



SIES

College of Arts,
Science &
Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

(Affiliated to University of Mumbai)

Faculty: Science

Program: S.Y.B.Sc

Subject: ZOOLOGY

Academic Year: 2019 – 2020

**Revised Syllabus in Zoology
under Choice Based Credit System (CBCS)
Approved by the Board of Studies in Zoology
Effective from academic year 2019 – 2020**

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

Semester III and Semester IV
(Choice Based Credit System, with effect from academic year 2019-20)

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. This syllabus is also designed to inculcate an interdisciplinary approach amongst students by making them explore the world of Biochemistry, Biophysics and Bioinformatics. 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:

- ✓ Origin and Evolution and Development Biology will help students understand how the processes and mechanisms related to Evolution are phenomena connected to Developmental Biology.*
- ✓ Molecules and Life, Metabolism and Energy reveal the intricate chemical reactions which sustain life, and thereby will help students appreciate the fact that the same principles/ laws govern the physical and the living worlds.*
- ✓ Economic Zoology (Entomology and Animal Husbandry) 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.*
- ✓ Biotechnology and Bioinformatics – involving tools and techniques besides the application of computers, to keep pace in this technologically-driven world.*

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. The comments and recommendations of the contributors and reviewers have been carefully considered and implemented wherever feasible. It was approved by the Board of Studies in the meeting held on 27th April 2019 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*

Members of the Board of Studies in the subject of Zoology

- ✓ *Professor (Dr.) Chhaya Panse – Principal and Head, Department of Zoology, MD College, Mumbai (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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S. Y. B. Sc. Zoology Syllabus (Autonomous)
Choice Based Credit System
(With effect from academic year 2019-20)

Grid of Syllabus – Semester III

Theory				
Paper Code	Unit No.	Unit Name	Credits	Lectures/week
SIUSZO31	1	Wonders of Animal Kingdom – Invertebrate Life	2	1
	2	Developmental Biology		1
	3	Origin of Life and Evolution		1
SIUSZO32	1	Molecules and Life	2	1
	2	Metabolism and Energy		1
	3	Genetics		1
SIUSZO33	1	Introduction to Parasitology and Protozoan Parasites	2	1
	2	Economic Entomology		1
	3	Animal Husbandry – Vermiculture, Poultry, Goat farming		1
Practical				
SIUSZOP31	Based on SIUSZO31 (Practical I)		1	3
SIUSZOP32	Based on SIUSZO32 (Practical II)		1	3
SIUSZOP33	Based on SIUSZO33 (Practical III)		1	3
Total			9	18

Grid of Syllabus – Semester IV

Theory				
Paper Code	Unit No.	Unit Name	Credits	Lectures/week
SIUSZO41	1	Wonders of Animal Kingdom – Chordate Life	2	1
	2	Cellular Organization		1
	3	Basic Concepts in Research		1
SIUSZO42	1	Molecular Biology	2	1
	2	Biotechnology		1
	3	Bioinformatics		1
SIUSZO43	1	Helminth Parasitology	2	1
	2	Fishery Science		1
	3	Animal Husbandry – Sheep farming, Cattle farming, Dairy Science		1
Practical				
SIUSZOP41	Based on SIUSZO41 (Practical I)		1	3
SIUSZOP42	Based on SIUSZO42 (Practical II)		1	3
SIUSZOP43	Based on SIUSZO43 (Practical III)		1	3
Total			9	18

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 (<i>U, Ap</i>) <ul style="list-style-type: none">• 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 (<i>U, An, E</i>) <ul style="list-style-type: none">• 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 (<i>Ap, C</i>) <ul style="list-style-type: none">• 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 (<i>U, An, E</i>) <ul style="list-style-type: none">• 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 (<i>U, Ap, An, C</i>) <ul style="list-style-type: none">• 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 (<i>U, Ap, An</i>) <ul style="list-style-type: none">• 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 (<i>U, Ap, E</i>) <ul style="list-style-type: none"> • 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 (<i>U, Ap, An</i>) <ul style="list-style-type: none"> • 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 (<i>R, U, Ap, An</i>) <ul style="list-style-type: none"> • 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 (<i>U, An, E</i>) <ul style="list-style-type: none"> • 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 (<i>R, U, E, C</i>) <ul style="list-style-type: none"> • 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.

	<ul style="list-style-type: none"> • 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	<p>Research Aptitude and Interdisciplinary Approach (<i>Ap, An, E, C</i>)</p> <ul style="list-style-type: none"> • 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 SYBSc

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 skepticism 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 III – Theory

Course Code: SIUSZO31

Course Name: Invertebrate life, Developmental Biology, Evolution

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Wonders of Animal Kingdom – Invertebrate Life	<p>CO1: Recognise and describe the innovations in form and function of invertebrate life and relate their possession to the capability of these living forms to explore and adapt to varied habits and habitats. Understand the significance of these animals to mankind, both useful and harmful.</p> <ul style="list-style-type: none"> • Describe skeletal types developed for protection; types of reproduction to form their own kind and the phenomenon of bioluminescence in the most primitive life forms – the unicellular Protozoa. • Describe canal systems of varying complexity; types of spicules as part of endoskeleton and as criterion for classifying; reproduction and capacity for regeneration in less specialised animal forms – the multi-celled Porifera. • Discuss existence of polymorphism representing division of labour and evolutionary significance; and types and theories of formation of coral reefs considered as highly productive areas of ocean, in the tissue level of organization – the Coelenterata. • State the characteristics of acoelomate Platyhelminthes and pseudocoelomate Nematelminthes making them successful parasites. • Attribute metamerism to the very existence of Annelida and discuss reproduction in this coelomate phylum. • Analyse the survival value in possessing larval stages and showing the phenomenon of metamorphosis in the jointed limbs – the 	R, U, An	PO2, PO7, PO8 PSO1, PSO2, PSO3

	<p>Arthropoda.</p> <ul style="list-style-type: none"> • Explain shell coiling and torsion as an adaptation to balance the „belly-footed“ shelled body, a representative of the Mollusca. • Comprehend the design of hydraulic system – water vascular system, and discuss different larval stages in the spiny-skinned Echinodermata. 		
Unit 2: Developmental Biology	<p>CO2: Explore the ground plan of animal development at the molecular, cellular, genetic and evolutionary levels. Reflect upon the implications of developmental biology in experimental biology (research) and for human welfare.</p> <ul style="list-style-type: none"> • Know <i>Dictyostelium</i>, an accessible organism for studies of signaling via chemoattractant receptors. • Discuss the process of fertilization and the phenomenon of parthenogenesis in animals. • Classify different types of eggs, cleavage patterns and blastula in various animal groups. • Define gastrulation, understand its mechanism in forming germ layers and setting the embryo up for organ formation. 	<i>U, An</i>	<p><i>PO2, PO7</i></p> <p><i>PSO1, PSO2</i> <i>PSO4</i></p>
Unit 3: Origin of Life and Evolution	<p>CO3: Conceptualize the beginning of universe and the origin of life and its progression by experimental evidence for chemical evolution and theories of organic evolution. Insight into the process of evolution and its mechanisms that have shaped the biosphere.</p>	<i>R, An</i>	<p><i>PO2, PO7</i></p> <p><i>PSO1, PSO2,</i> <i>PSO4</i></p>

Course Code: SIUSZO32

Course Name: Biochemistry and Genetics

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Molecules and Life	<p>CO1: Agree that water molecule forms the basis for sustenance of life on earth through insight into its molecular structure, chemical and physical properties. Explain acids, bases, pH and buffers; apply Henderson-Hasselbalch equation for calculating pH; plot titration curves and comprehend the role of buffers in biological systems.</p>	<i>U, Ap, An</i>	<p><i>PO1, PO2</i></p> <p><i>PSO1, PSO2</i></p>
Unit 2: Metabolism and Energy	<p>CO2: Examine bioenergetics to become aware of the energy exchanges occurring in living organisms and analyse metabolism – the marvelously engineered network of enzymatic reactions, that transforms nutrients to sustain</p>	<i>U, An</i>	<p><i>PO2, PO8</i></p> <p><i>PSO1, PSO2</i></p>

	life. Discuss thermodynamics to know how fundamental laws of physical science govern living organisms. Ground in the fundamentals of carbohydrate, protein and lipid metabolism which have application in biochemical research and medicine.		
Unit 3: Genetics	CO3: Further probe into classical genetics – an area of genetics focusing on mechanisms of inheritance in organisms responsible for resemblances and variations, and that are central to diversity of life on earth. Realise the implications for developing treatment for a trait – genetic disorder in humans, and for improving traits – yield, resistance to disease, etc. in domesticated animals/ livestock by understanding behaviour of gene in chromosome and its functional state.	<i>U, An</i>	<i>PO2, PO8</i> <i>PSO1, PSO2</i>

Course Code: SIUSZO33

Course Name: Parasitology, Entomology and Economic Zoology

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Introduction to Parasitology and Protozoan parasites	CO1: Acquaint with parasitology – an interdisciplinary field of science embracing zoology, microbiology, immunology, etc. and concerned with basic biology and clinical aspects of parasites, organisms that impact human health. In-depth coverage of few protozoan parasites of human concern. Become aware about the potential for pursuing training in diagnostic parasitology in health care laboratories with this basic knowledge. Realise importance of hygiene standards in disease prevention.	<i>U, An</i>	<i>PO1, PO2, PO8</i> <i>PSO1</i>
Unit 2: Economic Entomology	CO2: Understand entomology – the science of insects (kind of arthropods) from commercial viewpoint by discussing general biology/ life histories of selected insect species, both useful and harmful to human interest. Encourage the entrepreneur in students of zoology.	<i>U, An</i>	<i>PO1, PO8</i> <i>PSO1, PSO3</i>
Unit 3: Animal Husbandry – Vermiculture, Poultry, Goat farming	CO3: Uncover animal husbandry – a branch of agricultural science by an extensive discussion on vermiculture (dealing with earthworm, an invertebrate), poultry (involving feathered vertebrates) and goat farming (involving a mammal). Acknowledge the existence and characteristics of these farm animals making them entities from which to procure products of human utility. Provoke raw enthusiasm of the zoology student for business.	<i>U, An</i>	<i>PO1, PO8</i> <i>PSO1, PSO3</i>

	Hope for scope as research worker in agricultural research or to obtain basic training in raising farm animals for a future/ livelihood.		
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Semester IV – Theory

Course Code: SIUSZO41

Course Name: Chordate life, Cell biology and Scientific research

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Wonders of Animal Kingdom – Chordate life	CO1: Describe the novel features developed in chordates that enabled them to explore and adapt to new ecological opportunities. Establish kinship relationship among the different taxa in Chordata. Encourage active exploration of the animal kingdom.	<i>R, U</i>	<i>PO2, PO7</i> <i>PSO1, PSO2</i>
Unit 2: Cellular Organization	CO2: Justify that cell is indeed the basic structural and functional unit of life by a thorough discussion on the structural constituents (plasma membrane and cell organelles) of cell and their functions. Gain clearer understanding of form and function interrelation at the organizational level of cell other than at organismal level. Critical thinking over the advances in tools for biological studies that have made possible this detailing of the cellular organization otherwise unknown to the naked eye.	<i>U, E</i>	<i>PO2</i> <i>PSO1, PSO2</i>
Unit 3: Basic Concepts in Research	CO3: Establish thorough grounding in the art of scientific method which inquires the dynamic nature of science by a precise, honest, disciplined and mindful approach. Illumine investigative side of student inquirer for manifestation of his/her intellectual calling that could be a matter of wide public interest.	<i>An, C</i>	<i>PO1, PO2, PO3, PO7, PO8</i> <i>PSO1, PSO2, PSO4</i>

Course Code: SIUSZO42

Course Name: Molecular biology, Biotechnology and Bioinformatics

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Molecular Biology	CO1: Acknowledge the ground-breaking discovery of the molecular structure of genetic material that laid the foundation for understanding „central dogma of molecular biology – the processing of genetic information – forming 20-letter alphabet of protein structure from nucleotide symbols of genetic material“.	<i>U, An</i>	<i>PO2, PO8</i> <i>PSO1, PSO2, PSO4</i>

	Emphasize the unifying nature of genetic program in living organisms.		
Unit 2: Biotechnology	CO2: Elaborate on recombinant DNA technology/ genetic engineering – the principal aspect of biotechnology which allows laboratory construction of new DNA molecules that may not occur biologically. Consider biotechnology as an avenue for genetic research with its spectacular achievements/ applications having social implications.	<i>U, An</i>	<i>PO2, PO7</i> <i>PSO1, PSO2, PSO4</i>
Unit 3: Bioinformatics	CO3: Gain substantial background of a revolutionising field of science – bioinformatics, that studies an organism’s genome using computational tools, and holds application in medicine (studying genetic disorders) and studying phylogeny amongst others. Uncover the Human Genome Project and realise its potential in bettering human society.	<i>U, An</i>	<i>PO1, PO2,PO4, PO8</i> <i>PSO1, PSO2, PSO4</i>

Course Code: SIUSZO43

Course Name: Parasitology, Fisheries and Economic Zoology

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Helminth Parasitology	CO1: Further into parasitology by an extensive discussion on helminth (multicellular animals with long, thin bodies) parasites with complex life cycles and an extraordinary array of adaptations ensuring their survival in a wide range of hosts. Penetrating insight into the debilitating effects of these lower forms of life that can sweep the so-called superior human race of its well-being; hence also create awareness in general public of such pathogens.	<i>R, U, An</i>	<i>PO1, PO2,PO6, PO8</i> <i>PSO1, PSO2</i>
Unit 2: Fishery Science	CO2: Account for a branch of applied zoology – fishery science dealing with fish and other aquatic invertebrates that hold interest of mankind as a source of nourishment and a resource for commerce. Comprehensive information of biology, methods of procuring and culturing, processing and marketing of selected few species of Indian fish, molluscs and crustaceans. Motivate to be self-starter or personnel in fishery industry by acquiring further knowledge and skills.	<i>R, U</i>	<i>PO6,</i> <i>PO7,</i> <i>PSO1</i>
Unit 3: Animal Husbandry – Sheep farming, Cattle farming, Dairy Science	CO3: Expand the account on animal farming by detailing in sheep, cow and buffalo farming, as well as dairy science. Delve in the animal wealth of India for an investment in this area as future progressive farmers.	<i>U, An</i>	<i>PO1, PO2,PO6, PO7</i> <i>PSO1, PSO2</i>

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 III – Practical

Course Code: SIUSZOP31

Course Name: Practical I based on SIUSZO31

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	<ul style="list-style-type: none"> • Identify and describe various specimens, permanent microscope slides with respect to specific characteristic features in invertebrate animal kingdom. • Discuss crustacean and echinoderm larvae, and insect metamorphosis. • Describe types of egg and early embryonic stages of chosen animal species. • Identify, compare, and discuss the types of speciation - a process in evolution of life forms. 	<i>U, An</i>	<i>PO2, PO7, PO8</i> <i>PSO1, PSO3</i>

Course Code: SIUSZOP32

Course Name: Practical II based on SIUSZO32

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	<ul style="list-style-type: none"> • State the principle and explain the working of pH meter, an instrument to measure pH – a parameter with implications on functioning of biological system. Use pH meter for plotting titration curve and determining pKa. • Calculate pH using Henderson-Hasselbalch equation and apply this for preparation of buffer solutions with different pH. • State the principle and explain the working of colorimeter – a light sensitive instrument used for measuring concentration of coloured solutions, in biochemical assays, etc.; perform selection of best filter for a coloured solution in question. • Use glucometer and glucose estimation kit for estimating blood glucose level. 	<i>U, Ap, An, E</i>	<i>PO1, PO2, PO8</i> <i>PSO1, PSO2, PSO3, PSO4</i>

Course Code: SIUSZOP33

Course Name: Practical III based on SIUSZO33

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	<ul style="list-style-type: none">Identify, describe, and comment on pathogenesis of selected protozoan parasites by observing permanent slides/ blood smears.Identify and discuss the life histories of some beneficial and harmful insects to understand their purpose for mankind; perform structure-function analysis of insect body by preparing mountings of honey bee mouth parts, legs and sting apparatus.Identify and describe breeds of fowl and goat through pictures, applicable for selection of a breed to suit the purpose.Use colorimeter to estimate protein and total lipid content of two egg varieties (hen's egg) and know about any difference in the content, and about factors that may influence it; understand the principle of Biuret/ Folin-Lowry method and ferric chloride method.	<i>U, An, E, C</i>	<i>PO2, PO7, PO8</i> <i>PSO1, PSO2, PSO3, PSO4</i>

Semester IV – Practical

Course Code: SIUSZOP41

Course Name: Practical I based on SIUSZO41

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	<ul style="list-style-type: none">Explain functional morphology in the animal world by identifying and describing different museum specimens of chordates/ vertebrates.Apply the knowledge of osmosis to study features of plasma membrane (cell boundary); describe the structure and function of cell organelles through observing their electron micrographs.Understand chromosomes by performing and observing (under light microscope) squash preparation of onion root tip and temporary preparation of polytene chromosomes of Chironomus larva.Understand the ways of scientific research by study of bibliography, preparing an abstract and power point presentation for scientific research paper – for initiating into the scientific research world.	<i>U, Ap, E, C</i>	<i>PO1, PO2, PO3, PO4, PO5, PO7, PO8</i> <i>PSO1, PSO2, PSO3, PSO4</i>

Course Code: SIUSZOP42

Course Name: Practical II based on SIUSZO42

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	<ul style="list-style-type: none">• Apply the basic understanding of molecular biology and biotechnology for problem solving.• Analyse the importance of information technology in understanding biology through bioinformatics.	<i>Ap, An, E, C</i>	<i>PO1, PO2, PO4, PO8</i> <i>PSO1, PSO2, PSO4</i>

Course Code: SIUSZOP43

Course Name: Practical III based on SIUSZO43

Course Outcome (CO)	Details	Cognitive Level	Affinity with PO/ PSO
	<ul style="list-style-type: none">• Identify, describe, and analyse the pathology of helminth parasites of the animal world by observing museum specimens and permanent slides.• Identify and discuss aspects of fish (chosen specimens – preserved/ fresh) such as morphological characters, fishery; knowledge about the tools (crafts and gears) in fishery by observing models/ photographs.• Understand the science of animal husbandry by identifying and observing photographs of selected breeds of cattle, buffalo and sheep; perform assessment of milk quality by checking for milk adulterants and density measurement by a tiny, simple glass device – lactometer.• Create a field visit report based on the field visit undertaken for direct experience and observation of the natural world of animals.	<i>U, Ap, An, E, C</i>	<i>PO1, PO2, PO5, PO6, PO7, PO8</i> <i>PSO1, PSO2, PSO3, PSO4</i>

Semester III – Theory

Paper Code: SIUSZO31

Invertebrate life, Developmental Biology, Evolution

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 acquaint the learner with key concepts of embryology, amazing processes occur at the initial stages of the development that lead to formation of complex life form.
- 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.

Unit1: Wonders of Animal Kingdom – Invertebrate Life

15 Lectures

1.1 Unicellular, Multicellular and Acoelomate/ Pseudocoelomate life

- 1.1.1 Protozoa: Skeleton, reproduction, bioluminescence
- 1.1.2 Porifera: Canal systems, spicules, reproduction and regeneration
- 1.1.3 Coelenterata: Polymorphism; Coral reefs –Types and theories of formation
- 1.1.4 Platyhelminthes and Nematelminthes: Parasitic adaptations

1.2 Coelomate life

- 1.2.1 Annelida: Metamerism and reproduction
- 1.2.2 Arthropoda: Crustacean larvae and metamorphosis in insects
- 1.2.3 Mollusca: Shell and torsion
- 1.2.4 Echinodermata: Water vascular system and echinoderm larvae

Unit2: Developmental Biology

15 Lectures

- 2.1 Acquisition of multicellularity – Signaling in *Dictyostelium*
- 2.2 Fertilization and parthenogenesis
- 2.3 Eggs and Cleavage
 - 2.3.1 Types of eggs
 - 2.3.2 Types of cleavage
- 2.4 Blastulation: Types of blastula with examples: amphibian, avian and mammalian
- 2.5 Gastrulation: epiboly, emboly, invagination, involution and infiltration
- 2.6 Fate of three germ layers and coelom formation
- 2.7 Maternal genes, segmentation genes, Homeotic genes in early development in *Drosophila*
- 2.8 Aging

Unit3: Origin of Life and Evolution

15 Lectures

- 3.1 Origin of Life
 - 3.1.1 Origin of universe
 - 3.1.2 Chemical evolution: Haldane and Oparin theory, Miller-Urey experiment

- 3.1.3 Origin of eukaryotic cell
- 3.2 Theories of Organic Evolution
 - 3.2.1 Theory of Lamarck
 - 3.2.2 Theory of Darwin and Neo-Darwinism
 - 3.2.3 Mutation Theory
 - 3.2.4 Modern Synthetic theory
 - 3.2.5 Weismann's Germplasm theory
 - 3.2.6 Neutral theory of Molecular evolution
- 3.3 Evolution
 - 3.3.1 Genetic basis of evolution: Reproduction and significance of Meiosis;
 - 3.3.2 Population Genetics: Gene pool, gene frequencies, Hardy-Weinberg equilibrium
 - 3.3.3 Variations as raw material for Evolution; types of Variations, Mutation and Recombination
 - 3.3.4 Elemental forces of Evolution: Migration (Gene flow), Mutation, Natural Selection and Genetic drift
 - 3.3.5 Speciation: Modes of speciation; Types of isolation and isolating mechanisms
 - 3.3.6 Concept of Macroevolution and Megaevolution

References:

Wonders of Animal Kingdom – Invertebrate Life

- Biological science, 3rd edition – D.J. Taylor, N. P. O. Green, G. W. Stout. Cambridge University press, Low priced edition.
- Zoology – S. A. Miller and J. B. Harley, Tata McGraw hill
- Biology – Silvia S. Maddor, W.C.B. Publications
- Modern textbook of Zoology – Invertebrates; Eleventh Edition; Professor R.L. Kotpal; Rastogi publication
- Invertebrate Zoology; E.L. Jordan and P.S. Verma
- A manual of Zoology - Part I, Invertebrata; Ayyar, M. Ekambaranath
- Invertebrate Zoology – Volumes of different Phyla; Hyman L.H.
- Invertebrate Zoology for Degree students; V. K. Agarwal; S.Chand Publication; 2012
- Invertebrate Zoology - Vol 1; Parker and Haswell
- Biology of Invertebrates; Fourth Edition; J.A.Pechnik; Tata McGraw Hill
- A textbook of Zoology; T.J.Parker & W.A.Haswell; MacMillan
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- Invertebrate Zoology – A functional evolutionary approach; Seventh Edition; Edward E. Ruppert, Richard S. Fox & Robert D. Barnes; Cengage Learning India Pvt. Ltd.; 2004
- Invertebrate Zoology Volume II- Jordan and Verma; S. Chand and Co.
- Invertebrate Zoology- Majupuria T. C., Nagin S. and Co.
- Invertebrate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
- Modern Textbook of Zoology, Invertebrates, Kotpal R. L.

Developmental Biology

- Developmental biology; Gilbert
- Developmental biology; Patten
- Developmental biology; Wolpert
- Text book of embryology; N. Arumugam
- Chicken Development – Embryology; W.H. Freeman & B. Bracegirdle

Origin of Life and Evolution

- Theory of Evolution- Smith, Cambridge Press, and Low price Ed.
- Evolution - Strickberger, CBS publication
- Evolution- P.S.Verma and Agarwal
- Introduction to Evolution by Moody
- Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
- Biology -The Unity and Diversity of Life. C. Starr, R. Taggart, C. Evers, L. Starr, Brooks/Cole Cengage learning International Edition

Paper Code: SIUSZO32 Biochemistry and Genetics

- *To give learner insight into the structure of Organic and Inorganic molecules, and their role in sustenance of life.*
- *To give the learner a brief highlight of all the metabolic process of the body and the use of metabolic outcome ATP in the Growth and propagation of life.*
- *To understand the Non-Mendelian genetics - the chromosomes, and the role of genetics in sex determination and sex-linked inheritance, multiple alleles, linkage and, crossing over.*

Unit1: Molecules and Life

15 Lectures

1.1 Water: The basic molecule of life

1.1.1 Molecular structure of Water: Tetrahedral geometry, hydrogen bonds and flickering clusters, macromolecular association

1.1.2 Physical and chemical properties of water in relation to life processes:

1.1.3 Density, specific heat, heat of vapourisation, heat of fusion, surface tension, hydrogen bonds with solutes, interaction with non-polar compounds, water as a reactant

1.1.4 Dissociation of water and ion product of water (K_w)

1.2 Acids, bases and buffers

1.2.1 pH, pH scale – Use of pH paper, Universal indicator and pH meter,

1.2.2 Dissociation of strong electrolytes

1.2.3 Acids and bases, dissociation of weak acids and weak bases, dissociation constant pK_a , Henderson-Hasselbalch equation; Titration curves of weak acids

1.2.4 Buffers and physiological buffers in biological systems

Unit 2: Metabolism and Energy

15 Lectures

2.1 Concepts of Thermodynamics

2.1.1 An overview of Carbohydrate metabolism
Significant pathways of Carbohydrate metabolism

2.1.2 An overview of Lipid metabolism

2.1.3 An overview of Protein metabolism

- 2.1.3.1 Amino acid pool, essential and non-essential amino acids
- 2.1.3.2 Metabolism of amino acids – Transamination, deamination (Oxidative and Non-oxidative)
- 2.1.4 Ornithine cycle

Unit 3: Genetics

15 Lectures

- 3.1 Sex determination
 - 3.1.1 Methods of sex determination:
 - Chromosomal mechanisms – XX-XO, XX-XY and ZZ-ZW
 - Sex determination in honey bees: Haplodiploidy
 - Sex determination in Drosophila: Genic balance theory
 - 3.1.2 Barr body and Lyon hypothesis of X chromosome inactivation
 - 3.1.3 Environmental mechanism
 - 3.2 Inheritance related to sex
 - 3.2.1 Inheritance of X-linked genes
 - 3.2.2 Inheritance of Y-linked genes
 - 3.2.3 Inheritance of Z-linked genes
 - 3.2.4 Sex limited genes
 - 3.2.5 Sex influenced genes
 - 3.3 Multiple Alleles:
 - 3.3.1 Concept, definition, characters and symbolism
 - 3.3.2 Coat colour in rabbit, eye colour and vestigial wing alleles in Drosophila
 - 3.3.3 Inheritance of ABO blood groups and Rh factor in humans
 - 3.4 Quantitative or Polygenic inheritance:
 - 3.4.1 Concept, definition and characteristics
 - 3.4.2 Skin colour, eye colour and height in humans, Milk gene in cow, Meat gene in Poultry
 - 3.5 Linkage
 - 3.5.1 Concept
 - 3.5.2 Coupling and repulsion hypothesis
 - 3.5.3 Chromosome theory of linkage and arrangement of linked genes
 - 3.5.4 Types: Complete and incomplete
 - 3.5.5 Linkage groups
 - 3.6 Crossing over
 - 3.6.1 Concept
 - 3.6.2 Cytological evidence for crossing over
 - 3.6.3 Mechanism, Types and factors affecting crossing over
- Significance

References:

Molecules and Life / Metabolism and Energy

- Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014
- Biochemistry; Fourth Edition; U. Satyanarayana & U. Chakrapani; Elsevier; 2013
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- A Textbook of Biochemistry, 9thPP edition, Dr. Rama Rao A.V.S.S and Dr A Suryalakshmi.
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- Harper's Biochemistry, 1996, 26thPP edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA
- Outline of Biochemistry, 1976, E.E. Conn and P.K. Stumpf. John Wiley and Sons USA
- Principles of Biochemistry, 2005, 2ndPP and 3rdPP edn. Lehninger A.L. Nelson D.L. and Cox M.M
- Concepts in Biochemistry – Rodney Boyer
- Introduction to Practicals in Biochemistry – David Plummer

Genetics

- Genetics – Winchester Oxford IBH publication
- Principle of genetics - W. Sinnott, L.C. Dunn and Theodosius Dobzhansky, McGraw hill publication.
- Principles of Genetics. Gardner, E.J., Simmons, M.J and Snustad, D.P. John Wiley and Sons
- Concepts of Genetics. Klug, W.S., Cummings M.R., Spencer, C.A. Benjamin Cummings.
- Genetics- A Molecular Approach. Russell, P. J Benjamin Cummings.
- Genetics: Analysis of Genes and Genomes. Daniel L., Hartl, Elizabeth W. Jones Jones& Bartlett Publishers
- Introduction to Genetic Analysis. Griffiths, A.J.F., Wessler. S.R., Lewontin, R.C. and Carroll, S.B. W. H. Freeman and Co.
- Principles of Genetics – Eight edition- Eldon John Gardner, Michael J. Simmons, D. Peter Snustad
- Genetics- Weaver, Hedrick, third edition, McGraw 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, Leroy Hood, Michael 7. L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education
- Genetics – the continuity of life – Daniel Fairbanks and Anderson

Paper Code: SIUSZO33
Parasitology, Entomology and Economic Zoology

Learner's objective

- To acquaint learners with the concepts of parasitism, their relationship with environment, make them aware about the modes of transmission of parasites.
- To acquaint the learner with general morphological, Anatomical and behavioral properties of the insects.
- To disseminate information on economic aspects of zoology like apiculture, vermiculture, dairy science.
- To encourage young learners for self-employment.

Unit1: Introduction to Parasitology and Protozoan parasites **15 Lectures**

1.1 Types of parasites and hosts

- 1.1.1 Parasites: ectoparasites, endoparasites, monogenetic, digenetic, temporary, permanent, extracellular parasites, intracellular parasites, facultative, accidental
- 1.1.2 Hosts: definitive, intermediate, paratenic, reservoir
- 1.1.3 Host-parasite relationship: Host specificity –
 - Structural specificity
 - Physiological specificity
 - Ecological specificity
- 1.1.4 Protozoan parasites: Morphology, mode of infection, life cycle, pathogenicity, prophylaxis and treatment of–
 - *Entamoeba histolytica*
 - *Plasmodium vivax*
 - *Trypanosoma gambiense*
 - *Leishmania donovani*

Unit 2: Economic Entomology **15 Lectures**

- 2.1 Honeybee: Social life and communication, life history, apiculture, economic importance
- 2.2 Lac insect: Life cycle, lac culture, composition and uses of lac
- 2.3 Silk moth: Life history, sericulture, economic importance
- 2.4 Life history and control measures of –
 - 2.4.1 *Schistocera gregaria*
 - 2.4.2 Aphids
 - 2.4.3 *Sitophilus oryzae*
 - 2.4.4 *Tribolium confusum*
- 2.5 Methods of insect control:
 - 2.5.1 Chemical control–Synthetic and natural chemicals
 - 2.5.2 Biological control (biotic controllers of insects) –*Bacillus thuringiensis*
Entomophagus insects, Parasitic insects, insectivorous birds

Unit 3: Animal Husbandry – Vermiculture, Poultry, Goat farming **15 Lectures**

3.1 Vermiculture

- 3.1.1 An introduction to different species of earthworms used in vermiculture
- 3.1.2 Methods of vermiculture

- 3.1.3 Maintenance and harvesting
- 3.1.4 Vermicompost
- 3.1.5 Economic importance of vermiculture
- 3.2 Poultry
 - 3.2.1 Definition, nomenclature and breeds of fowl
 - 3.2.2 Housing and equipments, brooding and rearing
 - 3.2.3 Raising broilers
 - 3.2.4 Factors affecting size of eggs, abnormal eggs, hatching of eggs
 - 3.2.5 Poultry diseases – Coccidiosis, Avian flu
- 3.3 Goat farming
 - 3.3.1 Importance of goat farming
 - 3.3.2 Indigenous breeds and exotic breeds
 - 3.3.3 Nutrition, prevention and treatment of diseases
 - 3.3.4 Recent techniques to improve production

References

Introduction to Parasitology and Protozoan parasites

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- Medical Parasitology A CD and T K. Dey Allied agency, Kolkata
- Animal Parasitism Clark P R Prentice Hall of India, New Delhi
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- A textbook 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
- Medical Parasitology- Arora

Entomology

- Handbook of Economic Zoology - Jawad A and Sina SPS. Chand and Co., New Delhi
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- Bee and Bee Keeping- Roger A. Morse, Conell University Press London
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- Insects; Mani M.S.; Reprint NBT Pub., New Delhi; 2006
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- Entomology; M.S. Nalina Sundari & R. Santhi; MJP Publishers, Chennai; 2008
- Fundamentals of Entomology; Richard J. Elzinga; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978
- General & Applied Entomology; Second Edition; V.A. Little; Harper & Row Publishers, Inc; 1967

Animal Husbandry – Vermiculture, Poultry, Goat farming

- Vermiculture Technology - Clive A. Edwards, Norman Q. Arancon and Rhonda Sherman
- A Handbook on Animal Husbandry ICAR Publication
- Live Stock and Poultry Production-Harbans Singh and Earl N More Prentice Hall of India, New Delhi
- A Textbook of Animal Husbandry - GC. Banerjee Oxford and IBH Publishing Co.

Practical I (SIUSZOP31) based on SIUSZO31

- 1) Mounting of foraminiferan shells from sand
- 2) Observation of Binary fission and Conjugation in Paramecium (Permanent Slides)
- 3) Observation of V. S. of Grantia and L. S. of Leucosolenia
- 4) Observation of Polymorphism: Obelia Colony and medusa, Physalia, Vellela, Porpita
- 5) Observation of Corals: Fungia, Madrepora, Meandrina [Brain Coral], Tubipora and Sea Fan.
- 6) Observation of Liverfluke: T. S. and its Larvae
- 7) Observation of Heteronereis and Trochophore Larva
- 8) Study of Crustacean Larvae: Nauplius, Cypris, Zoea, Megalopa, Alima, Mysis and Phyllosoma
- 9) Study of Metamorphosis in insect:
 - a) Juvenile and adult of Lepisma
Life history of
 - b) House fly
 - c) Mosquito (Culex or Anopheles)
 - d) Beetle
 - e) Butterfly
- 10) Study of shells in Mollusca: Chiton, Dentalium, Trochus, Placuna, Solen, Sepia, Nautilus, Sinistral and Dextral Shells
- 11) Study of Echinoderm larvae: Bipinnaria, Ophiopleuteus, Echinopleuteus, Auricularia, Doliolaria
- 12) Embryology:
 - a) Study of different types of eggs: Isolecithal, Mesolecithal, Telolecithal
 - b) Study of blastulae: Amphioxus, Frog, Mammal
 - c) Study of Gastrulae: Frog, Primitive streak, Section of primitive streak of chick embryo
- 13) Identification of:
 - a) Allopatric speciation (Cyprinodon species)
 - b) Sympatric speciation (hawthorn fly and apple maggot fly)
 - c) Parapatric speciation (Snail)

Practical II (SIUSZOP32) based on SIUSZO32

- 1) Study of pH meter: Principle and Working.
- 2) Preparation of buffer of different pH using Henderson-Hasselbalch equation
- 3) Preparation of titration curve for strong acid and strong base with the help of pH meter
- 4) Determination of pKa for weak acid
- 5) Study of Colorimeter:
 - a) Principle and working
 - b) Selection of best filter
 - c) Determination of concentration using colorimeter
- 6) Estimation of the Blood glucose level using glucometer and using glucose estimation kit [GOD/POD method]

- 7) Mounting of Barr body
- 8) Problems in Genetics

Practical III (SIUSZOP33) based on SIUSZO33

- 1) Identification of Protozoan parasites: Entamoeba, Plasmodium, Trypanosoma, Leishmania
- 2) Economic entomology:
 - a) Study of life cycle of honey bee and bee hive
 - b) Mountings of honeybee –Mouth parts, Legs of honeybee, Sting apparatus
 - c) Life cycle of Silk Moth
 - d) Study of Harmful insect–Locust/Grasshopper, Aphids, Rice weevil, Flour beetle, Entomophagus insect –Dragonfly, Parasitic Insect – Ichneumon wasp.
- 3) Animal husbandry: Poultry – Layers (Leghorn),Broiler, Goat – Jamnapuri, Surti
- 4) Colorimetric estimation of protein in two different varieties of hen eggs (Country/Farm) – Biuret or Folin – Lowry method (Std. graph to be provided or Concentration of the Std. to be given).
- 5) Colorimetric estimation of total lipids in the yolk of two different varieties of hen eggs(Country/Farm)–FeCl₃ method.(Std. graph to be provided or Concentration of the Std. to be given)

Semester IV – Theory
Paper Code: SIUSZO41
Chordate life, Cell biology and Scientific research

Learning objectives

- *To do an introductory survey of the diversity of Chordate animal life, to understand that part of the world around us composed of animals. Also, to gain an insight on the evolutionary sequence of in vertebrate life from simpler to more complex ones, to which man himself belongs.*
- *To understand the basic functional unit of life the “cell”, its structure, types and the general processes that occur inside the cell*
- *To develop scientific temperament, qualities such as critical thinking and analysis.*
- *To develop the skills of scientific communication, understand the ethical aspects of research*

Unit1: Wonders of Animal Kingdom – Chordate life **15 Lectures**

1.1 Protochordata: Retrogressive metamorphosis in ascidians

1.2 Vertebrata

1.2.1 Pisces: Origin and evolution, Swim bladder, breeding and parental care

1.2.2 Amphibia: Origin and evolution, Neoteny and parental care in amphibians

1.2.3 Reptilia: Origin and evolution, Adaptive radiation in reptiles, Venomous and non-venomous snakes

1.2.4 Aves: Origin and evolution, Migration in birds

1.2.5 Mammalia: Origin and evolution, Egg laying mammals and marsupials, Aquatic mammals

Unit 2: Cellular Organization **15 Lectures**

2.1 Plasma membrane

2.1.1 Structure and function

2.1.2 Importance of membrane fluidity and asymmetry

2.1.3 Membrane transport, passive diffusion, facilitated transport, active transport, exocytosis and endocytosis

2.2 Cytoplasmic membrane system

2.2.1 Structure and functions of –Endoplasmic reticulum (smooth [SER] and rough [RER])

2.2.2 Structure and functions of Golgi complex

2.2.3 Structure and functions of Lysosomes (primary and secondary lysosomes)

2.3 Mitochondria

2.3.1 Structural organization

2.3.2 Chemical energy and ATP, Krebs cycle, electron transport system and oxidative phosphorylation

2.4 Nucleus

2.4.1 Structure of nucleus and nucleolus, nuclear pore and pore complex

2.4.2 Organization of chromatin and chromosomes

2.4.3 Giant chromosomes: Polytene and lamp brush chromosomes

Unit3: Basic Concepts in Research **15 Lectures**

3.1 Science: A process of inquiry – a dynamic approach to investigation

3.1.1 Making observations, Forming and Testing hypothesis, Deductive and Inductive reasoning

- 3.1.2 Any case study in scientific inquiry (for example – Investigating coat colouration in mouse populations)
- 3.1.3 Experimental variables and Controls: experimental tests, controlled experiments, identifying important variables
- 3.2 Relevance of research: basic research, applied research, translational research
- 3.3 Research methodology: Scientific approach and attitude
- 3.4 Scientific writing: Writing a research article
 - 3.4.1 Primacy of the research question, structure and components of research paper, common mistakes seen in manuscripts submitted to a journal
 - 3.4.2 Writing an abstract, selection of keywords, citing references or bibliography (Numeric, Harvard and American Psychological Association [APA] style)
- 3.5 Peer review
 - 3.5.1 Fundamental principle of high quality scientific publication
 - 3.5.2 Systematic approach for critiquing a manuscript: reviewing the manuscript, writing your critique, writing your comments
- 3.6 Research ethics
 - 3.6.1 Significance and compliance, conflict of interest, plagiarism
 - 3.6.2 Overview of ethics in animal research or preclinical trials, Institutional Animal Ethics Committee (IAEC), Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) guidelines
 - 3.6.3 Overview of ethics in clinical trials, Institutional Ethics Committee (IEC), Indian Council of Medical Research (ICMR) and International Conference on Harmonisation – Good Clinical Practice (ICH-GCP) guidelines

References:

Wonders of Animal Kingdom – Chordate life

- Vertebrate Zoology Volume I- Jordan and Verma S. Chand and Co.
- Chordate Zoology- Dhami P. S. and Dhami J. K. R. Chand and Co.
- Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition.
- Zoology- Miller S. A. and Harley J. B., Tata McGraw Hill.
- Biological Science, Taylor D.J., Stout G.W., Green N.P.O, Soper R., Cambridge University Press.

Cellular Organization

- Cell Biology Genetics, Molecular Biology Evolution and Ecology; Verma P.S. and Agrawal P.K., 9thPP edition, S. Chand Publication, New Delhi.
- Cell Biology by Singh and Tomoar Rastogi Publication.
- Cell and molecular Biology E.D.P De Robertis and E.M.R Robertis, CBS Publishers and Distributors
- The cell: A molecular Approach – Goeffrey M. Coper ASM Press Washington D.C.
- A textbook of cytology- Suruchi Tyagi Dominant Publishers and Distributors New Delhi.
- Cell Biology Pawar C.B. Himalaya publication
- Cell and Molecular Biology – DeRoberties
- Cell Biology – Gerald Karp

Basic Concepts in Research

- Research basics – Spickard James

- Research methods – McBurney, Donald
- Research design and methods – a process approach – Bordens, Kenneth
- Science Research Writing – For non-native speakers of English – Glasman, Hilary
- Research Methodology, Methods and Techniques- by C.R. Kothari, Wiley Eastern Ltd. Mumbai
- Practical research planning and design 2ndPP edition- Paul D Leedy, Macmillan Publication

Paper Code: SIUSZO42
Molecular biology, Biotechnology and Bioinformatics

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 understand the role of computer in the field of biology and explore the Available databases of the nucleotides and protein sequences.*

Unit1: Molecular Biology

15 Lectures

- 1.1 Central dogma of Molecular Biology
- 1.2 Transcription in prokaryotes: Initiation, elongation, termination of m-RNA, *E.coli* RNA polymerase
- 1.3 Differences in transcription in prokaryotes and eukaryotes
- 1.4 Posttranscriptional modifications: Capping, tailing, splicing (intron and exon)
- 1.5 Genetic code: Properties, salient features, Wobble hypothesis, Base ambiguity symbols, Single letter code
- 1.6 Structure and chemical composition of prokaryotic and eukaryotic ribosomes
- 1.7 Cloverleaf model of t-RNA, Aminoacylation of t-RNA, activation of t-RNA, recognition of t-RNA
- 1.8 Translation in prokaryotes: Chain initiation, chain elongation, chain termination
- 1.9 Differences in translation in prokaryotes and eukaryotes
- 1.10 Posttranslational modifications
- 1.11 DNA methylation

Unit 2: Biotechnology

15 Lectures

- 2.1 Tools in recombinant DNA technology
 - 2.1.1 Molecular tools: Restriction enzymes, DNA ligases
 - 2.1.2 Cells and organisms as tools for recombinant DNA technology – Brief idea, Properties and types of Vectors–plasmids (pBR322), bacteriophage & cosmid vectors.
 - 2.1.3 Gene libraries and construction of gene library: c-DNA synthesis(reverse transcription)
- 2.2 Applications of Biotechnology in:
 - 2.2.1 Agriculture –Golden rice, Herbicide resistance, Nitrogen fixation, Bt toxin
 - 2.2.2 Therapeutics/Clinical: Hepatitis B vaccine, Stem Cell therapy, Monoclonal antibodies
 - 2.2.3 Environment: Use of microbes in Bioremediation of Heavy Metals.

Unit 3: Bioinformatics

15 Lectures

3.1 Basics of computing and concept of database

3.2 Genomics: DNA sequencing by Sanger's Method

3.3 Introduction to Human Genome project

3.4 Introduction to Proteomics :

Protein sequence analysis (Homologous, Analogous, orthologous and paralogous sequences)

3.5 Biological databases:

Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ)

Protein sequence databases (UniProt, KB, PIR, PDB)

3.6 Bioinformatics web resource (NCBI, OMIM, PubMed)

3.7 Applications of Bioinformatics

Molecular Biology

- Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013
- DNA & Biotechnology; Third Edition; Molly Fitzgerald-Hayes & Frieda Reichsman; Academic Press; 2009
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- Molecular Biology of the cell (6thPP ed) by the Insertus Campbell Biology (9thPP Ed.)
- Genetics – The continuity of life; Daniel Fairbanks and Ralph Andersen; Brooks/Cole Publishing Company; 1999
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- Current Protocols in Molecular Biology; Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, Seidman J. G., John A. Smith and Kevin Struhl; John Wiley & Son, Inc.; 2003
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- Molecular Biotechnology- Principles and applications of recombinant DNA; Glick B.R. and Pasternak J. J.; ASM press, Washington; 2010
- Microbiology; Fifth Edition; Pelczar M.J. et al; Tata McGraw-Hill Co., New Delhi; 2001
- Introduction to Protein Structure; Second Edition; Branden C. and Tooze J.; Garland Publishing; 1999
- Proteins; Second Edition; Creighton T.E.; W.H. Freeman; 1993
- Proteomics - Protein Sequence to Function; Pennington, S.R and M.J. Dunn; Viva Books; 2002
- Genetic engineering – Principles and Practice; Sandhya Mitra; Macmillan India Ltd., New Delhi
- Biotechnology – Fundamentals and Applications; Third Enlarged Edition; S.S. Purohit; Student Edition, Jodhpur; 2005
- Biotechnology – Expanding Horizons; B.D. Singh; Kalyani Publishers, Ludhiana
- A textbook of Biotechnology; R.C. Dubey; S. Chand and Company Ltd., New Delhi
- Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013
- Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006
- Molecular Biotechnology – Principles & Applications of Recombinant DNA; Fourth Edition; Bernard R. Glick, Jack J. Pasternak & Cheryl L. Patten; American Society for Microbiology, Washington DC; 2010
- DNA & Biotechnology; Third Edition; Molly Fitzgerald-Hayes & Frieda Reichsman; Academic Press; 2009

Bioinformatics

- Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi & others; CBS Publishing; 2003
- Bioinformatics - A practical guide to analysis of Genes & Proteins; Andreas D Baxevanis & B. F. Francis; John Wiley; 2000
- Introduction to Bioinformatics; First Edition; T.K. Attwood, D.J. Parry-Smith; Pearson Education, Eleventh Reprint; 2005
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- Basic Bioinformatics; S. Ignacimuthu, s.j.; Narosa Publishing House; 1995
- An Introduction to Bioinformatics Algorithms; Neil C. Jones and Pavel A. Pevzner; MIT Press, First Indian Reprint; 2005
- Bioinformatics - Managing Scientific Data; Zoe Lacroix, Terence Critchlow; Morgan Kaufmann Publishers (Elsevier Science); 2003
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- Systems Metabolic Engineering; Dr. Christoph Wittmann & Sang Yup Lee; Springer; 2012
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Paper Code: SIUSZO43
Parasitology, Fisheries and Economic Zoology

Learning Objectives

- *To acquaint learners with the concepts of Helminth parasites, their relationship with environment, make them aware about the modes of transmission of parasites.*
- *To disseminate information on economic aspects of zoology like sheep farming, cattle farming and dairy science.*
- *To learn about fishes, their culturing, crafts and gear used and economical aspects of fisheries.*
- *To encourage young learners for self-employment.*

Unit1: Helminth Parasitology

15 Lectures

- 1.1 Morphology, mode of infection, lifecycle, pathogenecity, prophylaxis and treatment of:
- 1.1.1 *Taenia solium*
- 1.1.2 *Enterobius vermicularis*
- 1.1.3 *Ancylostoma duodenale*
- 1.1.4 *Wuchereria bancrofti*
- 1.1.5 *Dracunculus medinensis*

Unit2: Fishery Science

15 Lectures

- 2.1 Types of Fisheries (Marine: coastal, offshore and deep sea fisheries; Brackish water, Freshwater, Culture fisheries with emphasis on locally important species)
- 2.2 Important Capture Fisheries of India
- 2.2.1 Fin-fish: Oil sardine, Mackerel, Bombay duck, Pomfret and Shark
- 2.2.2 Crustacean fisheries: Prawns, crabs and lobsters
- 2.2.3 Molluscan fisheries: Edible and pearl oyster, process of pearl formation
- 2.2.4 Fish preservation
- 2.2.5 Principles of preservation
- 2.2.6 Methods of preservation

- 2.2.7 Fish products
- 2.2.8 Crafts and gears used on Indian coasts
- 2.2.9 Crafts: Dugout, Outrigger canoe, Catamaran, Masula, Satpati, Trawler
- 2.2.10 Gears: Gill net and driftnet, dol net, cast net, purse seine, shore seine, long line and hooks

Unit 3: Animal Husbandry – Sheep farming, Cattle farming, Dairy Science

15 Lectures

3.1 Sheep farming

- 3.1.1 Various breed of sheep: Indigenous and exotic breeds
- 3.1.2 Determining the age of sheep by their teeth
- 3.1.3 Breeding and Management of sheep
- 3.1.4 Economic importance
- 3.1.5 Cattle farming:
- 3.1.6 Classification of breeds – Milch breeds, Dual Purpose Breeds, Draught breeds
- 3.1.7 Various breeds of cow: Indigenous and exotic
- 3.1.8 Various breeds of buffalo: Indigenous and exotic
- 3.1.9 Breeding and management of buffaloes
- 3.1.10 Economic importance

3.2 Dairy Science:

- 3.2.1 Composition of Milk
- 3.2.2 Milk Products
- 3.2.3 Ethical issues in animal husbandry.

References:

Fishery Science

- Fish and Fisheries in India - Jhingran V G Hindustan Publishing Corp., New Delhi
- Marine Fisheries - D. V Bal and K V Rao; Tata Mcgraw Hill, New Delhi
- Crafts and gear of India Y Sri Krishnan & Lata Shenoy, ICAR Publication
- Fish and Fisheries – Srivastava
- Wealth of India – An Encyclopedia of India's Raw Material Resources
- Food and Agriculture Organisation, India – projects and activities
(<http://www.fao.org/countryprofiles/index/en/?iso3=IND>)
- A textbook of marine ecology – Thampy and Nair

Practical I (SIUSZOP41) based on SIUSZO41

- 1) Study of Ascidian tadpole (Retrogressive metamorphosis)
- 2) Study of swim bladder (*in situ*)
- 3) Parental Care and Breeding: Seahorse, Gouramy, Siamese fighter, Catfish, Tilapia, Caecilian, Midwife toad, Neoteny (axolotl larvae)
- 4) Adaptive radiation in reptiles: Turtle, Tortoise, Chameleon, Flying lizard (*Draco dussumieri*), Wall lizard (Gecko), Rat Snake, Sea Snake, Crocodile or Gharial
- 5) Study of venomous snakes: Krait, Cobra, Russell's viper, Sawscaled viper, Jaw of Venomous Snake

- 6) Study of Adaptive radiations in Mammals: Duckbilled Platypus, Kangaroo, Bottlenose dolphin, Blue whale, Sea Cow [Dugong], Flying Squirrels, Hoolock Gibbon
- 7) Study of Osmosis using RBCs
- 8) Study of ultra-structure of Cell Organelles using electron micrograph- Mitochondria, Endoplasmic reticulum, Golgi complex, Nucleus and Lysosomes
- 9) Study of Chromosome morphology using Onion root tip-squash preparation
- 10) Study of Polytene Chromosome: Temporary preparation of Salivary gland of Chironomous larva/ drosophila/mosquito
- 11) Bibliography
- 12) Abstract writing
- 13) Preparation of Power point presentation based on the research paper provided to you

Practical II (SIUSZOP42) based on SIUSZO42

- 1) Problems in Molecular Biology
- 2) Problems based on Biotechnology
- 3) Internet connectivity, search engines, visits to bioinformatics and related sites.

Practical III (SIUSZOP43) based on SIUSZO43

- 1) Study of Helminthes Parasites
 - a) Identification of Taenia, Enterobius, Ancylostoma, Wuchereria and Dracunculus.
 - b) Parasitic adaptation–Scolex & Mature Proglottid of Tapeworm.
- 2) Study of Morphological Characters of a fish: Pomfret, Shark, Sting Ray, Bombay duck and Mackerel
- 3) Study of Fishery–Identification of the specimen with special reference to Fishery
 - a) Fresh water fishery – Rohu, Catla, Mrigal.
 - b) Marine water fishery–Oil sardine, mackerel, Bombay duck, Pomfret and Shark
 - c) Study of Crustacean fisheries & Molluscan fisheries: Prawns/ Shrimps, Lobsters, Crabs, Edible/pearl oyster, Sepia, Loligo, Katelaysia, Mytilus
- 4) Identification and Uses of Crafts and Gear
 - a) Crafts: Dugout, Outrigger, Catamaran, Masula, Satpati, Trawler
 - b) Gears: Gill net, Dol net, Cast net, Purse seine, Shore seine, Longline
- 5) Identification of animals with reference to Animal husbandry:
 - a) Cattle – Milk breeds – Sahiwal
 - b) Dual purpose breeds – Hariyana
 - c) Draught purpose – Khillari
 - d) Sheep – Gaddi, Marvari
 - e) Buffalo – Murrah, Jaffrabadi
- 6) To detect adulterants in the Milk (starch, glucose and urea)
- 7) Extraction of Casein from Milk and its Qualitative test.
- 8) Preparation of Paneer from Milk
- 9) To measure the density of Milk by Lactometer

10) Field Visit Report: Visit to nearby Poultry farm / Goatery / Animal Husbandry farm / Apiary/ Sericulture Plant / Dairy farm / Sheep farm / Vermiculture Unit/ Fish farm / Fish Market / Fish Landing Center / Fish Processing Industry
(Visit to minimum any one of them is compulsory as a part of study tour; either short or long to be taken as a part of the workload)

**Practical Examination Question Paper Pattern
Semester III–Practical (SIUSZOP31)
Practical I based on SIUSZO31**

Time: 2 hours	Marks: 50
Q.1 Major Experiment	16
Mounting and identification of any four foraminiferan shells from the given sample	
Q.2 Identification	24
Spot A: Any one specimen /permanent slides with reference to Reproduction in Paramoecia or canal system in Porifera	
Spot B: Any one specimen /permanent slides with reference to Polymorphism in Coelenterates or any one coral	
Spot C: Any one specimen /permanent slides with reference to T. S of Liver fluke, larvae of Liver Fluke, Trocophore larva or Heteronereis	
Spot D: Any one specimen /permanent slides with reference to Crustacean larvae/Echinoderm larvae	
Spot E: Any one specimen /permanent slides with reference to Metamorphosis in insects	
Spot F: Any one specimen /permanent slides with reference to Shell in Mollusca	
Spot G: Any one specimen /permanent slides with reference to Embryology	
Spot H: Any one specimen /permanent slides with reference to Speciation	
Q.3 Viva voce based on practical I and theory paper I	05
Q.4 Journal	05

**Semester III – Practical (SIUSZOP32)
Practical II based on SIUSZO32**

Time: 2 hours	Marks: 50
Q.1 Prepare a Titration Curve using strong acid and base.	15
OR	
Determination of pKa for Weak acid	
OR	
Select the Best Filter for each of the given two Coloured solutions.	
Q.2 Estimation of the Blood glucose level using glucose estimation kit [GOD/POD method]	15
OR	
Determination of concentration of unknown solution with the help of colorimeter	
OR	
Prepare a temporary slide to show the presence of Barr bodies	
OR	
Prepare buffers as per the instructions and check the pH using pH meter and Henderson Hasselbalch equation	

Q.3 Solve problems based on Genetics	10
Q.4 Viva voce based on Practical II and Theory paper II	05
Q.5 Journal	05

**Semester III – Practical (SIUSZOP33)
Practical III based on SIUSZO33**

Time: 2 hours	Marks: 50
Q.1 Estimation of total Protein in the given sample of Egg	12
OR	
Estimate total Fats/Lipids in the given sample of Egg.	
Q.2 Mount (Mouthparts/Sting apparatus/all the three types of legs) of Honey bee	10
Q.3 Identification	18
Spot A: Any one slide wrt Protozoan parasite	
Spot B: Any one specimen or slide wrt Life cycle of Honey bee or silk worm or Bee hive	
Spot C: Any one specimen or slide of Harmful insects	
Spot D: Any one specimen or slide of harmful insects	
Spot E: Any one specimen or slide from Animal husbandry	
Spot F: Any one specimen or slide from Animal husbandry	
Q.4 Viva voce based on Practical III and Theory III	05
Q.5 Journal	05

**Practical Examination Question Paper Pattern
Semester IV–Practical
Practical I (SIUSZOP41) based on SIUSZO41**

Time: 2 hours	Marks: 50
Q.1 Demonstrate the process of osmosis in RBCs using different solutions provided to you	12
OR	
Prepare a temporary slide showing the presence of polytene chromosomes	
Q.2 Prepare a power point presentation based on the research paper provided to you and present it	05
Q.3 Write an abstract on the research paper provided to you	05
Q.4 Identification:	18
Spot A: Any one specimen/ slide with reference to Protochordates	
Spot B: Any one specimen/ slide with reference to breeding and parental care	
Spot C: Any one specimen/ slide with reference to adaptive radiations in reptiles	
Spot D: Any one specimen/ slide with reference to adaptive radiations in mammals	
Spot E: Any one specimen/ slide with reference to venomous / non-venomous snakes	
Spot F: Any one specimen/ slide with reference to Ultra structure of Cell organelles	
Q.5 Viva voce based on Practical I and Theory I	05
Q.6 Journal	05

**Semester IV–Practical
Practical II (SIUSZOP42) based on SIUSZO42**

Time: 2 hours

Marks: 50

Q.1 Problems based on molecular biology	10
Q.2 Problems based on molecular biology	10
Q.3 Identification of genes and restriction sites on plasmid map	05
Q.4 Submission of report on Bioinformatics	15
Q.5 Viva voce based on Practical II and Theory paper II	05
Q. 6 Journal	05

**Semester IV–Practical
Practical III (SIUSZOP43) based on SIUSZO43**

Time: 2 hours

Marks: 50

Q.1 Extract casein from given sample of Milk and confirm its presence by qualitative test	12
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OR

Detect the presence of adulterants (Starch/ Urea/ Glucose) in the given sample of milk

Q.2 Measure the density of milk by lactometer	05
Q.3 Identification:	18
Spot A: Anyone specimen/ Slide with reference to Helminth parasites	
Spot B: Anyone specimen/ Slide with reference to parasitic adaptation	
Spot C: Anyone specimen/ Slide with reference to Fish morphology	
Spot D: Anyone specimen/ Slide with reference to Fishery biology	
Spot E: Anyone specimen/ Slide wrt Crafts/ Gears	
Spot F: Anyone specimen/ Slide wrt Animal husbandry	
Q.4 Viva voce based on Practical III and Theory paper III	05
Q.5 Report on Filed visit and viva based on it	05
Q.6 Journal	05

S. Y. B. Sc. Zoology Syllabus (Autonomous)
Choice Based Credit System
(With effect from academic year 2019 - 20)

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/Assignment/Poster presentation/Research paper review/Abstract writing / Group discussion by the student: **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 4th 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.
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Semester End Assessment Practical

Marks: 50

Duration: 2 hours
