



**Sion (West), Mumbai – 400022
(Autonomous)**

Faculty: Science

Program: M.Sc.-I

Subject: ZOOLOGY

Academic Year: 2018 – 2019

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

M.Sc. I Zoology Syllabus (Autonomous)
Semester I and Semester II
(Credit Based Semester and Grading System, with effect from academic year 2018-19)

Preamble

“Excellence is not an act, it’s a habit.”

Academic freedom is a privilege entitled with Academic Autonomy. This paradigm shift urged us for restructuring and refining the curriculum for the postgraduate section in the subject of Zoology. A clarity of the basic concepts of science is a requisite to build a strong foundation in scientific knowledge. This syllabus will offer students to acquire an in-depth knowledge of the subject and also help them equip with the skills and attitudes necessary to enhance their competencies in this technological revolution.

Some topics included in this syllabus like Phylogeny and Systematics, Genetics and Evolution will help students recognize that there are common threads that connect all living organisms. The tools and techniques in Biology included in the syllabus will expose students to the vast arena of technological improvements applied to better understand the world around. The topics on Biochemistry and Metabolism, the intricate chemical reactions which sustain life, will help students appreciate the fact that the same principles/ laws govern the physical and the living worlds.

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 materializing this syllabus. The syllabus 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 we hope, this syllabus will inculcate an interdisciplinary approach in students and develop a mind for scientific inquiry aspiring to explore new dimensions of the subject.

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

M.Sc. Zoology Syllabus (Autonomous) – Semester I
Credit Based Semester and Grading System (With effect from academic year 2018-19)

THEORY				
Course name and code	Unit	Topic Headings	Credits	Lectures/ week
SEMESTER I				
Paper I: Non chordates, Chordates and their Phylogeny- I				
SIPSO11	1	Phylogeny, Systematics of Nonchordates and assorted topics - I	4	1
	2	Phylogeny, Systematics of Nonchordates, Hemichordata and assorted topics		1
	3	Phylogeny, Systematics of Chordates and assorted topics - I		1
	4	Comparative Vertebrate Osteology- I		1
Paper II: Biochemistry and Metabolism – I				
SIPSO12	1	Biomolecules- A structural and functional approach-I	4	1
	2	Biochemical Thermodynamics		1
	3	Metabolic Pathways and Integration of Metabolism - I		1
	4	Regulation of Metabolism		1
Paper III: Genetics, Evolution and Developmental Biology- I				
SIPSO13	1	Genetics- Chromosomal Theory of Inheritance and Mendelism- I	4	1
	2	Genetics- Extension of Mendelism and Non-Mendelian Inheritance- I		1
	3	Evolution- I		1
	4	Developmental Biology- I		1
Paper IV: Tools and Techniques in Biology - I				
SIPSO14	1	Principles and applications of Microtomy, Microscopy and Centrifugation	4	1
	2	Principles and applications of Radioisotopes and Extraction techniques		1
	3	Principles and applications of Spectroscopy		1
	4	Good laboratory practices and Research Methodology - I		1
PRACTICAL				
SIPSO11	1	Based on SIPSO11 (Non chordates, Chordates and their Phylogeny- I)	2	4
SIPSO12	2	Based on SIPSO12 (Biochemistry and Metabolism – I)	2	4
SIPSO13	3	Based on SIPSO13 (Genetics, Evolution and Developmental Biology- I)	2	4
SIPSO14	4	Based on SIPSO14 (Tools and Techniques in Biology - I)	2	4
Total			24	32

M.Sc. Zoology Syllabus (Autonomous) – Semester II
Credit Based Semester and Grading System (With effect from academic year 2018-19)

THEORY				
Course name and code	Unit	Topic Headings	Credits	Lectures/ week
SEMESTER I				
Paper I: Non chordates, Chordates and their Phylogeny- II				
SIPSO21	1	Phylogeny, Systematics of Nonchordates and assorted topics - II	4	1
	2	Phylogeny of Protochordates, Agnatha and assorted topics		1
	3	Phylogeny, Systematics of Chordates and assorted topics - II		1
	4	Comparative Vertebrate Osteology- II		1
Paper II: Biochemistry and Metabolism – I				
SIPSO22	1	Biomolecules- A structural and functional approach-II	4	1
	2	Enzymes and Enzyme kinetics		1
	3	Metabolic Pathways and Integration of Metabolism - II		1
	4	Inborn Errors of Metabolism		1
Paper III: Genetics, Evolution and Developmental Biology- II				
SIPSO23	1	Genetics- Chromosomal Theory of Inheritance and Mendelism- II	4	1
	2	Genetics- Extension of Mendelism and Non-Mendelian Inheritance- II		1
	3	Evolution- II		1
	4	Developmental Biology- II		1
Paper IV: Tools and Techniques in Biology - II				
SIPSO24	1	Principles and applications of Chromatography - I	4	1
	2	Principles and applications of 1 Chromatography - II (Gel Chromatography and Affinity Chromatography)		1
	3	Principles and applications of Chromatography (GC, HPTLC) and Electrophoresis		1
	4	Good laboratory practices and Research Methodology - II		1
PRACTICAL				
SIPSO21	1	Based on SIPSO21 (Non chordates, Chordates and their Phylogeny- I)	2	4
SIPSO22	2	Based on SIPSO22 (Biochemistry and Metabolism – I)	2	4
SIPSO23	3	Based on SIPSO23 (Genetics, Evolution and Developmental Biology- I)	2	4
SIPSO24	4	Based on SIPSO24 (Tools and Techniques in Biology - I)	2	4
		Total	24	32

Programme: Master of Science, M.Sc. Part 1 – Zoology

“The world can only be grasped by action, not by contemplation.”- Jacob Bronowski

The characteristic graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science Post 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 analyzing data. • Understand the scope and limitations of tools or software 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 takings tasks to their logical conclusion. • Inculcate the ability to facilitate coordinated effort as a group or team in the interests of common cause and recognize the contribution of team members.
PO6 (AttitudeLevel)	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 ones actions. • Acquire the ability to explore and evolve by becoming self-sufficient and self-reliant.

	<ul style="list-style-type: none"> Adapt lifelong learning approaches to broaden one's horizons for personal growth and development.
PO7 (AttitudeLevel)	<p>Ethical Values and Environmental Concerns (<i>U, Ap, E</i>)</p> <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 (AttitudeLevel)	<p>Gender Sensitization and Community Service (<i>U, Ap, An</i>)</p> <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	<p>Conceptual Understanding and Emerging Applications (<i>R, U, Ap, An</i>)</p> <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 analyze the scope of emerging applications of biological sciences in medicine, genetics, wild life, 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	<p>Analytical reasoning and Scientific Inquiry (<i>U, An, E</i>)</p> <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 analyze, 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. Analyze 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	<p>Laboratory Skills and Fieldwork (<i>R, U, E, C</i>)</p> <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. • 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. Realize 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 realize 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 behavior such as fabricating, falsifying or misrepresenting data or to committing plagiarism. • Inculcate the ability to recognize 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 M.Sc. Part 1

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: SIPSZO11

Course Name: Non chordates, Chordates and their Phylogeny- I

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Phylogeny, Systematics of Nonchordates and assorted topics - I	CO1: <ul style="list-style-type: none">• Appreciate the diversity of non-chordates living in varied habitats and having varied habits.• Learn about the importance of systematics, taxonomy, and structural organization of animals.• Attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones by a study of the levels of organization in animal kingdom. Also, to know the different modifications the animal life has made for its survival, through phylogenetic and taxonomic studies.• Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.• Critically analyze the organization, complexity and characteristic features of non-chordates and familiarize with the morphology and anatomy of representatives of various animal phyla.	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 2: Phylogeny, Systematics of Nonchordates, Hemichordata and assorted topics	CO2: <ul style="list-style-type: none">• Appreciate the diversity of non-chordates and Hemichordates living in varied habit and habitats.• Understand evolutionary history and relationships of different non-chordates and Hemichordates through functional and structural affinities.	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

	<ul style="list-style-type: none"> Critically analyze the organization, complexity and characteristic features of Non-chordates, Hemichordates and familiarize with the morphology and anatomy of representatives of various animal phyla. 		
Unit 3: Phylogeny, Systematics of Chordates and assorted topics- I	CO3: <ul style="list-style-type: none"> Expand the knowledge of diversity of life forms by an account of more complex life forms. Connecting the dots of extinct life with the extant one by understanding the evolutionary history and relationships of different Chordates through functional and structural affinities. Critically analyze the organization, complexity and characteristic features of chordates and familiarize with the morphology and anatomy of representatives of various animal phyla. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 4: Comparative Vertebrate Osteology- I	CO4: <ul style="list-style-type: none"> Comparative vertebrate anatomy- a branch of biology that has a paramount significance in the field of evolutionary biology. Comprehend the embryonic development of skull, jaws, and vertebrae in vertebrates. Compare and contrast between different types of vertebrae in tetrapods. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

Course Code: SIPSZO12

Course Name: Biochemistry and Metabolism – I

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Biomolecules - A structural and functional approach-I	CO1: <ul style="list-style-type: none"> Understand the basic concepts of Biochemistry for advancing in varied fields of biological sciences having social relevance. Understand the Biochemistry by a discussion about Biomolecules (here, focusing on Carbohydrates, Proteins, Lipids, Nucleic acids, and some complex biomolecules), their structure, function, classification, reactions and uses. 	<i>R, U</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 2: Biochemical Thermodynamics	CO2: <ul style="list-style-type: none"> To know about the energy transductions that occurs in or between organisms through thermodynamic study. To get acquainted to the laws of thermodynamics. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

	<ul style="list-style-type: none"> To understand the role of high energy compounds in living organisms. Understand the roles of ATP and reduced co-factors in shuttling energy and electrons within the cells. Comprehend the mechanism of biological oxidation and its significance. 		
Unit 3: Metabolic Pathways and Integration of metabolism - I	CO3: <ul style="list-style-type: none"> Thoroughly learn about the regulation of carbohydrates and lipid metabolism. Understand the properties of enzymes and importance of catalysis with respect to energy production. Understand the concepts of bioenergetics including determining and evaluating the free energy and redox potential in relation to metabolism. Understand the functioning of enzymes and cofactors in bioenergetics reactions. Describe the central role of ATP. Understand the switches in metabolic pathways during fasting and fed state. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 4: Regulation of Metabolism	CO4: <ul style="list-style-type: none"> Understand the roles of hormones in regulating metabolism. Get acquainted to various enzymes incorporated in regulation of metabolic pathways. Comprehend the regulation of metabolism by extracellular signals such as nutrient supply, nutrient transport, endocrine control and neural control. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

Course Code: SIPSZO13

Course Name: Genetics, Evolution and Developmental Biology - I

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Genetics - Chromosomal theory of Inheritance and Mendelism - I	CO1: <ul style="list-style-type: none"> To uncover the rules governing the transmission of genetic traits and the relation between genes and chromosomes, through the study of classical genetics and its extension. To inculcate the understanding of organization of genetic material, structure of chromosomes, chromosome number, shape, and types. Acknowledge the lasting contribution of Gregor Mendel and his methodology 	<i>R, U, An, Ap</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

	<p>demonstrating his scientific and perseverant traits.</p> <ul style="list-style-type: none"> • Build a conceptual framework of the science of inheritance – genetics, through discussion on Mendelian inheritance. 		
Unit 2: Genetics - Extension of Mendelian Genetics and Non-Mendelian Inheritance - I	<p>CO2:</p> <ul style="list-style-type: none"> • Broaden the conceptual framework of the science of inheritance – genetics, through discussion on Extension of Mendelian genetics and Non-Mendelian inheritance. 	<i>R, U, An, Ap</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 3: Evolution - I	<p>CO3:</p> <ul style="list-style-type: none"> • Introduction to evolution for understanding of events and processes that have shaped, reshaped the living world on planet earth. • Know about the remarkable contribution of evolutionary biologists and their theories of evolution. • Understand the role of genetics in evolution by studying population genetics. 	<i>R, U, An, Ap</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 4: Developmental Biology - I	<p>CO4:</p> <ul style="list-style-type: none"> • To appreciate how a single cell becomes an organized group, which is then programmed at specific times to become specialized for certain tasks, ultimately to form an entire organism. • Understand the basic concepts in developmental biology. • Learn the detailed account on cell differentiation and totipotency. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

Course Code: SIPSZO14

Course Name: Tools and Techniques in Biology - I

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Microtomy, Microscopy and Centrifugation	<p>CO1:</p> <ul style="list-style-type: none"> • To learn about the principles of microtomy which bridge the process between specimen collection and microscopic analysis. • To get habituated to the standard operating procedure and calibration, use, care/maintenance of microtome- one of the most essential skills in histological studies. • Get acquainted to the principle, working and applications of centrifugation techniques. • Learn about the standard operating procedure 	<i>R, U, Ap, An</i>	<i>PO1,</i> <i>PO2, PO4</i> <i>PSO1, PSO2,</i> <i>PSO3</i>

	<p>and calibration, use, care/maintenance of centrifuge- a skill-based approach.</p> <ul style="list-style-type: none"> • Get acquainted to the principle, working and applications of various microscopy techniques so as to develop a focused approach and get a magnified view of diverse prospects in biology. • Learn about the standard operating procedure and calibration, use, care/maintenance of microscopes- a skill-based approach. 		
Unit 2: Radioisotopes and Extraction techniques	<p>CO2:</p> <ul style="list-style-type: none"> • Get acquainted to the principle and applications of radioisotopes which have revolutionized the world of medicine, agriculture, and many other branches of biology. • Comprehend the principle and applications of Filtration, Distillation and Extraction-sought after techniques for commercial purposes. 	<i>R, U, Ap, An</i>	<p><i>PO1, PO2, PO4</i></p> <p><i>PSO1, PSO2, PSO3</i></p>
Unit 3: Principles and applications of Spectroscopy	<p>CO3:</p> <ul style="list-style-type: none"> • Get acquainted to the principle, working and applications of various spectroscopy techniques which represent a scientific measurement of matter through its interaction with different components of the electromagnetic spectrum. • Learn about the standard operating procedure and calibration, use, care/maintenance of spectrophotometer- a skill-based approach. 	<i>R, U, Ap, An</i>	<p><i>PO1, PO2, PO4</i></p> <p><i>PSO1, PSO2, PSO3</i></p>
Unit 4: Good Laboratory Practices and Research Methodology - I	<p>CO4:</p> <ul style="list-style-type: none"> • Analyze the importance of laboratory safety practices and safety symbols, for awareness regarding conduct as a science student. • Inculcate in students research aptitude and to develop an open, inquiring mind that is willing to explore new territories and learn new things. • Encourage the spirit of curiosity of students, in order to develop the potential to be problem solvers and scientific investigators in their own way. • Develop and enhance the research skills in order to make students adapt to the research culture. • Develop an ability to distinguish between a purpose statement, a research question or hypothesis, and a research objective. • Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and 	<i>R, U, Ap, An</i>	<p><i>PO1, PO2, PO3, PO4, PO5, PO7</i></p> <p><i>PSO1, PSO2, PSO3, PSO4</i></p>

	implementing a research project. <ul style="list-style-type: none"> • Develop a skill of reviewing the literature which facilitates the deeper understanding of chosen topic, identifying experts and current research within that area, and answering key questions about current trends. 		
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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 analyze and reason for the sake of awareness, hence to reach a valid answer.

Semester I – Practical

Course Code: SIPSZOP11

Course Name: Practical I based on SIPSZO11

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/PSO
SIPSZOP11	<ul style="list-style-type: none"> • Identify and describe various specimens, permanent microscope slides with respect to specific characteristic features in invertebrate animal kingdom. • Study the systematics and features of major and minor non-chordate phyla. • Study the systematics and features of protochordates and some chordates. • Understand the significance of accessory respiratory organs in some fish species and analyze its connection with evolution. • Temporary mounting of spicules in holothurians (Sea Cucumber) in order to study its structure and understand its significant role in morphology and taxonomy of holothurians. • Study the comparative account of structure of different types of vertebrae and understand their role in the process of evolution. 	<i>R, U, An, C</i>	<i>PO1, PO2, PO8</i> <i>PSO1, PSO2, PSO3</i>

Course Code: SIPSZOP12

Course Name: Practical II based on SIPSZO1

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
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SIPSZOP12	<ul style="list-style-type: none"> • Detection and identification of carbohydrates in the given test sample based on changes in color due to chemical reactions, which further have many commercial applications in the fields of food science, biochemistry, medicine etc. • Understand the glycogen metabolism, its clinical significance by estimating it in a given tissue sample. • Learn about the breakdown of glycogen which is an energy yielding process by subjecting it to the hydrolysis using acids and enzymes. • Understand the process of isolation of starch from potato in a laboratory. • Determine the acid value, saponification value and RM number of fat/oil sample which have their commercial applications in evaluating the quality of raw materials and their degradation during storage of fats/oils, checking for the adulteration, determining the purity of fat/oil sample respectively. 	<i>R, U, An, E</i>	<i>PO1, PO2, PO6</i> <i>PSO2, PSO3</i>
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Course Code: SIPSZOP13

Course Name: Practical III based on SIPSZO13

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOP13	<ul style="list-style-type: none"> • Understand chromosomes by performing and observing (under light microscope) squash preparation of onion root tip to study stages of mitosis and temporary squash preparation of testis cockroach/ grasshopper/ <i>Tradescantia</i> pollen to study stages of meiosis. Also demonstrate the inter-chromosomal connections in the cells of <i>Tradescantia</i> buds. • Temporary preparation of polytene chromosomes from <i>Drosophila</i> or Chironomus larva, to provide an important model system for studying the architectural changes in chromatin morphology associated with the process of transcription initiation and elongation. • Study of chromosome structures in human karyotype and different types of chromosome banding techniques used in clinical and research purposes. • Detect the presence of Barr body in the buccal smear and understand its genetic and clinical significance. 	<i>R, U, An, Ap, E</i>	<i>PO2, PO5, PO6</i> <i>PSO1, PSO2, PSO3</i>

Course Code: SIPSZOP14

Course Name: Practical IV based on SIPSZO14

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOP14	<ul style="list-style-type: none"> Analyze the importance of laboratory safety practices and safety symbols, for awareness regarding conduct as a science student. Explain the principle and 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. Explain the principle and 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. Explain the principle and working of a microtome- an instrument used in various histo-pathological studies. Learn and demonstrate the techniques of tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning using a microtome, staining and analyzing the sections. 	<i>R, U, An, Ap, E</i>	<i>PO2, PO5, PO6</i> <i>PSO1, PSO2, PSO3</i>

Semester II – Theory

Course Code: SIPSZO21

Course Name: Nonchordates, Chordates and their Phylogeny - II

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Phylogeny, Systematics of Nonchordates and assorted topic - II	CO1: <ul style="list-style-type: none"> Appreciate the diversity of non-chordates living in varied habitats and having varied habits. Learn about the importance of systematics, taxonomy, and structural organization of animals. Attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones by a study of the levels of organization in animal kingdom. Also, to know the different modifications the animal life has made for its survival, through phylogenetic and taxonomic studies. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

	<ul style="list-style-type: none"> • Understand evolutionary history and relationships of different non-chordates through functional and structural affinities. • Critically analyze the organization, complexity and characteristic features of non-chordates and familiarize with the morphology and anatomy of representatives of various animal phyla. 		
Unit 2: Phylogeny of Protochordates, Agnatha and assorted topics - II	CO1: <ul style="list-style-type: none"> • Expand the knowledge of diversity of life forms by an account of more complex life forms. • Connecting the dots of extinct life with the extant one by understanding the evolutionary history and relationships of different Chordates through functional and structural affinities. • Critically analyze the organization, complexity and characteristic features of chordates and familiarize with the morphology and anatomy of representatives of various animal phyla. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 3: Phylogeny, Systematics of Chordates, and assorted topics - II	CO1: <ul style="list-style-type: none"> • Expand the knowledge of diversity of life forms by an account of more complex life forms. • Connecting the dots of extinct life with the extant one by understanding the evolutionary history and relationships of different Chordates through functional and structural affinities. • Critically analyze the organization, complexity and characteristic features of chordates and familiarize with the morphology and anatomy of representatives of various animal phyla. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 4: Comparative Vertebrate Osteology - II	CO4: <ul style="list-style-type: none"> • Comparative vertebrate anatomy- a branch of biology that has a paramount significance in the field of evolutionary biology. • Compare and contrast between limbs of tetrapods. • Understand the mechanism of support and movements. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

Course Code: SIPSZO22

Course Name: Biochemistry and Metabolism - II

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Biomolecules - A structural and functional approach - II	CO1: <ul style="list-style-type: none"> Understand the basic concepts of Biochemistry for advancing in varied fields of biological sciences having social relevance. Understand the Biochemistry by a discussion about Biomolecules (here, focusing on Proteins), their structure, function, classification, reactions. 	<i>R, U</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 2: Enzymes and Enzyme kinetics	CO2: <ul style="list-style-type: none"> Understand the dynamics of enzyme functioning and their kinetics, their classification, and types. They will also be introduced to the concept of enzyme inhibition and how enzymes can be halted for therapeutic purposes. Understand the quantitative terms, chemical changes catalyzed by the component enzymes of the route. 	<i>R, U, An</i>	<i>PO1, PO2,</i> <i>PSO1, PSO2</i>
Unit 3: Metabolic Pathways and Integration of metabolism - II	CO3: <ul style="list-style-type: none"> Thoroughly learn about the metabolism of Proteins including the metabolism of amino acids and ammonia. Thoroughly learn about the mechanism of Nucleic acids. Understand the integration of major metabolic pathways of energy metabolism. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 4: Regulation of Metabolism and Inborn Errors of Metabolism	CO4: <ul style="list-style-type: none"> Comprehend the knowledge of metabolism in health and disease. Familiarize with various inborn errors in the metabolism of carbohydrates, proteins, lipids and minerals. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

Course Code: SIPSZO23

Course Name: Genetics, Evolution and Developmental Biology - II

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Genetics - Chromosomal theory of Inheritance and Mendelism - II	CO1: <ul style="list-style-type: none"> To uncover the rules governing the transmission of genetic traits and the relation between genes and chromosomes, through the study of classical genetics and its extension. Understand the significance of probability and statistics in genetics by knowing some basic tools. 	<i>R, U, An, Ap</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

	<ul style="list-style-type: none"> Get acquainted to the modern concept of gene. 		
Unit 2: Genetics - Extension of Mendelian Genetics and Non-Mendelian Inheritance - II	CO2: <ul style="list-style-type: none"> Broaden the conceptual framework of the science of inheritance – genetics, through discussion on Extension of Mendelian genetics and Non-Mendelian inheritance. Build a conceptual framework of the science of inheritance – genetics, through discussion on Mendelian inheritance, cytoplasmic inheritance and touching on human genetics. 	<i>R, U, An, Ap</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 3: Evolution - II	CO3: <ul style="list-style-type: none"> Introduction to evolution for understanding of events and processes that have shaped, reshaped the living world on planet earth. Understand the processes that change allelic frequency and thereby responsible for evolution. Get acquainted to the role of environmental variation in evolution. Learn about various phenomena such as heterosis, inbreeding depression, heritability etc. that influence the process of evolution. 	<i>R, U, An, Ap</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 4: Developmental Biology - II	CO4: <ul style="list-style-type: none"> To appreciate how a single cell becomes an organized group, which is then programmed at specific times to become specialized for certain tasks, ultimately to form an entire organism. Understand the mechanism of cell specialization with reference to RBCs, secretory cell, retinal rod cell. Learn about the organizer and its role in embryonic development with reference to amphibians. Comprehend the mechanism behind metamorphosis, regeneration and aging and programmed cell death. 	<i>R, U, An</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

Course Code: SIPSZO24

Course Name: Tools and Techniques in Biology - II

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
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<p>Unit 1: Principles and applications of Chromatography - I</p>	<p>CO1:</p> <ul style="list-style-type: none"> • Understand the analytical techniques for separating chemical components in biological samples. • Gain knowledge about the principles and applications of chromatography. • Get familiar to the principle, working and applications of Planar Chromatography. • Understand the principle, working and applications of Column Chromatography. • Understand the principle, working and applications of Ion Exchange Chromatography. 	<p><i>R, U, Ap, An</i></p>	<p><i>PO1, PO2</i></p> <p><i>PSO1, PSO2, PSO3</i></p>
<p>Unit 2: Principles and applications of Chromatography - II</p>	<p>CO2:</p> <ul style="list-style-type: none"> • Understand the analytical techniques for separating chemical components in biological samples. • Gain knowledge about the principles and applications of chromatography • Get familiar to the principle, working and applications of Gel Chromatography. • Comprehend the different types of Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedure of affinity chromatography. 	<p><i>R, U, Ap, An</i></p>	<p><i>PO1, PO2</i></p> <p><i>PSO1, PSO2, PSO3</i></p>
<p>Unit 3: Principles and applications of Chromatography and Electrophoresis</p>	<p>CO3:</p> <ul style="list-style-type: none"> • Get acquainted to the instrumentation, selection of operating conditions, analysis of data and applications of advanced techniques of chromatography like Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC). • Understand the electrophoretic techniques used for separating macromolecules in biological samples and their applications. • Since all solutes are not colored knowledge of visualizing agent will help the students locate the isolated solutes in electrophorogram. 	<p><i>R, U, Ap, An</i></p>	<p><i>PO1, PO2</i></p> <p><i>PSO1, PSO2, PSO3</i></p>
<p>Unit 4: Good Laboratory Practices and Research Methodology - II</p>	<p>CO4:</p> <ul style="list-style-type: none"> • Get an insight into overview of Globally Harmonized System (GHS) Physical Hazards and GHS Health and Environmental Hazards. • Preparation of standard operating procedure and calibration, use, care/maintenance of advanced laboratory instruments such as HPTLC, HPLC, GC. • Acquire an overview of Good Manufacturing Practices (GMP) / Good Clinical Practices (GCP) guidelines. • Identify and discuss the complex issues 	<p><i>R, U, Ap, An</i></p>	<p><i>PO1, PO2, PO3, PO4, PO5, PO7</i></p> <p><i>PSO1, PSO2, PSO3, PSO4</i></p>

	<p>inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.</p> <ul style="list-style-type: none"> • Develop a skill of reviewing the literature which facilitates the deeper understanding of chosen topic, identifying experts and current research within that area, and answering key questions about current trends. • Get acquainted to ethics in research, ethical standards, policies, issues, improve ethical judgment and decision making. • Gain knowledge about different funding agencies and how to apply for grants and securing research funding of conducting research. 		
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Semester II – Practical

Course Code: SIPSZOP21

Course Name: Practical I based on SIPSZO21

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/PSO
SIPSZOP21	<ul style="list-style-type: none"> • Identify and describe various specimens, permanent microscope slides with respect to specific characteristic features in invertebrate animal kingdom. • Study the systematics and features of major and minor non-chordate phyla. • Study the systematics and features of some chordates. • Study the comparative account of tetrapod limbs, pectoral and pelvic girdles of vertebrates and understand their role in the process of evolution. 	<i>R, U, An, C</i>	<i>PO1, PO2, PO8</i> <i>PSO1, PSO2, PSO3</i>

Course Code: SIPSZOP22

Course Name: Practical II based on SIPSZO2

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
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SIPSZOP22	<ul style="list-style-type: none"> • Determination of total cholesterol and HDL cholesterol from serum in order to understand the clinical significance. • Detection and identification of amino acids and proteins in the given test sample based on changes in color due to chemical reactions, which further have many commercial applications in the fields of food science, biochemistry, medicine etc. • Determine the creatinine in serum and urea in order to deduce the functioning of kidneys. • Get acquainted to the significance of SDH in respiration by determining its specific activity based on changes in colour due to chemical reactions. • Comprehend the role of casein in milk and demonstrate its isolation from the given milk sample. 	<i>R, U, An, E</i>	<i>PO1, PO2, PO6</i> <i>PSO2, PSO3</i>
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Course Code: SIPSZOP23

Course Name: Practical III based on SIPSZO23

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOP23	<ul style="list-style-type: none"> • Learn to solve given problems in genetics. • Understand pedigree analysis which is in turn used to analyze the pattern of inheritance of a particular trait throughout a family. Pedigrees show the presence or absence of a trait as it relates to the relationship among parents, offspring, and siblings. • Quantitative estimation of DNA and RNA from a suitable tissue by Diphenylamine and Orcinol method respectively which provide an estimate of purity of nucleic acids with respect to contaminants. • Demonstration of isolation of limb bud and its chorio-allantoic grafting to explore the ability of the chick <i>chorio-allantoic membrane to support an excised limb bud from a donor embryo.</i> • Understand and observe the morphogenetic movements in chick embryo. 	<i>R, U, An, E</i>	<i>PO1, PO2, PO6</i> <i>PSO2, PSO3</i>

Course Code: SIPSZOP24

Course Name: Practical IV based on SIPSZO24

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSOP24	<ul style="list-style-type: none"> • Separation of pigments from leaves or flowers by adsorption column chromatography. • Separation of amino acids by ion exchange chromatography using cation exchanger. • Separation and identification of amino acids by two-dimensional paper chromatography. • Demonstrate the SDS-polyacrylamide gel electrophoresis in order to obtain high resolution separation of complex mixtures of proteins. 	<i>R, U, An, E</i>	<i>PO1, PO2, PO6</i> <i>PSO2, PSO3</i>

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

Semester I – Theory

**Paper Code: SIPSZO11
Nonchordates, Chordates and their Phylogeny – I**

Learning Objectives:

- *To attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones by a study of the levels of organization in animal kingdom. Also, to know the different modifications the animal life has made for its survival, through phylogenic and taxonomic studies.*
- *To study comparative vertebrate osteology to know about the skeletal framework found in the vertebrates; a study which can be helpful in forensic context to differentiate human bones from other vertebrates and also in archaeology.*

Unit 1: Phylogeny, Systematics of Nonchordates and assorted topics - I **15 Lectures**

1.1: Principles of Systematics, importance of taxonomic studies in Biology, use of morphometric studies, osteological studies, use of homologous organs

1.2: Taxonomic keys: Different kinds of taxonomic keys, their merits and demerits

1.3: Phylogeny, salient features, classification up to classes (wherever applicable) of the following phyla:

*1.3.1: Protista (Protozoa)

*1.3.2: Porifera

1.3.3: Coelenterata

1.3.4: Ctenophora

Unit 2: Phylogeny, Systematics of Nonchordates, Hemichordata and assorted topics **15 Lectures**

2.1: Phylogeny, salient features, classification (wherever applicable) up to classes of the following phyla:

2.1.1 : Mollusca

2.1.2 : Bryozoa

2.1.3 : Brachiopoda

2.1.4 : Echinodermata

2.1.5 : Chaetognatha

2.2: Systematic position and affinities of Hemichordata

2.3: Assorted Topics

*2.3.1: Economic importance of Protozoa

*2.3.2: Mesenteries in Coelenterata

*2.3.3 Economic importance of Arthropoda

2.3.4: Sense organs in Arthropoda

2.3.5: Spines and pedicellariae in Echinodermata

*2.3.6: Invertebrate larvae: larval forms of free-living invertebrates, larval forms of parasites;
Strategies and evolutionary significance of larval forms

Unit 3: Phylogeny, Systematics of Chordates and assorted topics - I

15 Lectures

- 3.1: Discovery of Coelacanth
- 3.2: Overview of fish phylogeny
- 3.3: Primitive tetrapods: Labyrinthodonts
- 3.4: Crossopterigians: A blue print
- 3.5: Dipnoi: A group that has failed to evolve as Amphibia
- 3.6: Lissamphibia
- *3.7: Sphenodon: a living fossil
- *3.8: Extinct reptiles
- *3.9: Adaptive radiation in Reptilia

Unit 4: Comparative Vertebrate Osteology - I

15 Lectures

- 4.1: Embryonic development of:
Neurocranium, Splanchnocranium and Dermatocranium
- *4.2: Comparative account of jaw suspension
- *4.3: Embryonic development of vertebra
- 4.4: Vertebral column of tetrapods: Atlas, Axis, Typical Vertebra, Thoracic vertebra, Trunk vertebra, Caudal vertebra of Dog fish and Bony fish, Frog, Varanus, Pigeon and Rabbit

*** Topics for Seminars**

Students' activity:

Field visits/Field trips/Excursions/Study tours/field projects to the relevant locations such as Zoological/National parks, Sanctuaries, museums, shores in order to observe organisms in their natural habitat as well as to combine theoretical/experiential learnings with actual observations in the field.

Semester I – Theory
Paper code: SIPSZO12
Biochemistry and Metabolism- I

Learning Objectives:

- *To go into the details of biomolecules which form the chemical basis of life.*
- *To know about the energy transductions those occur in or between organisms through thermodynamic study.*
- *To study in detail the chemical processes that occur in living organisms that maintain life and the modes to regulate them.*

Unit 1: Biomolecules - A structural and functional approach - I

15 Lectures

1.1: Concepts

- *1.1.1: Biological macromolecules
- *1.1.2: Polymerization and macromolecules
- *1.1.3: Central role of Carbon
- *1.1.4: Common functional groups
- *1.1.5: Common ring structure and isomerization in biological molecules

1.2: Carbohydrates

- 1.2.1: Classification: Monosaccharides, oligosaccharides and polysaccharides
- 1.2.2: Monosaccharides: Structure, classification, D- and L-isomers, anomers and mutarotation, open chain and ring forms, pyranose and furanose forms, reactions of monosaccharides, glycosidic bond and nomenclature
- 1.2.3: Oligosaccharides
- 1.2.4: Polysaccharides: Homopolysaccharides and heteropolysaccharides
- 1.2.5: Biological functions of carbohydrates

1.3: Lipids

- 1.3.1: Classification: Simple and complex lipids
- *1.3.2: Fatty acids: Even and odd carbon fatty acids, numbering the carbon atoms, saturated and unsaturated fatty acids, cis- and trans-configuration, nomenclature and short hand representation of fatty acids
- 1.3.3: Acylglycerols: Monoglycerides, diglycerides and triglycerides; stereospecific numbering of glycerols in glycerides; properties of triacylglycerols
- 1.3.4: Complex lipids: Phospholipids, sphingolipids, sterols and waxes, amphipathic lipids – Membrane lipid bilayers
- 1.3.5: Biological functions of lipids

1.4: Nucleic acids (RNA and DNA)

- 1.4.1: Components: Pentose, nitrogenous bases, nucleosides, tautomeric forms of purines and pyrimidines
- 1.4.2: Structure of DNA: *Watson and Crick model; different forms of DNA double helix
- *1.4.3: Structure, types and functions of RNA

1.5: Complex biomolecules

- *1.5.1: Glycoproteins: Blood group substances

1.5.2. Glycolipids: Gangliosides

1.5.3. Lipoproteins: Classification and functions – Chylomicrons, VLDL, LDL, HDL and free fatty acid-albumin complex

Unit 2: Biochemical Thermodynamics

15 Lectures

2.1: Laws of thermodynamics, free energy, entropy, enthalpy, exergonic and endergonic reactions

***2.2:** High energy compounds: ATP, ADP, ATP-ADP cycle, ATP-AMP ratio

2.3: Biological oxidation: Electron transport chain and mitochondria; Oxidative phosphorylation – mechanism, uncoupling of oxidative phosphorylation and its significance

2.4: Free radicals, antioxidants and antioxidant system

Unit 3: Metabolic Pathways and Integration of metabolism - I

15 Lectures

3.1: Metabolism

Concept, definitions, catabolism, anabolism

3.2: Carbohydrate metabolism

*3.2.1: Glycolysis: Reaction sequence, flow of carbon, conversion of pyruvate to lactate and Acetyl coenzyme-A; significance of pyruvate-lactate interconversion; aerobic and anaerobic glycolysis; energetics of glycolysis; regulation of glycolysis

3.2.2: Gluconeogenesis: Reaction sequence from pyruvate, gluconeogenesis from amino acids, glycerol, propionate, lactate; regulation of gluconeogenesis

*3.2.3: Glycogen metabolism: Glycogenesis, Glycogenolysis; regulation of the two pathways

3.2.4: Significance of the following pathways: Hexose monophosphate shunt as a multifunctional pathway; * Uronic Acid Pathway; Glyoxalate cycle

3.3: Lipid Metabolism

3.3.1: Dynamics of body lipids, mobilization of fats, regulation of hormone sensitive TG-lipase, fate of glycerol and free fatty acids

3.3.2: Fatty acid metabolism: Oxidation of even-carbon and odd-carbon atom fatty acids, oxidation of unsaturated fatty acids, biosynthesis of fatty acids including desaturation; metabolism of phospholipids, cholesterol and *alcohol

Unit 4: Regulation of Metabolism

15 Lectures

***4.1:** Concept of homeostasis

4.2: Regulation of metabolic flux by genetic mechanisms: Control of enzyme synthesis, constitutive and inducible enzymes; *induction and repression of enzymes (lac operon and trp operon); regulatory proteins – Helix turn Helix, Zinc Fingers, Leucine Zippers

4.3: Regulation of metabolism by extracellular signals: nutrient supply, nutrient transport, endocrine control and neural control

*** Topics for Seminars**

Semester I – Theory

Paper Code: SIPSZO13 Genetics, Evolution and Developmental Biology - I

Learning Objectives

- *To uncover the rules governing the transmission of genetic traits and the relation between genes and chromosomes, through the study of classical genetics and its extension.*
- *To understand the evolutionary processes that have helped shape life on earth through a study of organic evolution; also to understand the evolutionary path our ancestors walked to attain to this present day Homo sapiens species.*
- *To study Developmental Biology to appreciate how embryonic cells interact ultimately to form the entire organism.*

Unit 1: Genetics - Chromosome theory of Inheritance and Mendelism - I **15 Lectures**

1.1: Mitosis and Meiosis

- 1.1.1: Mitosis: *Interphase and cell cycle, genetic control of cell cycle, *stages of mitosis
- 1.1.2: Meiosis: An overview of meiosis, first meiotic division, second meiotic division, comparison of spermatogenesis and oogenesis in animal cells
- *1.1.3: Non-disjunction and its implications

1.2: Organization of Genetic material

- *1.2.1: Structure of chromosomes
- *1.2.2: Chromosome number, shape and types
- 1.2.3: Structural features of eukaryotic chromosomes: Chromatids, centromeres and telomeres; significance of telomeres; telomeres and cancer
- 1.2.4: Heterochromatin and euchromatin
- 1.2.5: *In situ* hybridization
- *1.2.6: Giant chromosomes: Lampbrush and polytene chromosomes
- 1.2.7: Human chromosomes
- 1.2.8: Chromosome banding
- *1.2.9: Variations in chromosome structure and chromosome number

1.3: Principles of Mendelian Genetics

- *1.3.1: Mendel's first law – Segregation of alleles
- *1.3.2: Mendel's second law – Independent assortment
- 1.3.3: Monohybrid and dihybrid crosses
- 1.3.4: Molecular basis of dominance (genotype, phenotype, dominance, alleles)
- 1.3.5: The cellular basis of segregation and independent assortment

Unit 2: Genetics - Extension of Mendelian Genetics and Non-Mendelian Inheritance - I **15 Lectures**

2.1: Alleles and Phenotypes

- *2.1.1: Incomplete or partial dominance and co-dominance
- *2.1.2: Epistasis
- 2.1.3: Complementation analysis
- *2.1.4: Multiple alleles

*2.1.5: Lethal alleles (recessive and dominant)

2.1.6: Penetrance and expressivity

2.2: Quantitative Inheritance

2.2.1: Traits controlled by many loci

2.2.2: Location of polygenes

2.2.3: Heritability: Measurement of heritability

2.3: Linkage, Crossing over and Gene mapping

2.3.1: Chromosomal theory of linkage

*2.3.2: Mechanism and types of crossing over

2.3.3: Mapping in prokaryotes and bacterial viruses

2.3.4: Gene mapping in eukaryotes (Three-point cross)

2.3.5: Genetic mapping in humans:

a) Physical chromosome mapping: Deletion mapping, somatic cell hybridization mapping, mapping by *in situ* hybridization; correspondence of genetic and physical maps

b) Practical application of chromosome mapping: Tracking the inheritance of an allele with coupled DNA markers

Unit 3: Evolution - I

15 Lectures

3.1:

*3.1.1: Concept of evolution and theories of organic evolution: Lamarckism, Darwinism, De Vries
Mutation theory, Neo-Darwinism

*3.1.2: Evolution of horse

3.1.3: Human evolution

3.2: Population and Evolutionary genetics

*3.2.1: Gene pool

3.2.2: Calculating allelic frequencies

3.2.3: The Hardy-Weinberg equilibrium and mating systems (non-random mating, assortative mating, inbreeding, dis-assortative mating)

Unit 4: Developmental Biology - I

15 Lectures

4.1: Basic concepts in Developmental Biology

4.1.1: Cell fate and commitment

4.1.2: Mechanism of developmental commitment

*4.1.3: Mosaic and regulative development

4.1.4: Pattern formation and compartments

4.1.5: Morphogenesis and cell adhesion:

a) Differential cell affinity

b) *Cadherins and catenins

c) *Sorting out of embryonic tissues and cell recognition

4.2: Cell differentiation and Totipotency

4.2.1: Nucleocytoplasmic interaction

*4.2.2: Mechanism of gene action during cell differentiation

*4.2.3: Factors affecting cellular differentiation

4.2.4: Maintenance of differentiation

* Topics for Seminars

Semester I – Theory

Paper Code: SIPSZO14 Tools and Techniques in Biology - I

Learning Objectives

- *To deal with the tools and techniques in Biology that have helped enhance our understanding of the various aspects of Biology.*
- *To develop a research attitude among the students by introducing Research methodology.*

Unit 1: Microtomy, Microscopy and Centrifugation

15 Lectures

1.1: Microtomy

Tissue fixation, dehydration, clearing, infiltration, embedding for paraffin method, sectioning, mounting, staining: differential and specific

1.2: Principles and applications of Microscopy

*Light microscopy, phase contrast microscopy, fluorescence microscopy, polarization microscopy, confocal scanning microscopy, transmission electron microscopy, specimen preparation for electron microscopy, scanning electron microscopy

***1.3: Principles and applications of Centrifugation**

Basic principles of centrifugation; Low speed and high-speed centrifuges, ultracentrifuge; applications of centrifugation: Preparative techniques, analytical measurements; care of centrifuges and rotors

Unit 2: Radioisotopes and Extraction techniques

15 Lectures

2.1: Principles and applications of Radioisotopes

*Use of isotopes in biological sciences; units of radioactivity; detection and measurement of radioactivity by scintillation counting, autoradiography, preparation for the experiment, performing the experiment

2.2: Principles and application of Filtration, Distillation and Extraction Ordinary filtration under suction pressure, fractional distillation, steam distillation, technique of extraction with solvents

Unit 3: Principles and applications of Spectroscopy

15 Lectures

***3.1: Ultraviolet and visible absorption spectroscopy**

3.2: Fluorescence spectroscopy

3.3: Nuclear magnetic resonance spectroscopy

3.4: Mass spectroscopy

3.5: Atomic absorption spectrophotometer

Unit 4: Good Laboratory Practices and Research Methodology - I

15 Lectures

***4.1: Safety in laboratories; use, care and maintenance of common laboratory equipments:**

Microscope, pH meter, colorimeter/ spectrophotometer, analytical balance, centrifuge, electrophoresis apparatus, glassware; general safety measures, personal protection, chemical hazards, spillage and waste disposal, first aid

4.2: Research methodology

Meaning of research; objective of research; motivation in research; types of research; research approaches; significance of research; research methods versus methodology; Research and scientific methods; Importance of knowing how research is done; Research process; Criteria for good research

4.3: Research problem and research design

Selecting a research problem, necessity of defining a problem, techniques involved in defining the problem; meaning of research design, need for research design, important concepts related to research design, different research designs, basic principles of experimental design, important experimental designs

* Topics for Seminars

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

**Semester I – Practical I (SIPSZOP11)
Based on SIPSZO11**

1. *Study of Animal type:
Sepia: Morphology, digestive system, nervous system, reproductive system; mounting of jaws, radula, statocyst and spermatophore
2. Study of Systematics and major features of:
 - a) Protozoa: *Amoeba*, *Volvox*, *Noctiluca*, *Paramecium*, *Plasmodium*
 - b) Porifera: *Leucosolenia*, *Grantia*, *Euplectella*, *Euspongia*
 - c) Coelenterata: *Obelia* colony, *Physalia*, *Porpita*, Sea anemone, *Madrepora*, *Aurelia*
 - d) Mollusca: Chiton, Dentalium, Patella, Aplysia, *Limnaea*/ *Achatina*, *Mytilus*, *Loligo*/ Octopus, *Nautilus*
 - e) Echinodermata: Starfish, Brittle star, Sea urchin, Sea cucumber, Feather star
 - f) Minor Phyla: Comb jelly, *Lingula*, *Sagitta*
 - g) Hemichordata: *Balanoglossus*
3. Study of accessory respiratory organs in *Anabas*, *Clarias*, *Saccobranchus* and *Boleophthalmus*.
4. Study of larval forms: Echinoderm larvae and Tornaria larva
5. Study of Systematics and major features of:
 - a) Cephalochordata: *Amphioxus*
 - b) Agnatha: *Petromyzon*, *Myxine*
 - c) Pisces: Shark, Sting ray, Electric ray, Hippocampus, Eel and any lung fish
 - d) Amphibia: *Caecilian*, Salamander, Frog, Toad
 - e) Reptilia: Turtle/ Terrapin, Tortoise, *Calotes*/ Chameleon, *Draco*, Phrynosoma, Viper, Rattle snake, *Hydrophis*, Crocodile/Alligator/ Gharial
- *6. Mounting of spicules of Holothurian.
7. Comparative Osteology:
Types of vertebrae: Procoelous, Opisthocoelous, Amphicoelous and Heterocoelous

Note: *Demonstration practical/ Dissection/ Virtual dissection/ Model (2D or 3D)/ Chart of the animal system as per UGC guidelines.

Semester I – Practical II (SIPSZOP12)
Based on SIPSZO12

1. Qualitative tests for carbohydrates and identification of the nature of carbohydrates in the given sample: Molisch's test, Anthrone test, Iodine test, Barfoed's test, Seliwanoff's test, Fehling's test, Benedict's test, Picric acid test, Mucic acid test, and Bial's test.
2. Determination of glucose by Benedict's (volumetric) method.
3. Determination of reducing sugars by 3,5-dinitrosalicylic acid (colorimetric) method.
4. Estimation of glycogen in the given tissue (liver/ skeletal muscle/ kidney/ brain).
5. Acid and enzyme hydrolysis of glycogen and colorimetric estimation of the products by 3,5-DNSA method.
6. Isolation of starch from potato.
7. Determination of acid value of fats/ oils.
8. Determination of saponification value of fats/ oils.
9. Reichert-Meissl (RM) number of fat.

Semester I – Practical III (SIPSZOP13)
Based on SIPSZO13

1. Temporary squash preparation of onion/ garlic root tip cells to study stages of mitosis.
2. Temporary squash preparation of testis of cockroach/ grasshopper/ *Tradescantia* pollen to study stages of meiosis.
3. Demonstration of inter-chromosomal connections in the cells of *Tradescantia* buds.
4. Temporary preparation of polytene chromosomes from salivary gland cells of *Drosophila*/ Chironomus larva.
5. Study of chromosome structures in human karyotype.
6. Study of different types of chromosome banding techniques.
7. Temporary preparation of buccal smear to study sex chromatin in human.

Semester I – Practical IV (SIPSZOP14)
Based on SIPSZO14

1. Identification of pictograms, symbols and signs of safety in laboratory.
2. Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining.
3. Solutions and Buffers:
 - a) Mode of expressing concentration of solutions: Molarity (M), molality (M), normality (N), Mass concentration, mass fraction, mass percentage or % (w/w), % by volume (v/v), parts per million (ppm) (explain with practical exercises).
 - b) Types of solutions: Stock solutions (explain with practical exercises).
4. Preparation of buffers of different pH using Henderson-Hasselbalch equation and its verification using pH meter.
5. Determination of pKa of a weak acid.
6. Colorimeter: Selection of filter and determination of unknown concentration of solute.

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Semester II – Theory

Paper Code: SIPSZO21

Nonchordates, Chordates and their Phylogeny - II

Learning Objectives:

- *To attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones by a study of the levels of organization in animal kingdom. Also, to know the different modifications the animal life has made for its survival, through phylogenic and taxonomic study.*
- *To study comparative vertebrate osteology to know about the skeletal framework found in the vertebrates; a study which can be helpful in forensic context to differentiate human bones from other vertebrates and also in archaeology*

Unit 1: Phylogeny, Systematics of Nonchordates and assorted topic - II

15 Lectures

1.1: Platyhelminthes and Nematelminthes

1.2: Acanthocephala

***1.3:** Annelida

***1.4:** Sipunculoidea

1.5: Arthropoda

1.6: Onychophora: Peripatus, a connecting link between Annelida and Arthropoda

Unit 2: Phylogeny of Protochordates, Agnatha and assorted topics - II

15 Lectures

***2.1:** Urochordata and its affinities

***2.2:** Cephalochordata and its affinities

2.3: Vertebrate ancestry and origin of vertebrates

2.4: Changes leading to first vertebrates

2.5: Salient features and phylogeny of Ostracoderms

***2.6:** Affinities of Cyclostomes:

a) Resemblance with Cephalochordates

b) Differences from fishes

c) Vertebrate characters

d) Specialized characters

Unit 3: Phylogeny, Systematics of Chordates and assorted topics - II

15 Lectures

3.1: Warm blooded reptiles; Archaeopteryx: A connecting link between Reptiles and Aves

3.2: Affinities of Aves and classification up to subclass

3.3: Origin of flight: Theory of cursorial and arboreal origin

***3.4:** Birds as glorified reptiles

***3.5:** Egg laying mammals: A connecting link between reptiles and mammals

***3.6:** Classification of mammals up to orders

***3.7:** Dentition in mammals

3.8: Walking gait: Plantigrade, Digitigrade and Unguligrade

Unit 4: Comparative Vertebrate Osteology - II**15 Lectures****4.1:** Pectoral and pelvic girdles of Dog fish, Bony fish, Frog, Varanus, Pigeon and Rabbit**4.2:** Comparative anatomy of limbs of tetrapods***4.3:** Mechanism of support and movements: Running, jumping and digging*** Topics for Seminars***Students' activity:*

Field visits/Field trips/Excursions/Study tours/field projects to the relevant locations such as Zoological/National parks, Sanctuaries, museums, shores in order to observe organisms in their natural habitat as well as to combine theoretical/experiential learnings with actual observations in the field.

**Semester II – Theory
Paper Code: SIPSZO22
Biochemistry and Metabolism - II**

Learning Objectives:

- To go into the details of biomolecules which form the chemical basis of life.
- To study enzymes, the catalysts found in living organisms.
- To study in detail the chemical processes that occur in living organisms that maintain life and the modes to regulate them.
- To learn about the inadequacies of the metabolic machinery due to defects at the genetic level.

Unit 1: Biomolecules - A structural and functional approach - II**15 Lectures****1.1:** Proteins as polymers of amino acids

- *1.1.1: Amino acids: Structure, classification based on structure, polarity, nutritional requirement and metabolic fate, properties of amino acids, derivatives of amino acids, non-transcribed amino acids as protein constituents, D-amino acids
- 1.1.2: Organization of protein structure: Primary structure and peptide bond, secondary, tertiary and quaternary structure; conjugate proteins: Haemoglobin, cytochromes, myoglobin; bonds involved in protein organization
- 1.1.3: Properties of proteins: Classification, denaturation, and protein folding
- 1.1.4: Biological functions of proteins: Biologically important peptides: Glutathione, octa-, nona-, and deca-peptides

Unit 2: Enzymes and Enzyme kinetics**15 Lectures*****2.1:** Enzymes: Nomenclature and classification with numerical code; chemical nature of enzymes***2.2:** Mechanism of enzyme action: Fischer's Lock and Key Theory, Koshland's Induced fit model; Mechanism of enzyme catalysis**2.3:** Enzyme kinetics: Michaelis-Menten equation; Lineweaver-Burk plot; significance of V_{max} and K_m ; factors affecting enzyme activity; enzyme activation and inhibition**2.4:** Regulatory enzymes: Covalently modulated; allosteric regulation; Isoenzymes (LDH, CK, ALP, ADH)**2.5:** Non-protein enzymes: Ribozymes**2.6:** Advanced enzymes in human healthcare, e.g. fungal lactase, hemicellulase, trypsin chymotrypsin

mix

Unit 3: Metabolic Pathways and Integration of metabolism - II

15 Lectures

3.1: Protein Metabolism

3.1.1: Metabolism of amino acids: Amino acid pool, transamination, oxidative and non-oxidative

deamination; metabolism of branched chain amino acids; fate of carbon skeleton of amino acids

*3.1.2: Metabolism of ammonia: Urea cycle

3.2: Metabolism of Nucleic acids

3.2.1: Synthesis of ribonucleotides: A brief idea of *de novo* pathway and salvation pathway

*3.2.2. Conversion of ribonucleotides to deoxyribonucleotides

3.2.3: Degradation of nucleotides

3.3: Integration of Metabolism

3.3.1: Energy demand and supply; integration of major metabolic pathways of energy metabolism

3.3.2: Intermediary metabolism; organ specialization and metabolic integration

3.3.3: Metabolism in starvation

Unit 4: Regulation of Metabolism and Inborn Errors of Metabolism

15 Lectures

4.1: Inborn errors of metabolism

4.1.1: Carbohydrate metabolism: Glycogen storage disease,* G-6-PD deficiency

4.1.2: Lipid metabolism: Metabolic disorders of cerebroside

4.1.3: Protein metabolism: PKU, Albinism, Cystinuria

4.1.4: Purine metabolism: Primary Gout

4.2: Mineral metabolism and diseases: Hypocalcemia, Hypercalcemia, and osteoporosis

*** Topics for Seminars**

Semester II – Theory

Paper Code: SIPSZO23

Genetics, Evolution and Developmental Biology - II

Learning Objectives:

- *To uncover the rules governing the transmission of genetic traits through the study of classical genetics applying statistics.*
- *To study the concept of sex determination in different animals.*
- *To understand the evolutionary processes that change the structure of natural populations over time.*
- *To study Developmental Biology and its aspects: Metamorphosis, Regeneration and Aging.*

Unit 1: Genetics - Chromosome theory of Inheritance and Mendelism - II

15 Lectures

1.1: Mendelian genetics, Probability and Statistics

1.1.1: Combining probabilities (sum rule and product rule)

1.1.2: Chi square test

1.2: Modern Concept of Gene

*1.2.1: Difference between prokaryotic and eukaryotic gene structure

- 1.2.2: Properties of genes, gene-enzyme relationship
- 1.2.3: One gene-one enzyme hypothesis, one gene-one polypeptide concept
- 1.2.4: Fine structure of gene; cistron, recon and muton
- 1.2.5: Split gene: exon and intron
- 1.2.6: Mobile genes and transposons
- 1.2.7: Pseudo alleles

Unit 2: Genetics - Extension of Mendelian Genetics and Non-Mendelian Inheritance - II 15 Lectures

2.1: Determination of sex

- *2.1.1: Environmental control of sex (*Bonellia*, *Crepidula*); temperature dependent sex determination (TSD) in reptiles
 - 2.1.2: Genic control of sex determination in Maize, *Caenorhabditis elegans*
- *2.1.3: XX-XO, XX-XY and ZZ-ZW method of sex determination
 - 2.1.4: Genic balance theory of sex determination in *Drosophila*
 - 2.1.5: Gynandromorphs in *Drosophila*
 - 2.1.6: Haplodiploidy in honey bees
 - 2.1.7: Sex chromatin, Lyon hypothesis, X inactivation
 - 2.1.8: SRY and Dax genes
- *2.1.9: XX males and XY females in human

2.2: Non-Mendelian Inheritance

- *2.2.1: Maternal effects; Shell coiling in snails, pigmentation in moths
- 2.2.2: Cytoplasmic inheritance: Mitochondria, chloroplasts, plasmids, infective particles

Unit 3: Evolution - II

15 Lectures

- ***3.1:** Additive gene action and continuous variation : Heterosis and inbreeding depression: Measuring inbreeding; effects of inbreeding
- 3.2:** Processes that change allelic frequencies: Mutation, migration, natural selection, directional selection, stabilizing and disruptive selection, heterozygote advantage; balance between selection and mutation; genetic drift – random genetic drift
- 3.3:** Environmental variation: Causes of environmental variation; genotype by environmental interaction
- 3.4:** Broad sense heritability:
 - a) Effect of dominance, epistasis and environmental variations on selection
 - b) Quantitative trait loci and DNA markers
 - c) Realized heritability
- 3.5:** Limits on selection

Unit 4: Developmental Biology - II

15 Lectures

- 4.1:** Cell specialization: RBC, secretory cell, retinal rod cell
- 4.2:** Organizer and its role in embryonic development
- 4.3:** Primary embryonic induction
- 4.4:** Metamorphosis, Regeneration and Aging:
 - 4.4.1: Metamorphosis:
 - *a) Amphibian metamorphosis
 - b) Metamorphosis in insects – Types of insect metamorphosis; eversion and differentiation of imaginal discs; hormonal control of insect metamorphosis

- c) Programmed cell death
- *4.4.2: Regeneration: Regeneration in Hydra; regeneration of salamander limbs
- *4.4.3: Aging: Senescence, life span and causes of aging

*** Topics for Seminars**

Semester II – Theory
Paper Code: SIPSZO24
Tools and Techniques in Biology - II

Learning Objectives:

- *To deal with the tools and techniques in Biology that have helped enhance our understanding of the various aspects of Biology.*
- *To develop a research attitude among the students by introducing Research methodology and to learn about how to write and present a research proposal in a scientific way.*

Unit 1: Principles and applications of Chromatography - I **15 Lectures**

***1.1:** Planar chromatography (Paper and Thin layer):

Preparation of stationary support, solvent, detection and measurement of components, applications

1.2: Column chromatography:

Packing and operation of column, loading the column, eluting the column, collection of eluent, detection of eluent, applications

1.3: Ion exchange chromatography:

Ion exchange resins, selection of ion exchanger, choice of buffers, preparation and use of ion exchangers, storage of resins

Unit 2: Principles and applications of Chromatography - II **15 Lectures**

2.1: Gel chromatography:

*Theory of gel filtration, physical characteristics of gel chromatography, chemical properties of gel, selection of gel, gel preparation and storage, operation of gel column, applications

2.2: Affinity chromatography:

Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedures and applications

Unit 3: Principles and applications of Chromatography and Electrophoresis **15 Lectures**

3.1: Gas chromatography:

3.1.1: Gas chromatography (GC): Instrumentation, selection of operating conditions, analysis of data and applications

3.1.2: HPLC

3.2: Electrophoresis:

*3.2.1: Theory of electrophoresis

*3.2.2: Horizontal agarose gel electrophoresis

*3.2.3: Vertical polyacrylamide gel electrophoresis

3.2.4: Pulse field electrophoresis

3.2.5: Capillary electrophoresis

3.2.6: Isoelectric focusing of proteins

3.2.7: Two-dimensional electrophoresis

Unit 4: Good Laboratory Practices and Research Methodology - II

15 Lectures

4.1: Interpretation and report writing

4.1.1: Meaning of interpretation, technique of interpretation, precautions in interpretation

4.1.2: Significance of report writing, layout of research report, types of reports, precautions for writing a research report

*4.1.3: Presentation of research work: Oral, poster and writing a research paper

4.2: Review of related literature:

Understanding the role of review; how to begin a search for related literature: Library reference, recording and indexing, classification of references, internet sites for biological references; downloading the information through internet; requests for reprints through e-mail and post; classification and filing of reprints

4.3: Writing a research proposal:

Characteristics of a proposal, content and organization of a proposal, weakness in proposal seeking funding

* Topics for Seminars

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Semester II – Practical I (SIPSZOP21) Based on SIPSZO21

1. *Study of Animal type:

Periplaneta americana: Morphology, digestive system, nervous system, reproductive system and life history; mountings of cornea, salivary glands, gonapophyses and spermatheca.

2. Study of Systematics and major features of:

a) Helminthes: *Planaria*, Liverfluke, Tapeworm, *Ascaris*, *Trichinella*

b) Annelida: *Nereis*, Earthworm, Leech

c) Sipunculoidea: *Sipunculus*

d) Arthropoda: Lobster, *Balanus*, Crab, *Lepas*, Scorpion, Spider, *Limulus*, Centipede, Millipede, Beetle

e) Urochordata: Simple Ascidian, *Salpa/ Doliolum*

f) Cephalochordata: *Amphioxus*

3. Study of larval forms: Larvae of Helminthes (Miracidium, Redia, Cercaria, Metacercaria);

Trochophore; Crustacean larvae; Ascidian tadpole

4. Study of Systematics and major features of:

a) Aves: Ostrich, Kiwi, Kite, Owl, Duck

b) Mammals: Duck-billed platypus, Echidna, Kangaroo, Shrew, Bat, Loris, Seal/ Walrus, Dolphin, Sea Cow, Tiger, Giant panda, Tapir, Camel, Striped squirrel, Guinea pig, Porcupine, Rabbit

5. Comparative Osteology:

a) Study of pectoral and pelvic girdles of Shark, Bony fish, Frog, Varanus, Pigeon, Rabbit

b) Study of comparative anatomy of tetrapod limbs (Frog, Varanus, Pigeon, Rabbit)

Note: *Demonstration practical/ Dissection/ Virtual dissection/ Model (2D or 3D)/ Chart of animal system as per UGC guidelines.

Semester II – Practical II (SIPSZOP22)
Based on SIPSZO22

1. Determination of total cholesterol and HDL cholesterol from serum.
2. Qualitative tests for amino acids and proteins: Ninhydrin test, Xanthoproteic test, Millon's test, Biuret test
3. Colorimetric estimation of proteins by Peterson-Lowry method.
4. Quantitative estimation of amino acids using Ninhydrin reagent.
5. Isolation of casein from milk.
6. Detection of conformation of BSA by viscosity measurement and effect of varying concentration of urea on viscosity of BSA.
7. Determination of creatinine in serum and urea.
8. Determination of SDH specific activity.

Semester II – Practical III (SIPSZOP23)
Based on SIPSZO23

1. Problems in genetics.
2. Pedigree analysis.
3. Quantitative estimation of DNA from a suitable tissue by Diphenylamine method.
4. Quantitative estimation of RNA from a suitable tissue by Orcinol method.
5. Observation of morphogenetic movements in chick embryo.
6. Isolation of limb bud and its chorio-allantoic grafting.

Semester II – Practical IV (SIPSZOP24)
Based on SIPSZO24

1. Identification of lipids in a given sample by TLC.
2. Separation of pigments from leaves or flowers by adsorption column chromatography.
3. Separation of amino acids by ion exchange chromatography using cation exchanger.
4. Separation and identification of amino acids by two dimensional paper chromatography.
5. SDS-polyacrylamide slab gel electrophoresis of proteins.

**M.Sc. Zoology Syllabus (Autonomous)
Credit Based Semester and Grading System
(With effect from academic year 2018-19)
Semester I and Semester II**

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Practical Examination Question Paper Pattern

Semester I – Practical I (SIPSZOP11) Based on SIPSZO11

Time: 5 hours

Marks: 50

- Q.1** *Dissect Sepia so as to expose its digestive system/ reproductive system/ nervous system. **14**
- Q.2** *Make temporary preparation/ mounting (stain if necessary) of:
Sepia: Jaws/ Radula/ Spermatophore/ Statocyst. **08**
- OR**
- Q.2*** Spicules of Holothurian.
- Q.3** Identify specimen/ slide **a, b, c, d** as per instructions. **16**
- Q.4** Identify specimen/ slide **e, f** as per instructions. **08**
- Q.5** Identify specimen/ slide **g** as per instructions. **04**

(* Demonstration/ Dissection/ Virtual dissection/ Model (2D or 3D)/ Chart of animal system as per UGC guidelines.)

Marking Scheme

Semester I – Practical I (SIPSZOP11)

- Q.1** *Dissect Sepia so as to expose its digestive system/ reproductive system/ nervous system. **14**

Category	Marks
Diagram	03
Dissection performance and presentation	07
Explanation and viva	04

- Q.2** *Make temporary preparation/ mounting (stain if necessary) of:
Sepia: Jaws/ Radula/ Spermatophore/ Statocyst. **08**

OR

Spicules of Holothurian.

Category	Marks
Diagram	02
Mounting and presentation	04
Explanation and viva	02

- Q.3** Identify specimen/ slide **a, b, c, d** as per instructions. **16**
- Q.4** Identify specimen/ slide **e, f** as per instructions. **08**
- Q.5** Identify specimen/ slide **g** as per instructions. **04**

For each specimen:

Category	Marks
Identification	1
Description (as per instruction)	3

Semester I – Practical II (SIPSZOP12)
Based on SIPSZO12

Time: 5 hours

Marks: 50

- Q.1** Estimate the yield of glycogen from skeletal muscles/ liver. Submit a report. **25**
OR
- Q.1** Demonstrate the enzymatic/ acid hydrolysis of glycogen from the given sample. Submit a report of the results obtained. **25**
OR
- Q.1** Identify the nature of carbohydrates in the given sample using qualitative tests (6 tests). **25**
Q.2 From the given material isolate starch and estimate the yield. Submit a report of the results obtained. **25**
OR
- Q.2** Estimate the amount of glucose by Benedict's volumetric method. Submit a report of the results obtained. **25**
OR
- Q.2** Determine the amount of reducing sugars from the given sample by DNSA method. Submit a report of the results obtained. **25**
OR
- Q.2** Determine the Saponification Value/ Acid Value/ Reichert-Meissl (RM) number of the given sample of lipid. Submit a report of the results obtained. **25**

Marking Scheme
Semester I – Practical II (SIPSZOP12)

- Q.1** Estimate the yield of glycogen from skeletal muscles/ liver. Submit a report. **25**
OR
- Q.1** Demonstrate the enzymatic/ acid hydrolysis of glycogen from the given sample. Submit a report of the results obtained. **25**
OR
- Q.1** Identify the nature of carbohydrates in the given sample using qualitative tests (6 tests). **25**

Category	Marks
Aim and requirement	01
Principle/Background theory	05
Performance	15
Result and Interpretation	04

- Q.2** From the given material isolate starch and estimate the yield. Submit a report of the results obtained. **25**
OR
- Q.2** Estimate the amount of glucose by Benedict's volumetric method. Submit a report of the results obtained. **25**
OR
- Q.2** Determine the amount of reducing sugars from the given sample by DNSA method. Submit a report

of the results obtained.

25

OR

Q.2 Determine the Saponification Value/ Acid Value/ Reichert-Meissl (RM) number of the given sample of lipid. Submit a report of the results obtained. 25

Category	Marks
Aim and requirement	01
Principle/Background theory	05
Performance	15
Result and Interpretation	04

Semester I – Practical III (SIPSZOP13)

Based on SIPSZO13

Time: 5 hours

Marks: 50

Q.1 Make a temporary squash preparation of testis of cockroach/ grasshopper/ *Tradescantia* young anther to study stages of meiosis. 20

OR

Q.1 Make a temporary preparation of polytene chromosomes from salivary gland cells of *Drosophila*/ Chironomus larva. 20

Q.2 Make a temporary squash preparation of onion/ garlic root tip cells to study stages of mitosis. 18

OR

Q.2 Make a temporary preparation of buccal smear to study sex chromatin in human. 18

Q.3 Make a Karyotype analysis from the given printed material and comment on the numerical and/ or structural variations in chromosomes. 12

OR

Q.3 Identify and describe different types of chromosome banding techniques. 12

Marking Scheme

Semester I – Practical III (SIPSZOP13)

Q.1 Make a temporary squash preparation of testis of cockroach/ grasshopper/ *Tradescantia* young anther to study stages of meiosis. 20

OR

Q.1 Make a temporary preparation of polytene chromosomes from salivary gland cells of *Drosophila*/ Chironomus larva. 20

Category	Marks
Aim and requirement	01
Principle/Background theory	02
Diagram	02
Performance	12
Result and Interpretation	03

Q.2 Make a temporary squash preparation of onion/ garlic root tip cells to study stages of mitosis. **18**

OR

Q.2 Make a temporary preparation of buccal smear to study sex chromatin in human. **18**

Category	Marks
Aim and requirement	01
Principle/Background theory	02
Diagram	02
Performance	10
Result and Interpretation	03

Q.3 Make a Karyotype analysis from the given printed material and comment on the numerical and/ or structural variations in chromosomes. **12**

Category	Marks
Background theory	02
Performance	10

OR

Q.3 Identify and describe different types of chromosome banding techniques. **12**

Category	Marks
Background theory	02
Identification & Description	10

**Semester I – Practical IV (SIPSZOP14)
Based on SIPSZO14**

Time: 5 hours

Marks: 50

Q.1 Demonstrate the relationship between absorbance of light and concentration of the dye in the given solution using different wavelengths for five dilutions. Tabulate the readings. Plot the absorbance curves on the same graph paper and explain the choice of ideal filter from your results.

OR

Q.1 Determine the pKa of the given weak acid. **20**

Q.2 Using Henderson-Hasselbalch equation calculate the pH of buffer prepared by mixing known volume of either acid and/ or salt solutions. Check pH using pH meter. **16**

OR

Q.2 (A) Identify the pictograms/ signs/ symbols **a** and **b** and comment on their significance in a laboratory. **08**

(B) Prepare a solution of given molarity/ normality. **08**

Q.3 From the infiltrated tissue prepare a block, trim and mount it on the holder for section cutting. **14**

Q.3 Trim the given block, mount it on the block holder, cut the sections and from ribbons prepare slides. **14**

OR

Q.3 Dewax the mounted ribbons and stain the sections with haematoxylin/ eosin. **14**

Marking Scheme
Semester I – Practical IV (SIPSZOP14)

Q.1 Demonstrate the relationship between absorbance of light and concentration of the dye in the 20 given solution using different wavelengths for five dilutions. Tabulate the readings. Plot the absorbance curves on the same graph paper and explain the choice of ideal filter from your results.

OR

Q.1 Determine the pKa of the given weak acid. **20**

Category	Marks
Aim and requirement	01
Principle	02
Performance & Graph	15
Result and Interpretation	03

Q.2 Using Henderson-Hasselbalch equation calculate the pH of buffer prepared by mixing known volume of either acid and/ or salt solutions. Check pH using pH meter. **16**

Category	Marks
Aim and requirement	01
Principle	02
Performance	08
Calculations, Result and Interpretation	05

OR

Q.2 (A) Identify the pictograms/ signs/ symbols **a** and **b** and comment on their significance in a laboratory. **08**

Category	Marks
Identification	1
Description (as per instruction)	3

(B) Prepare a solution of given molarity/ normality. **08**

Category	Marks
Calculation	4
Performance	4

Q.3 From the infiltrated tissue prepare a block, trim and mount it on the holder for section cutting. **14**

OR

Q.3 Trim the given block, mount it on the block holder, cut the sections and from ribbons prepare slides. **14**

OR

Q.4 Dewax the mounted ribbons and stain the sections with haematoxylin/ eosin. **14**

Category	Marks
Aim and requirement	01
Principle/Background theory	03
Performance	08
Result and Interpretation	02

Practical Examination Question Paper Pattern
Semester II – Practical I (SIPSZOP21)
Based on SIPSZO21

Time: 5 hours

Marks: 50

- Q.1** *Dissect Cockroach so as to expose its digestive system/ reproductive system/ nervous system. **14**
- Q.2** *Make temporary preparation/ mounting (stain if necessary) of:
Cockroach: Cornea/ Salivary glands/ Gonapophyses/ Spermatheca. **08**
- Q.3** Identify specimen/ slide **a, b, c, d** as per instructions. **16**
- Q.4** Identify specimen/ slide **e** and **f** as per instructions. **08**
- Q.5** Identify specimen **g** as per instructions. **04**
- (*Demonstration/ Dissection/ Virtual dissection/ Model (2D or 3D)/ Chart of animal system as per UGC guidelines.)

Marking Scheme
Semester II – Practical I (SIPSZOP21)

- Q.1** *Dissect Cockroach so as to expose its digestive system/ reproductive system/ nervous system. **14**

Category	Marks
Diagram	03
Dissection performance and presentation	07
Explanation and viva	04

- Q.2** *Make temporary preparation/ mounting (stain if necessary) of:
Cockroach: Cornea/ Salivary glands/ Gonapophyses/ Spermatheca. **08**

Category	Marks
Diagram	02
Mounting and presentation	04
Explanation and viva	02

- Q.3** Identify specimen/ slide **a, b, c, d** as per instructions. **16**
- Q.4** Identify specimen/ slide **e** and **f** as per instructions. **08**
- Q.5** Identify specimen **g** as per instructions. **04**

For each specimen:

Category	Marks
Identification	1
Description (as per instruction)	3

(*Demonstration/ Dissection/ Virtual dissection/ Model (2D or 3D)/ Chart of animal system as per UGC guidelines.)

Semester II – Practical II (SIPSZOP22)

Based on SIPSZO22

Time: 5 hours

Marks: 50

- Q.1** Estimate the protein content of the given tissue homogenate by Peterson-Lowry method. Submit a report of the results obtained. **28**
- OR**
- Q.1** Estimate the amino acid content of the given sample by Ninhydrin reagent. Prepare a standard graph. Submit a report of the results obtained. **28**
- OR**
- Q.1** Demonstrate the effect of inhibitor on Succinic Dehydrogenase activity. Submit a report of the results obtained. **28**
- OR**
- Q.1** Demonstrate the effect of variation in Urea concentration on the conformation of Protein by viscosity measurements. Submit a report of the results obtained. **28**
- OR**
- Q.1** Estimate the concentration of Creatinine in the given serum/ urine sample. Submit a report of the results obtained. **28**
- Q.2** Isolate Casein from the given sample of milk and determine its yield. Submit a report of the results obtained. **22**
- OR**
- Q.2** Determine Total /HDL Cholesterol from the given serum sample. Submit a report of the results obtained. **22**
- OR**
- Q.2** Detect proteins /amino acids in the given sample by qualitative tests (4 tests). Submit a report of the results obtained. **22**

Marking Scheme

Semester II – Practical II (SIPSZOP22)

- Q.1** Estimate the protein content of the given tissue homogenate by Peterson-Lowry method. Submit a report of the results obtained. **28**
- OR**
- Q.1** Estimate the amino acid content of the given sample by Ninhydrin reagent. Prepare a standard graph. Submit a report of the results obtained. **28**
- OR**
- Q.1** Demonstrate the effect of inhibitor on Succinic Dehydrogenase activity. Submit a report of the results obtained. **28**
- OR**
- Q.1** Demonstrate the effect of variation in Urea concentration on the conformation of Protein by viscosity measurements. Submit a report of the results obtained. **28**
- OR**
- Q.1** Estimate the concentration of Creatinine in the given serum/ urine sample. Submit a report of the results obtained. **28**

Category	Marks
Aim and requirement	01
Principle/Background theory	06
Performance	15
Result and Interpretation	06

Q.2 Isolate Casein from the given sample of milk and determine its yield. Submit a report of the results obtained. **22**

OR

Q.2 Determine Total /HDL Cholesterol from the given serum sample. Submit a report of the results obtained. **22**

OR

Q.2 Detect proteins /amino acids in the given sample by qualitative tests (4 tests). Submit a report of the results obtained. **22**

Category	Marks
Aim and requirement	01
Principle/Background theory	06
Performance	10
Result and Interpretation	05

Semester II – Practical III (SIPSZOP23)

Based on SIPSZO23

Time: 5 hours

Marks: 50

Q.1 Extract and quantitatively estimate the amount of DNA/ RNA from the given tissue homogenate. **20**

Q.2 Demonstrate the morphogenetic movements in chick embryo and isolate limb bud from the given chick embryo. **14**

OR

Q.2 Isolate limb bud from the given chick embryo and demonstrate the chorio-allantoic grafting from the given chick embryo. **14**

Q.3 (A) Solve the given problem on Genetics. **08**

(B) Solve the given problem on Pedigree analysis. **08**

Marking Scheme
Semester II – Practical III (SIPSZOP23)

Q.1 Extract and quantitatively estimate the amount of DNA/ RNA from the given tissue homogenate. **20**

Category	Marks
Aim and requirement	01
Principle	04
Performance	10
Result and Interpretation	05

Q.2 Demonstrate the morphogenetic movements in chick embryo and isolate limb bud from the given chick embryo. **14**

OR

Q.2 Isolate limb bud from the given chick embryo and demonstrate the chorio-allantoic grafting from the given chick embryo. **14**

Category	Marks
Aim and requirement	01
Principle	03
Performance	08
Result and Interpretation	02

Q.3 (A) Solve the given problem on Genetics. **08**

(B) Solve the given problem on Pedigree analysis. **08**

Semester II – Practical IV (SIPSZOP24)
Based on SIPSZO24

Time: 5 hours **Marks: 50**

Q.1 Demonstrate the technique of two-dimensional paper chromatography to separate the amino acids. Calculate R_f value. **30**

OR

Q.1 Demonstrate the use of adsorption column chromatography to separate the pigments from leaves or flowers. **30**

OR

Q.1 Demonstrate the technique of ion exchange column chromatography in the separation of amino acids using two buffers. **30**

Q.2 Identification of lipids in a given sample by TLC. **20**

OR

Q.2 Demonstrate SDS-PAGE under reducing conditions for separation of Plasma proteins. **20**

Marking Scheme
Semester II – Practical IV (SIPSZOP24)

Q.1 Demonstrate the technique of two-dimensional paper chromatography to separate the amino acids. Calculate Rf value. **30**

OR

Q.1 Demonstrate the use of adsorption column chromatography to separate the pigments from leaves or flowers. **30**

OR

Q.1 Demonstrate the technique of ion exchange column chromatography in the separation of amino acids using two buffers. **30**

Category	Marks
Aim and requirement	01
Principle	08
Performance	15
Calculations, Result and Interpretation	06

Q.2 Identification of lipids in a given sample by TLC. **20**

OR

Q.2 Demonstrate SDS-PAGE under reducing conditions for separation of Plasma proteins. **20**

Category	Marks
Aim and requirement	01
Principle	04
Performance	10
Result and Interpretation	05

**M.Sc. Zoology Syllabus (Autonomous)
Credit Based Semester and Grading System
(With effect from academic year 2018-19)
Semester I and Semester II**

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.

Seminar Marks: 20

Evaluation will be conducted on the basis of Seminar/ Presentation given by the student on a topic chosen from the syllabus for each paper. The marking scheme shall be:

- Content of Presentation: **05 marks**
- Quality of Presentation: **05 marks**
- Presentation skills: **05 marks**
- Question-Answer discussion: **05 marks**

Assignment Marks: 20

Evaluation will be conducted on the basis of Research paper review / Book review / Poster presentation / Abstract writing / Preparation of Standard Operating Procedure or Calibration of Instruments / Role play or Skit on topic relevant to the paper / Report on Industry or Field Visit or Writing an article relevant to the paper etc.

Semester End Assessment Theory (60%)

Marks: 60

Duration: 2 hours

Theory question paper pattern:

- There shall be five questions of 12 marks each. On each unit there will be one question and the 5th question will be based on the entire syllabus.

OR

There shall be four questions of 15 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: 5 hours
