensitive periods during development; Juvenile behaviour; Innate behaviour

3.2 : Animal Learning
3.2.1 : Conditioning and learning:
Classical conditioning; Acquisition; Extinction; Habituation and generalization
3.2.2: Instrument learning; Reinforcement; Operant behaviour
3.2.3 : Biological aspects of learning:
Constraints of learning; learning to avoid enemies; mimicry; learning to avoid sickness; stimulus relevance
3.2.4 : Cognitive aspects of learning:
Hidden aspects of conditioning; nature of cognitive process; insight learning; associative learning and representation

Semester II – Theory

Paper Code: SIUSZO22
Molecular basis of life - II, Biotechnology - II, and Evolution and Biodiversity

Learning Objectives

- *To develop an interest to learn the chemical language of life i.e., the molecular basis of life.*
- *To acknowledge the emerging field of Biotechnology that blends the technological advancements and the natural wealth – the living organisms, for improving human life.*
- *To acknowledge the importance of the natural treasure – the biodiversity around us, and to be judicious in the utilization of this natural economy.*

Unit 1: Molecular basis of life - II **Lectures 15**

1.1 : Lipids
1.1.1 : Fatty acids: Structure, types and properties
1.1.2: Monoglycerides, diglycerides and triglycerides
1.1.3: Phospholipids and sphingolipids
1.1.4: Sterols and waxes
1.1.5: Biological role of lipids

1.2 : Nucleic acids
1.2.1 : Chemical structure of nitrogenous bases and pentoses
1.2.2: Nucleosides and nucleotides
1.2.3: Polynucleotides: 3' ⟶ 5' phosphodiester linkage
1.2.4: Watson-Crick Model of DNA
1.2.5: Types of RNA: mRNA, tRNA and rRNA
1.2.6: Cloverleaf model of tRNA
1.2.7: Differences between DNA and RNA

Unit 2: Biotechnology - II **Lectures 15**

2.1 : Transgenic Animals and Animal Cloning
2.1.1 : Transgenic animals for production of pharmaceuticals:
alpha-1-antitrypsin, tissue plasminogen activator (tPA)
2.1.2: Animal cloning experiments for "Dolly"

2.2 : Biotechnology and Gene therapy
2.2.1 : Biotechnology in production of insulin and hGH
2.2.2 : Gene therapy: *Ex vivo* and *In vitro* approach; Gene therapy for SCID (Severe combined immunodeficiency) and Cystic fibrosis
2.2.3 : Ethical issues with reference to gene therapy

2.3 : Environmental Biotechnology
2.3.1 : Bioremediation: Concepts and applications

2.3.2 : Biodegradation of polycyclic aromatic hydrocarbons (PAHs) and petrochemicals

Unit 3: Evolution and Biodiversity **Lectures 15**

3.1: Evolution
3.1.1: Origin of life: Emergence of life on primitive earth
3.1.2: Evolution and adaptations:
Microevolution, Role of Natural selection in microevolution, Co-evolution

3.2 : Biodiversity
3.2.1 : Definition; Biodiversity hotspots; Benefits of biodiversity; Biodiversity conservation; Biowealth of India
3.2.2 : Human activities affecting biodiversity
3.2.3: Concept of ecological niche and adaptations

Semester II – Practical (SIUSZOP21)

Practical I based on SIUSZO21

1. Animal Diversity
a. Phylum Mollusca: *Chiton, Dentalium, Pila,* bivalve, Sepia and *Nautilus*
b. Phylum Echinodermata: Starfish, brittle star, sea urchin, sea cucumber, feather star
c. Phylum Hemichordata: *Balanoglossus*
d. Subphylum Urochordata: *Herdmania*
e. Subphylum Cephalochordata: *Amphioxus*
f. Division Agnatha: Class Cyclostomata: *Petromyzon*/ *Myxine*
g. Class Pisces: Subclass Chondrichthyes: Shark, skates, sting ray/ electric ray
Subclass Osteichthyes: *Sciaena*, flying fish
h. Class Amphibia: Frog, toad, caecilian, salamander
i. Class Reptilia: Chameleon, *Calotes*, turtle/ tortoise, snake, alligator/ crocodile
j. Class Aves: Kite, kingfisher, duck
k. Class Mammalia: Shrew, hedgehog, guinea pig, bat

2. Study of wheel organ of *Amphioxus*, scroll valve of shark, digestive system of pigeon, ruminant stomach.

3. Mounting of septal nephridium of earthworm (from preserved specimen); Observation of sagittal section of mammalian kidney, Bowman's capsule (under high power).

4. Urine analysis for detection of normal and abnormal constituents; Detection of uric acid from excreta of bird or cockroach.

5. Study of irritability in *Paramoecium* by demonstration of release of trichocysts.

6. Study of mammalian brain (entire and sagittal section with the help of specimen/ model); observation of T.S. of mammalian spinal cord.

7. Observation of permanent slides of:
Sponge gemmules, hydra budding, mammalian sperm, T.S. of mammalian testis, T.S. of mammalian ovary showing Graafian follicle; Observation of hen's egg with developing embryo at any stage of development.

8. Study of Mimicry:
Leaf insect, stick insect, stick worm (caterpillar), Kallima butterfly, Monarch butterfly and Common tiger butterfly.

Semester II – Practical (SIUSZOP22)

Practical II based on SIUSZO22

1. Thin layer chromatography of lipids using silica gel coated aluminium-backed TLC sheets and silica gel coated glass plates.

2. Adsorption chromatography using chalk to separate plant pigments or other pigments/ dyes (food colours).

3. Qualitative tests for lipids.

4. Extraction and qualitative detection of nucleic acids:
DNA (SDS-NaCl extraction); RNA (Phenol extraction)

5. Identification through photographs of methodology for transgenesis:
a. By microinjection into egg
b. Transgenesis of embryonic stem cell
c. Methodology for gene therapy for SCID (Severe combined immunodeficiency)

6. Study of bacteria using Gram stain (A mixture of bacteria and yeast cells to be given as sample).

7. To evaluate the quality of milk by Methylene blue reduction method.

8. Study of evidences of Evolution:
a. Analogy – Leg of grasshopper and leg of mammal; Wing of insect, wing of bird, wing of bat
b. Homology –Forelimb of amphibian/ reptilian and wing of bird/ bat
c. Any two fossils

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- Essentials of Ecology, 3rd edition – G. Tyler and Miller Jr. Thompson Books
- Biodiversity: S.V.S. Rana, Prentice Hall Publications
- Evolution: Strickberger, C.B.S. Publication
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- 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

ADDITIONAL READING:

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

Practical Examination Question Paper Pattern
Semester I – Practical (SIUSZOP11)

Practical I based on SIUSZO11

Time: 2 hours **Marks: 50**

Q.1 Major Experiment **14**
Effect of pH or temperature on amylase activity/ trypsin activity.

OR

Activity of digestive enzymes from the gut of cockroach (Invertase, amylase/ protease/ lipase).

OR

Determination of rate of heart beat of *Daphnia*.

Q.2 Minor Experiment **08**
Temporary mounting of: Trachea/ mesothoracic or metathoracic or abdominal spiracle from cockroach/
Paramoecium: food vacuole/ contractile vacuole/ ciliary movement

OR

Determination of population density of *Daphnia* or any suitable organism.

OR

Identification of parts of digestive system (any two) and explanation of their function from preserved (dead) dissected cockroach/ earthworm.

Q.3 Identification (3 marks each) **18**
a. Levels of organization
b. Animal diversity (Protozoa to Platyhelminthes)
c. Animal diversity (Nemathelminthes to Arthropoda)
d. Animal interaction (commensalism/ mutualism/ antibiosis/ parasitism/ predation)
e. and f. Nutrition/ Respiration/ Circulation

Q.4 Viva **05**

Q.5 Journal **05**

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Semester I – Practical (SIUSZOP12)

Practical II based on SIUSZO12

Time: 2 hours **Marks: 50**

Q.1 Major Experiment **15**

Demonstration of activity of immobilized enzyme: amylase or invertase.

OR

Qualitative tests for carbohydrates and proteins.

OR

Paper chromatography/ TLC for separation of amino acids.

Q.2 Minor Experiment **10**

Fermentation of fruit juice or sugarcane juice and detection of alcohol by benzoic acid.

OR

Effect of papain as meat tenderizer.

OR

Preparation of beads of calcium alginate for immobilization of enzyme amylase or invertase.

OR

Pedigree analysis

OR

Packaging of glassware (any one) and aseptic transfer of liquid.

Q.3 Identification (3 marks each) **15**

a., b. and c.: Laboratory instruments any three (burner/ centrifuge/ homogenizer/ balance/ colorimeter/ microscope/ any part of microscope

d. and e. Laboratory Safety (lab coat/ goggles/ gloves/ rubber bulbs/ hazard symbols/ fire extinguishers)

Q.4 Viva **05**

Q.5 Journal **05**

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Semester II – Practical (SIUSZOP21)

Practical I based on SIUSZO21

Time: 2 hours **Marks: 50**

Q.1 Major Experiment **14**

Detection of one normal and one abnormal constituent of urine OR any two abnormal constituents of urine.

OR

Detection of uric acid from the excreta of bird or cockroach.

Q.2 Minor Experiment **08**

Detection of ammonia excreted by fish.

OR

Mounting of septal nephridium of earthworm.

OR

Study of irritability in *Paramoecium* by demonstration of release of trichocysts.

Q.3 Identification (3 marks each) **18**

a. Animal diversity (Mollusca to Cyclostomata)
b. and c. Animal diversity (Pisces to Mammalia)
d. Excretion, control and coordination (Sagittal section of mammalian kidney/ Bowman's capsule/ mammalian brain/ T. S. of mammalian spinal cord)
e. Reproduction (Sponge gemmule/ Hydra budding/ mammalian sperm/ T. S. of mammalian testis/ T. S. of mammalian ovary/embryonic stage of development of hen's egg)
f. Mimicry (Leaf insect/ stick insect/ Kallima butterfly/ Monarch and common tiger butterfly)

Q.4 Viva **05**

Q.5 Journal **05**

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Semester II – Practical (SIUSZOP22)

Practical II based on SIUSZO22

Time: 2 hours **Marks: 50**

Q.1 Major Experiment **14**
Extraction and qualitative detection of DNA.

OR

Extraction and qualitative detection of RNA.

OR

Demonstration of Thin layer chromatography (TLC) of lipids and calculation of Rf value.

Q.2 Minor Experiment
a. Separation of pigments by adsorption chromatography using chalk and calculation of R_f value. **10**

OR

Gram staining of bacteria.

b. Evaluation of quality of milk by methylene blue reduction method. **07**

OR

Qualitative tests for lipids (any 2 tests).

Q.3 Identification (3 marks each) **09**
a. Transgenesis (microinjection/ embryonic stem cells/ SCID)
b. Evolution (Homology/Analogy)
c. Study of fossils (Ammonite/ Trilobite)

Q.4 Viva **05**

Q.5 Journal **05**

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F. Y. B. Sc. Zoology Syllabus (Autonomous)
Choice Based Credit 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 Report submitted by the student on field visit to Zoo/ National Park/ Sanctuary/ Aquarium/ Fish Market/ Nature Conservation Centre/ any Educational institute in the vicinity: **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^{th} 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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