AC/27.6.23/RS 2

SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

(*Affiliated to University of Mumbai*)

Faculty: Science

Program: M.Sc. -

Subject: ZOOLOGY

Academic Year: 2023 – 2024

Revised Syllabus in Zoology under
Choice Based Credit System (CBCS)
Approved by the Board of Studies in Zoology
Effective from academic year 2023-24 under the aegis of
National Education Policy

Preamble

"Where the mind is without fear and the head is held high..... "
— A poem written by Nobel Laureate Rabindranath Tagore (Nobel Prize in Literature in 1913), the poem represents Tagore's vision of a new and awakened India (it is quoted in this preamble in the context of National Education Policy – New Education Policy).

The implementation of India's National Education Policy 2020, the first education policy of the 21st century, which aims to address the growing developmental imperatives of our country. Universal high-quality education is fundamental for achieving full human potential, besides developing an equitable and just society, and promoting national development. It is the best way forward for developing and maximizing our country's rich talents and resources which eventually will determine the future of our country. Therefore, in this context, our institution's 'Empowered Autonomous Status' becomes all the more relevant, in terms of our contribution as an educational institution to 'Achieving the full potential of every student'.
Under the aegis of academic autonomy, we have the privilege of 'academic freedom' to revise our curriculum, however, we are also aware of the fact that 'academic freedom' needs to be justified with 'academic excellence'. One of the ways to achieve this, is through fine-tuning the curriculum. As students at the postgraduate level would have a foundation of the basics of the subject, this syllabus also focuses on the need to furnish them with skills and understanding essential to make them self-sufficient and build a future. Thus, in addition to enable students to acquire an in depth knowledge of the Core/Mandatory subject, the current syllabus also attempts to integrate a few courses under Department Specific Elective and Research Methodology, which will help students to be equipped with the necessary skills to enhance their core competencies in understanding synergism of pure and applied sciences. Some of the key features of this revised syllabus are as follows:-

- ✓ *Industry Internship / Apprenticeship / On Job Training – A course requiring students to participate in a professional activity or work experience, with an entity external to the educational institution. Internships will involve working with local industry, government or private organizations, etc. to provide opportunities for students to actively engage in on-site experiential learning. Moreover, it will also strengthen academia-industry linkage and increase employability of students.*
- ✓ *Research Methodology – A course requiring students to inculcate research aptitude and to develop an open, inquiring mind that is willing to explore new territories and learn new things. It will also encourage the spirit of curiosity of students, who are not just learners but also potential problem solvers and scientific investigators in their own way. It will not only develop and enhance their research skills in order to make them adapt to the research culture, but also nurture critical thinking and develop analytical reasoning amongst students. Moreover, this course will serve as a stepping stone/foundation for execution of a Research Project in their final year.*
- ✓ *Phylogeny and Systematics, Genetics and Evolution – these concepts have been retained, since it gives the essence of classical zoology which will help students to recognize and appreciate that there are common threads that connect all living organisms.*
- ✓ *Biochemistry & Tools and Techniques in Biology – A course that has been restructured to understand the concepts in biochemistry by integrating it with tools and techniques in biology; it also includes principle, working & applications of instruments used in chromatography, spectroscopy, electrophoresis etc; moreover, it has the concept of Globally Harmonized System, Standard Operating Procedure and Calibration, so as to give the students exposure to Good Laboratory Practices and Hazard Communication, which will inculcate a professional and analytical approach towards Lab safety, Instrumentation and Techniques.*
- ✓ *Department Specific Elective in the form of Biotechnology and Gene manipulation – A course that has been redesigned with emphasis on Medical Biotechnology, Applications of Industrial and Agricultural Biotechnology, which will keep the students abreast with cutting edge technological applications in medicine, healthcare, agriculture, industry etc.*

This syllabus is a collective and constructive effort of the faculty, experts from research institutions, alumni and the board members whose valuable suggestions and expertise were instrumental in materializing this syllabus. The comments and recommendations of the contributors and reviewers have been carefully considered and implemented wherever feasible. For effective teaching-learning, teachers are advised not to follow the syllabus too rigidly, but to exercise their professional discretion and judgement in implementing it. After all teaching is about creating a conducive environment for learners to sustain enthusiasm about the subject. We sincerely hope that all stakeholders from faculty to learners exploring this course will appreciate the importance of a well-designed curricular framework in shaping educational outcomes.
In conclusion, we hope this syllabus will encourage and maximize learning among students to develop open, inquiring minds for holistic development, thereby justifying the essence and spirit of National Education Policy.

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Members of the Board of Studies in the subject of Zoology and Syllabus Committee

- ✓ *Professor (Dr.) Manisha Kulkarni – Department of Zoology, Institute of Science, Fort, Mumbai (Vice Chancellor's Nominee)*
- ✓ *Professor (Dr.) Manoj Mahimkar – Principal Investigator, Cancer Research Institute, ACTREC, Kharghar, Navi Mumbai; (Subject expert from outside the Parent University to be nominated by the Academic Council)*
- ✓ *Dr. Sasikumar Menon – Director, Institute for Advanced Training & Research in Interdisciplinary Sciences (IATRIS), (Therapeutic Drug Monitoring Lab), Sion, Mumbai; Faculty, Pharma Analytical Sciences, Ruia College, Mumbai (Subject Expert from outside college/Industry expert)*
- ✓ *Mr. Kedar Gore – Director, The Corbett Foundation (Non-profit Organization), Mumbai, (Subject expert from outside college / Representative from Corporate sector / Allied area)*
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M.Sc. Part I-Zoology – Semester I (Syllabus Grid)

THEORY			
Course name and code	**Unit**	**Topic Headings**	**Credits**
SEMESTER I			
A) Major			
a) Mandatory Papers			
Paper I: Phylogeny & Systematics of Non-chordates, Developmental Biology and Genetics			
SIPZOCC511	1	Nonchordates-I	**4**
	2	Nonchordates-II and Hemichordates	
	3	Developmental biology - I	
	4	Genetics	
Paper II: Biochemistry and Tools & techniques in Biology			
SIPZOCC512	1	Biomolecules- A structural and functional approach	**4**
	2	Metabolic pathways and Integration of Metabolism	
	3	Principles and Applications of Microscopy	
	4	Principles and Applications of Spectroscopy	
Paper III: Biostatistics			
SIPZOCC513	1	Biostatistics- I	**2**
	2	Biostatistics- II	
b) Electives			
Paper IV: Biotechnology and Gene Manipulation			
SIPZOEL511	1	Large scale culture and production from recombinant microorganisms	**3**
	2	Medical Biotechnology	
	3	Genome Management and Analysis	
B) Research Methodology			
Paper V: Research Methodology			
SIPZORM511	1	Basic concepts in research, research methods and methodology	**3**
	2	Scientific research writing, research review and research ethics	
	3	Research grants, funding agencies and research projects	
PRACTICAL			
SIPZOCCP511	1	Based on Core course-1 (SIPZOCC511)	**2**
SIPZOCCP512	2	Based on Core course-2 (SIPZOCC512)	**2**
SIPZOELP511	3	Based on DSE (SIPZOEL511)	**1**
SIPZORMP511	4	Based on RM (SIPZORM511)	**1**
		Total	**22**

M.Sc. Part I – Zoology – Semester II (Syllabus Grid)

THEORY			
Course name and code	**Unit**	**Topic Headings**	**Credits**
SEMESTER II			
A) Major			
a) Mandatory Papers			
Paper I: Phylogeny & Systematics of Chordates, Developmental Biology and Evolution			
SIPZOCC521	1	Protochordates and Chordates-I	**4**
	2	Chordates-II	
	3	Developmental Biology- II	
	4	Evolution	
Paper II: Biochemistry and Tools & techniques in Biology			
SIPZOCC522	1	Metabolic pathways and Integration of Metabolism	**4**
	2	Enzyme and Enzyme Kinetics	
	3	Principles and Applications of Chromatography	
	4	Principles and Applications of Electrophoresis	
Paper III: Bioinformatics			
SIPZOCC523	1	Bioinformatics- I	**2**
	2	Bioinformatics- II	
b) Electives			
Paper IV: Biotechnology and Gene manipulation			
SIPZOEL521	1	Microbial synthesis of commercial products	**3**
	2	Enzyme technology in large scale production	
	3	Environmental biotechnology	
B) On Job training or Field project			
SIPZOOJ521	1	**No Theory Paper**	**-**
PRACTICAL			
SIPZOCCP521	1	Based on Core course-1 (SIPZOCC521)	**2**
SIPZOCCP522	2	Based on Core course-2 (SIPZOCC522)	**2**
SIPZOELP521	3	Based on DSE (SIPZOEL521)	**1**
SIPZOOJP521	4	Based on OJ (SIPZOOJ521)	**4**
		Total	**22**

SIES College of Arts, Science and Commerce (Autonomous)
Sion (West), Mumbai – 400 022

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 *(U, Ap)* • Apply the knowledge of various courses learned under a program to break down complex problems into simple components. • Adopt and assimilate problem-based learning models and apply one's learning to solve real life problem situations.
PO2 *(Skill Level)*	Critical Thinking *(U, An, E)* • Develop critical thinking based on a rationale to identify assumptions, verifying the accuracy and validity of assumptions, and making informed decisions. • Inculcate the ability of logical reasoning to question the rationale behind concepts, ideas, and perspectives.
PO3 *(Skill Level)*	Effective Communication Skills *(Ap, C)* • Improve written and oral communication skills so as to express thoughts and ideas effectively. • Demonstrate the ability to listen carefully and imbibe soft skills to convey and receive instructions clearly. • Develop presentation skills to present complex information in a clear, lucid and concise manner.
PO4 *(Skill Level)*	Proficiency with Information and Communication Technology *(U, An, E)* • Demonstrate ability to access, evaluate and use a variety of relevant information resources inclusive of internet and electronic media for the purpose of collating and 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 *(U, Ap, An, C)* • Demonstrate leadership skills formulating an inspiring vision, thereby building a team, motivating, and inspiring team members to engage and achieve that vision. • Develop management skills to guide people in 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 *(Attitud eLevel)*	Self-directed and Lifelong Learning *(U, Ap, An)* • 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. • Adapt lifelong learning approaches to broaden one's horizons for personal growth

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

Serial Number	**Details of Programme Specific Outcomes (PSOs)**
PSO1	Conceptual Understanding and Emerging Applications *(R, U, Ap, An)* • Inculcate conceptual and coherent understanding of zoology, and demonstrate a broad understanding of animal diversity, including fundamental and systematic knowledge of the scientific classification, taxonomy and evolutionary relationships of major groups of animals. • Understand the nature and basic concepts of biochemistry, molecular biology, ecology, evolution, developmental biology and genetics • Learn appropriate methodologies with cutting edge tools/techniques in biological sciences to seek solutions to emerging problems faced by mankind.
PSO2	Analytical reasoning and Scientific Inquiry *(U, An, E)* • Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions. • Encourage the ability to 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	Laboratory Skills *(R, U, E, C)* • Understand and apply standard operating procedures as per Good Laboratory Practices so as to develop laboratory skills and qualities required for conducting successful research projects • Develop instrumentation handling skills and laboratory techniques relevant to academia • 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 and laboratory practices in the context of teamwork as well as life on the outdoors.

PSO4	Research Aptitude and Interdisciplinary Approach *(Ap, An, E, C)* • Inculcate and adapt to research aptitude and culture, integrate research-based knowledge in an interdisciplinary framework, and 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: SIPZOCC511
Course Name: Phylogeny & Systematics of Non-chordates, Developmental Biology and Genetics
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Nonchordates- I	**CO1:** • 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.	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 2: Nonchordates-II Hemichordates	**CO2:** • 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. • Critically analyze the organization, complexity and characteristic features of Non-chordates, Hemichordates and familiarize with the morphology and anatomy of representatives of various	*R, U, An*	*PO1, PO2* *PSO1,PSO2*

	animal phyla.		
Unit 3: Developmental Biology - I	**CO3:** • 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. • Get acquainted to the concept of stem cells, their types, function, role in cancer biology and ethical issues related to stem cells.	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 4: Genetics	**CO4:** • To inculcate the understanding of organization of genetic material, structure of chromosomes Chromosome number, shape, and types. • Build a conceptual framework of the science of inheritance – genetics, through discussion on Mendelian inheritance, cytoplasmic inheritance and touching on human genetics. Acknowledge the lasting contribution of Gregor Mendel and his methodology demonstrating his scientific and perseverant traits.	*R, U, An, Ap*	*PO1, PO2* *PSO1, PSO2*

Course Code: SIPZOCC512
Course Name: Biochemistry and Tools & techniques in Biology
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	**CO1:** • 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.	*R, U*	*PO1, PO2* *PSO1, PSO2*
Unit 2: Metabolic pathways and Integration of Metabolism	**CO2:** • Understand the properties of enzymes and importance of catalysis with respect to energy production. • Understand the roles of ATP and reduced co-factors in shuttling energy and electrons within the cells. • Understand the concepts of bioenergetics including determining and evaluating the free energy and redox potential in relation to metabolism.	*R, U*	*PO1, PO2* *PSO1, PSO2*

	• Get acquainted to various enzymes incorporated in regulation of metabolic pathways. • 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. • Thoroughly learn about the regulation of carbohydrates and lipid metabolism. Also, the Metabolic importance of amino acids. • Understand the roles of hormones in regulating metabolism. • Comprehend the knowledge of metabolism in health and disease.		
Unit 3: Principles and Applications of Microscopy	**CO3:** • 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. • To learn about the principles of microtomy which bridges the process between specimen collection and microscopic analysis. Also, to get habituated to the standard operating procedure and calibration, use, care/maintenance of microtome- one of the most essential skills in histological studies.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2, PSO3*
Unit 4: Principles and Applications of Spectroscopy	**CO4:** • 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.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2, PSO3*

Course Code: SIPZOCC513
Course Name: Biostatistics
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO

Unit 1: Biostatistics-I	**CO1:** • It will help students to learn about the basics of statistics and its involvement in various steps like generation of hypothesis, collection of data, and application of statistical analysis. • Analyze the different types of data using appropriate statistical software.	*R, U, Ap, An, E*	*PO1, PO2* *PSO1, PSO2, PSO4*
Unit 2: Biostatistics-II	**CO2:** • Explore the basic principles to apply descriptive and inferential methodologies according to the type of study design for answering a particular research question. • Understand and apply hypothesis tests for a single mean and a single proportion as well as for two means (independent and paired/matched samples), and understand chi-squared test and ANOVA.	*R, U, Ap, An, E*	*PO1, PO2* *PSO1, PSO2, PSO4*

Course Code: SIPZOEL511
Course Name: Biotechnology and Gene Manipulation
The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: Large scale culture and production from recombinant microorganisms	**CO1:** • Keep abreast with the current trends in this fast-moving field of Biotechnology, that is an intersection of technology and Biology. • Gain an in-depth knowledge of the application of recombinant DNA technology in food, microbial technology and for the production of genetically engineered animal cells to obtain commercial products for human use. • Learn about different types of fermenters employed to obtain different commercial products and to understand basics of recombinant cell physiology, for process development and industrial production of recombinant proteins • Comprehend the knowledge of animal cell cultures and their role as adequate test systems for studying biochemical pathways, virus production, pathological mechanisms, and intra/intercellular responses.	*R, U, Ap, An*	*PO1, PO2, PO7* *PSO1, PSO2*

Unit 2: Medical Biotechnology	**CO2:** • To emphasize the significance of Biotechnology in the field of medicine for production of therapeutic agents viz., vaccines and monoclonal antibodies that have revolutionized medical science. • Get acquainted to the modern tools practiced in medical biotechnology. • Learn about the biological reagents such as engineered monoclonal antibodies and their role in improved laboratory diagnostics. • Gain knowledge about improvements in vaccine technology and improved therapeutics such as humanized monoclonal antibodies, genetically engineered cytokines like interferons, hormones, and growth factors.	*R, U, Ap, An,*	*PO1, PO2* *PSO1, PSO2*
Unit 3: Genome Management and Analysis	**CO3:** • Explore the basic tools of genetic engineering practiced in genome management and analysis. • To get acquainted to various gene transfer techniques employed in genome management- a skill-based approach in biotechnology. • Understand various methods used in genome analysis. Also, elucidate the mechanism, instrumentation, and commercial applications of the same.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2*

Course Code: SIPZORM511
Course Name: Research Methodology
The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/PSO**
Unit 1: Basic concepts in research, research methods and methodology	**CO1:** • 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. • Nurture the critical thinking and develop analytical reasoning amongst students. • Equip students with essential concepts and necessary skills for execution of a research project in their final year. • Develop skills in qualitative and quantitative data analysis and presentation. • Demonstrate the ability to choose methods appropriate to research objectives. Also,	*R, U, Ap, An*	*PO1, PO2, PO3, PO4, PO5, PO7* *PSO1, PSO2, PSO3, PSO4*

	develop the link between quantitative research questions and data collection and how research questions are operationalized in educational practice. • Develop an ability to distinguish between a purpose statement, a research question or hypothesis, and a research objective.		
Unit 2: Scientific research writing, research review and research ethics	**CO2:** • Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project. • 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.	*R, U, Ap, An*	*PO1, PO2, PO3, PO4, PO5, PO7* *PSO1, PSO2, PSO3, PSO4*
Unit 3: Research grants, funding agencies and research projects	**CO3:** • Gain knowledge about different funding agencies and how to apply for grants and securing research funding of conducting research.	*R, U, Ap, An*	*PO1, PO2, PO3, PO4, PO5, PO7* *PSO1, PSO2, PSO3, PSO4*

PRACTICAL

"*Study nature not books.*" – An old dictum.
The practical course in Zoology is designed for first hand study of animal life through observation of preserved specimens, *in situ* organ systems, microscopic examination of permanent slides, etc. as well as to perform experiments to strengthen the concept base.

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

Semester I – Practical

Course Code: SIPZOCCP511
Course Name: Based on Core course-1 (SIPZOCC511)

Details	**Course Outcomes (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**

SIPZOCCP511	• Identify and describe various specimens, permanent microscope slides with respect to specific characteristic features in invertebrate animal kingdom. • Understand chromosomes by performing and observing (under light microscope) squash preparation of onion root tip. • Understand the different mouthparts of insects and its mode of feeding in several ways using various sources of food. • Temporary preparation of polytene chromosomes from *Drosophila* 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. • Detect the presence of Barr body in the buccal smear and understand its genetic and clinical significance. • Learn in detail about the common fruit fly, *Drosophila melanogaster*, as a versatile model organism in diverse range of biological studies. Also, to learn about the contrasting traits between the female and male *Drosophila melanogaster* and its use in genetic studies.	*R, U, An, C*	*PO1, PO2, PO8* *PSO1, PSO2, PSO3*

Course Code: SIPZOCCP512
Course Name: Based on Core course-2 (SIPZOCC512)

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPZOCCP512	• 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. • 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. • Analyze the importance of laboratory safety practices and safety symbols, for awareness	*R, U, An, Ap, E*	*PO2, PO5, PO6* *PSO1, PSO2, PSO3*

	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.		

Course Code: SIPZOELP511
Course Name: Based on DSE (SIPZOEL511)

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPZOELP511	• Comprehend the significance of aseptic techniques in biotechnological experiments and demonstrating those techniques-an important step to skill development in biotechnology. • Understand the significance of culture media in microbiology, develop necessary skills for preparing culture media, demonstrate the techniques to culture bacteria using some commonly practiced techniques in laboratory. • Isolation of genomic DNA from the given strain of bacteria/ tissue and show the purity of the isolate by performing agarose gel electrophoresis, thereby developing skills in electrophoretic techniques. • Estimate the number of bacteria in the given culture by the technique of Nephelometry.	*R, U, An, Ap, E*	*PO2, PO5, PO6* *PSO1, PSO2, PSO3*

Course Code: SIPZORMP511
Course Name: Based on RM (SIPZORM511)

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO

SIPZORMP511	• Frame a title for a research paper, choose key words and write an abstract for the provided sample research paper having its title, abstract and key words masked. Also, compare the accuracy of their framed title, key words an abstract with that of the sample research paper. • Develop a skill of making of a research poster based on the given sample research paper and its presentation. • Develop a skill of presenting a research work in the form of PowerPoint tool in a specified time duration. • Write a review of a research work by following given set of guidelines- one of the necessary skills to have in research methodology. • Write a research proposal- a prerequisite to commencement of a research work.	*R, U, An, Ap, E, C*	*PO1, PO2, PO3, PO4, PO6* *PSO2, PSO4*

Semester II – Theory

Course Code: SIPZOCC521

Course Name: Phylogeny & Systematics of Chordates, Developmental Biology and Evolution

The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitiv eLevel**	**Affinity with PO/ PSO**
Unit 1: Protochordates and Chordates- II	**CO1:** • 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.	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 2: Chordates- II	**CO2:** • 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	*R, U, An*	*PO1, PO2* *PSO1, PSO2*

	of various animal phyla.		
Unit 3: Developmental Biology- II	**CO3:** • Introduction to the morphogenetic, molecular, and cellular, and genetic aspects of the developmental biology of animals**.** • Become familiar with the major animal model systems used in developmental biology, such as Sea urchin, Tunicates, *C. elegans*, *Drosophila*, Amphibians, Fish, Chick, and Mouse. • Students will understand the general developmental mechanisms, including terms and concepts of developmental biology, such as induction, autonomous specification, morphogens, differential adhesion etc. • The biological information that underlies ethical issues such as stem cells and human cloning.	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 4: Evolution	**CO4:** • To demonstrate understanding of ecological and evolutionary processes including the role of genetic variation, heredity. • Students will be able to understand natural selection as well as the implications these processes have for the origins and evolution of modern humans and their biology.	*R, U, An, Ap*	*PO1, PO2* *PSO1, PSO2*

Course Code: SIPZOCC122
Course Name: Biochemistry and Tools & techniques in Biology
The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: Metabolic pathways and Integration of Metabolism	**CO1:** • 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.	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 2: Enzymes and Enzyme kinetics	**CO2:** • Students will 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**.** • Student will understand in quantitative terms, the chemical changes catalyzed by the component enzymes of the route.	*R, U, An*	*PO1, PO2,* *PSO1, PSO2*

Unit 3: Principles and Applications of Chromatography	**CO3:** • Students will understand the analytical techniques for separating chemical components in biological samples. • Students will gain knowledge about the principles and applications of chromatography. • Student will inculcate the different types of Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedure of affinity chromatography.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2, PSO3*
Unit 4: Principles and Applications of Electrophoresis	**CO4:** • To help the students inculcate how the electrophoresis techniques use for separating macromolecules in biological samples and its applications. • Since all solutes are not colored knowledge of visualizing agent will help the students locate the isolated solutes in electrophorogram.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2, PSO3*

Course Code: SIPZOCC523
Course Name: Bioinformatics
The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: Bioinformatics- I	**CO1:** • Use and understand bioinformatics tools to analyses proteomics data, involving identification and quantification approaches. • Discuss standards in proteomics bioinformatics and recognize its importance. • Evaluate the strengths and weaknesses of several experimental and bioinformatics analysis approaches. • Use tools to perform functional annotation of lists of protein.	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 2: Bioinformatics- II	**CO2:** • Students will understand how to utilize bioinformatics tools and databases for retrieving, analyzing, understanding, and managing biological data. • The program aims to understand how genes and proteins determine their functions and establish evolutionary relationships.	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*

Course Code: SIPZOEL521
Course Name: Biotechnology and Gene manipulation
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Microbial synthesis of commercial products	**CO1:** • Students will gain in-depth understanding of basic aspects of microbiological science pertaining to industrial applications. The student will be able to assess treatment strategies.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2*
Unit 2: Enzyme technology in large scale production	**CO2:** • Students will learn about the process of fermentation which is frequently used for the cultivation of biomass and in the production of enzymes, pharmaceuticals, energy, food and feedstock, bioactive compounds, biopolymers, etc., in which different microorganisms are involved.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2*
Unit 3: Environmental biotechnology	**CO3:** • The aim of environmental biotechnology is to prevent, arrest and reverse. environmental degradation through the appropriate use of biotechnology in combination with other technologies. • The course is an introduction to environmental biotechnology and focuses on the utilization of microbial processes in bioremediation. And elementary relevant microbiological processes, microbial ecology and basic principles in bioremediation and biological waste water treatment. • Evaluate the potential for biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, with respect to bioleaching.	*R, U, Ap, An*	*PO1, PO2* *PSO1, PSO2*

Course Code: SIPZOOJ521
Course Name: On Job training or Field project
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
No Theory Paper	• Give students structured training for exposure to real working environment. • Combine experiential learning with theoretical concepts. • Increase employability of students. • Strengthen the academia-industry linkage. • To acquire the learning, skills, knowledge, and attitudes necessary to meet all the requirements of the overall program. • Understand the work ethics, human relations, and safety. • Develop management skills, in co-ordination with team members to achieve the goal.	*R, U, Ap, An, E*	*PO1, PO2, PO3, PO4, PO5, PO6, PO7* *PSO1, PSO2, PSO3 PSO4*

PRACTICAL

"*Study nature not books.*" – An old dictum.
The practical course in Zoology is designed for first hand study of animal life through observation of preserved specimens, *in situ* organ systems, microscopic examination of permanent slides, etc. as well as to perform experiments to strengthen the concept base.

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

Semester II – Practical

Course Code: SIPZOCCP521
Course Name: Based on Core course-1 (SIPZOCC521)

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPZOCCP521	• Appreciate the complexity of organisms in a hands-on learning environment. • Expand the understanding of diversity of animal life by an account of animals with more complex levels of organization (Protochordates and Vertebrates); an understanding that may aid a healthy man-animal coexistence. • Examine a beating heart under light microscope and determine its rate by using crustacean arthropod Daphnia. Also effect of stressors on its heart rate. Also, elucidate the effect of stressors on its heart rate. • Demonstration of isolation of limb bud and its chorio-allantoic grafting to explores the ability of the chick chorio-allantoic membrane to support an excised limb bud from a donor embryo.	*R, U, An*	*PSO2, PSO3*

Course Code: SIPZOCCP522
Course Name: Based on Core course-2 (SIPZOCC521)

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPZOCCP522	• 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. • Realize the ease of carrying out chromatography in college laboratory, a separation technique with wide applications. • 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. • 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.	*R, U, An, E*	*PO1, PO2, PO6* *PSO2, PSO3*

Course Code: SIPZOELP521
Course Name: Based on DSE (SIPZOEL521)

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPZOELP521	• Immobilize yeast cells in calcium alginate and prepare a bioreactor column to demonstrate invertase activity in the bioreactor column in order to understand the catalytic role of invertase and its commercial significance. • Plot a growth curve for the microorganisms provided to determine patterns of growth over time and to understand differential effects of media, genetics, and stress on microbial population growth. • 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. • Construction of phylogenetic tree- used as a tool to represent hypotheses about the evolutionary relationships among a group of organisms.	*R, U, An, E*	*PO1, PO2, PO6* *PSO2, PSO3*

Course Code: SIPZOOJP521
Course Name: Based on On-job training/Field Project (SIPZOOJ521)

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPZOOJP521	• Students are required to present the work done during the course of internship in order to: • Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media. • Confidently share views and express themselves. • Use ICT in a variety of learning and work situations. • Access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data.	*R, U, An, Ap, E, C*	*PO1, PO2, PO3, PO4, PO6* *PSO1, PSO2, PSO3*

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Semester I – Theory

A) Major

a) Mandatory Papers

Paper Code: SIPZOCC511

Core course-1: Phylogeny of Non-chordates, Developmental Biology and Genetics

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 phylogenetic and taxonomic studies.*
- *To study Developmental Biology to appreciate how embryonic cells interact ultimately to form the entire organism.*
- *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.*

Unit 1: Nonchordates **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 : Phylogeny, salient features, classification up to classes (wherever applicable) of the following phyla:
1.2.1 : Protista (Protozoa)
1.2.2 : Porifera
1.2.3 : Coelenterata
1.2.4 : Ctenophora
1.2.5 : Platyhelminthes and Nemathelminths
1.2.6 : Acanthocephala
1.2.7 : Annelida
1.2.8 : Sipunculoidea

Unit 2: Nonchordates and Hemichordata **15 Lectures**

2.1. : Phylogeny, salient features, classification up to classes (wherever applicable) of the following phyla:
2.1.1 : Arthropoda
2.1.2 : Onychophora: Peripatus, a connecting link between Annelida and Arthropoda
2.1.3 : Mollusca
2.1.4 : Bryozoa
2.1.5 : Brachiopoda
2.1.6 : Echinodermata
2.1.7 : Chaetognatha

2.2. : Systematic position and affinities of Hemichordata

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.

Unit 3: Developmental Biology **15 Lectures**

3.1 : Basic concepts in Developmental Biology
3.1.1 : Cell fate and commitment
3.1.2 : Mechanism of developmental commitment

3.1.3 : Mosaic and regulative development
3.1.4 : Pattern formation and compartments
3.1.5 : Morphogenesis and cell adhesion:
a) Differential cell affinity
b) Cadherins and Catenins
c) Sorting out of embryonic tissues and cell recognition

3.2 : Cell differentiation and Totipotency
3.2.1 : Nucleocytoplasmic interaction
3.2.2 : Mechanism of gene action during cell differentiation
3.2.3 : Factors affecting cellular differentiation
3.2.4 : Maintenance of differentiation

3.3 : Stem cells.
3.3.1 : Types of stem cells and their function in development
3.3.2 : Stem cells and their role in cancer biology.
3.3.3 : Ethical issues related to stem cells**.**

Unit 4: Genetics **15 Lectures**

4.1 : Organization of Genetic material
4.1.1 : Structure of chromosomes
4.1.2 : Chromosome number, shape, and types
4.1.3 : Variations in chromosome structure and chromosome number

4.2 : Principles of Mendelian Genetics
4.2.1 : Mendel's laws
4.2.2 : Incomplete or partial dominance and co-dominance
4.2.3 : Epistasis
4.2.4 : Multiple alleles
4.2.5 : Lethal alleles (recessive and dominant)
4.2.6 : Polygenic inheritance

4.3 : Linkage & crossing over
4.3.1 : Chromosomal theory of linkage
4.3.2 : Mechanism and types of crossing over

4.4 : Non-Mendelian Inheritance
4.4.1 : Maternal effects; Shell coiling in snails, pigmentation in moths
4.4.2 : Cytoplasmic inheritance: Mitochondria, chloroplasts, plasmids, infective particles

a) **Mandatory Papers**

Paper Code: SIPZOCC512

Core course-2: Biochemistry and Tools & techniques in Biology

Learning objectives:

- *To go into the details of biomolecules which form the chemical basis of life.*
- *To study in detail the chemical processes that occur in living organisms that maintain life and the modes to regulate them.*
- *To deal with the tools and techniques in Biology that has helped enhance our understanding of the various aspects of Biology.*

Unit 1: Biomolecules - A structural and functional approach **15 Lectures**

1.1: Carbohydrates

1.1.1: Classification: Monosaccharides, oligosaccharides and polysaccharides

a) Monosaccharides: Structure, classification, D- and L-isomers, anomers and mutarotation, pyranose and furanose forms, reactions of monosaccharides, glycosidic bond and nomenclature.
b) Oligosaccharides
c) Polysaccharides: Homopolysaccharides and heteropolysaccharides

1.2.2: Biological functions of carbohydrates

1.2: Lipids

1.2.1: Classification: Simple and complex lipids

1.2.2: Fatty acids: Even and odd carbon fatty acids, numbering the carbon atoms, saturated and unsaturated fatty acids, cis- and trans-configuration, nomenclature.

1.2.3: Acylglycerols: Monoglycerides, diglycerides and triglycerides. Properties of triacylglycerols

1.2.4: Complex lipids: Phospholipids, sphingolipids, sterols and waxes

1.2.5: Biological functions of lipids

1.3: Proteins

1.3.1: Amino acids: Structure, classification

1.3.2: Organization of protein structure: Primary structure and peptide bond, secondary, tertiary and quaternary structure;

1.3.3: Conjugate proteins: Haemoglobin, cytochromes, myoglobin; bonds involved in protein organization

1.3.4: Biological functions of proteins: Biologically important peptides: Glutathione, octa-, nona-, and deca-peptides

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: Ganglioside

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

Unit 2: Metabolic Pathways and Integration of metabolism **15 Lectures**

2.1: Carbohydrate metabolism

2.1.1 : Glycolysis: Reaction sequence, aerobic and anaerobic glycolysis, energetics of glycolysis. Regulation of glycolysis

2.1.2 : Gluconeogenesis: Reaction sequence from pyruvate, gluconeogenesis from amino acids and glycerol. Regulation of gluconeogenesis

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

2.1.4 : Significance of the following pathways: Hexose monophosphate shunt as a multifunctional pathway

2.1.5 : Inborn errors of metabolism in carbohydrate metabolism: Glycogen storage disease, G-6-PD deficiency

2.2: Lipid Metabolism

2.2.1 : 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

2.2.2 Inborn errors of metabolism in lipid metabolism: Metabolic disorders of cerebrosides

Unit 3: Principles and Applications of Microscopy, Microtomy techniques **15 Lectures**

3.1: Microscopy:

3.1.1: Light microscopy, phase contrast microscopy, fluorescence microscopy, polarization microscopy, confocal scanning microscopy; standard operating procedure and calibration, use, care/maintenance of microscopes

3.1.2: Transmission electron microscopy, scanning electron microscopy, Preparation of standard operating procedure and calibration, use, care/maintenance

3.2: Microtomy: Tissue fixation, dehydration, clearing, infiltration, embedding for paraffin method, sectioning, mounting, and staining: differential and specific; standard operating procedure and calibration, use, care/maintenance of microtome

Unit 4: Principles and Applications of Spectroscopy **15 Lectures**

4.1: Ultraviolet and visible absorption spectroscopy; standard operating procedure and calibration, use, care/maintenance of colorimeter/spectrophotometer

4.2: Fluorescence spectroscopy

4.3: Nuclear magnetic resonance spectroscopy

4.4: Mass spectroscopy

4.5: Atomic absorption spectrophotometer

a) Mandatory Papers

Paper Code: SIPZOCC113

Core course-3: Biostatistics

Learning objectives:

- *To get acquainted with various statistical techniques applied in biosciences.*
- *To get familiarized with several different tools used to analyze statistical data.*

Unit 1: Biostatistics- I **15 Lectures**

1.1: Basic concepts of sample statistics -Mean, Median, Mode, and Standard Deviation.

1.2: Concept of sample size and power

1.3: Concept of randomization and sampling techniques

1.4: Concept of significance and confidence limits

1.5: Introduction to Various statistical tests - parametric and non-parametric

1.6: Use of Statistical Packages for Data evaluation

1.7: Concept of level of significance, power of test and confidence limits

1.8: Application of normal distribution

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

2.1: Statistical approach to biological samples

2.2: Introduction to Data collection techniques

2.3: Design of experiments, for e.g. Block designs, Latin square

2.4: COV and ANOVA (one way ANOVA and two way ANOVA)

2.5: Concept of correlation, coefficient of correlation and its calculation by using Pearson's coefficient of correlation

2.6: Regression analysis with application to Standard Graph

2.7: Student's t test, chi square test, z test and f test

b) Electives

Paper Code: SIPZOEL111
DSE: Biotechnology and Gene manipulation- I

Learning objectives:

- *To keep abreast with the current trends in this fast-moving field of Biotechnology, that is an intersection of technology and Biology.*
- *To gain an in-depth knowledge of the application of recombinant DNA technology in food, microbial technology and for the production of genetically engineered animal cells to obtain commercial products for human use.*
- *To emphasize the significance of Biotechnology in the field of medicine for production of therapeutic agents viz., vaccines and monoclonal antibodies that have revolutionized medical science.*

Unit 1: Large scale culture and production from recombinant microorganisms **15 Lectures**

1.1 : Batch fermentation
1.2 : Fed batch fermentation
1.3 Continuous fermentation
1.4 : Maximizing the efficiency of fermentation process
1.5 : Harvesting, disrupting and downstream processing
1.6 : Basic Design of bioreactors and its types
1.7 : Mammalian cell lines and their characteristics
1.8 : Media for the cultivation of mammalian cells
1.9 : Commercial products produced with mammalian cell culture

Unit 2: Medical Biotechnology **15 Lectures**

2.1 : Subunit vaccines:
2.1.1 : Subunit vaccine production against viruses: Herpes simplex, Bovine foot and mouth disease virus
2.1.2 : Peptide vaccines: Synthetic drugs (engineered proteins)
2.1.3 : Genetic immunization: DNA vaccines, Antisense DNA, Therapeutic ribozymes
2.1.4 : Live recombinant vaccines
2.1.5 : Attenuated vaccines against Cholera, Salmonella sp.
2.1.6 : Vector vaccines: Vaccine directed against viruses – Rabies virus G-protein, Hepatitis B surface antigen.
2.1.7 : Anti-idiotypic vaccine for cancer treatment.
2.1.8 : Recent development in vaccine development w.r.t. Covid19

2.2 : Monoclonal antibodies (mAbs) and therapeutic applications:
2.2.1 : mAbs for prevention of rejection of transplanted organs
2.2.2 : Treatment of bacterial blood infection
2.2.3 : Human monoclonal antibodies
2.2.4 : Hybrid human-mouse monoclonal antibodies
2.2.5 : HIV therapeutic agents
2.2.6 : Anti-tumour antibodies

Unit 3: Genome Management and Analysis **15 Lectures**

3.1 : The basic tools of genetic engineering:
3.1.1 : Cloning vectors: General purpose plasmid vectors: pUC19, pBR322, Bacteriophage and cosmid vectors.
3.1.2 : Yeast artificial chromosomes (YACs) as vectors

3.2 : Gene transfer techniques:
3.2.1 : Calcium phosphate co-precipitation, electroporation.
3.2.2 : Liposome mediated, crispr- cas9
3.2.3 : Gene gun or Biolistic approach, Protoplast fusion, viral mediated gene transfer techniques.

3.3 : Analysis of Genome:
3.3.1 DNA fingerprinting
3.3.2 Immunological assays: Western blot, ELISA
3.3.3 : Polymerase chain reaction and its Variants (RT-PCR, qPCR)
3.3.4 : Chemical synthesis of DNA: Oligonucleotide synthesis by Phosphoramidite method.

B) Research Methodology

Paper Code: SIPZORM111

RM: Research Methodology

Learning objectives:

- *To inculcate in students research aptitude and to develop an open, inquiring mind that is willing to explore new territories and learn new things.*
- *To encourage the spirit of curiosity of students, in order to develop the potential to be problem solvers and scientific investigators in their own way.*
- *To develop and enhance their research skills in order to make them adapt to the research culture*
- *To nurture critical thinking and develop analytical reasoning amongst students*
- *To equip students with essential concepts and necessary skills for execution of a research project in their final year.*

Unit 1: Basic concepts in research, research methods and methodology **15 Lectures**

Basic concepts in research - meaning of research, objectives of research, characteristics and purposes of research, significance and relevance of research

Research process or the process of Science – Scientific inquiry, Steps of scientific inquiry or flow diagram for the scientific method, Observation, Developing and Testing Hypothesis, Inductive reasoning, Predictions & Experiments, Deductive reasoning, Presenting & Analyzing the data, Scientific theory, Example / Case study of the Scientific method, Example / Case study of Hypothesis testing.

Types of research – fundamental research, applied research, translational research, etc and comparison of types of research – descriptive versus analytical, fundamental versus applied, qualitative versus quantitative, conceptual versus empirical; research methods versus research methodology.

Research problem – meaning and statement of research problem, formulating research problem, identification and selection of research problem, techniques involved in defining a research problem, types of variables (experimental and control groups etc)

Research design – meaning of research design, nature and importance of research design, concepts related to research design, types of research design, experimental designs for examples – informal experimental design, formal experimental design etc.

Methods of data collection, data presentation and data analysis – types of data (primary and secondary data), data collection methods (primary and secondary), tabulation and presentation of data, Hypothesis testing – overview of parametric test, non-parametric tests (chi-square test, analysis of variance, non-parametric tests), overview of multivariate analysis techniques (correlation analysis, regression analysis).

Unit 2: Scientific research writing, research review and research ethics **15 Lectures**

Report writing – meaning of report, meaning of research report and report writing, different steps in report writing, characteristic of report, significance of report

Scientific research writing – writing a research article/paper/manuscript, types of research articles, writing an abstract, types of abstracts, selection of key words, citing references/bibliography

(Harvard style, Numeric style, APA style, end note/foot note), overview of science communication organisations/companies or forums, opportunities as professional writers (examples such as Cactus Communications, India BioScience Newsletter etc).

Literature review – Introduction to literature review, steps in writing a literature review, relevance of literature review, primary research article/original research article, secondary research article/review article.

Research review and journals – critique and review of research paper/manuscript, overview of types of research journals and publications (examples of peer-reviewed, open access journals) relevance of impact factor, h-index, citations, overview of ResearchGate (professional network for researchers and scientists)

Model organisms in research and guidelines – Concept of model organisms, recommended laboratory animal models, Purpose bred species, Animal study design/preclinical trials, Organization for Economic Cooperation and Development (OECD) guidelines, Committee for Control and Supervision of Experiments on Animals (CCSEA) guidelines, Alternative to animal models.

Research ethics – Avoiding plagiarism, Awareness of misconduct or fraud, Acknowledgement / Declaration of conflict of interest; Plagiarism checker software (Examples – Turnitin, Urkund etc); Overview of composition and responsibilities of Institutional Animal Ethics Committee (IAEC), Overview of composition and responsibilities of Institutional Ethics Committee (IEC), Overview of Indian Council of Medical Research guidelines (ICMR) for Biomedical research, Overview of International Conference on Harmonization – Good Clinical Practices (ICH-GCP) guidelines

Unit 3: Research grants, funding agencies and research projects **15 Lectures**

Research grants/funds – concept of getting research grants or funds or research projects.

Research projects – writing a research proposal / project; components of research proposal/project; major/minor research projects (University Grants Commission, University of Mumbai etc), components of research grants (for example - consumables, contingency grants, utilization certificate etc)

Funding agencies in India – overview of government and nongovernment funding agencies in India (Examples such as Department of Science & Technology; Department of Biotechnology; Indian Council of Medical Research; Council of Scientific & Industrial Research; Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha & Homeopathy; Indian National Science Association; etc);

Research fellowships in India – concept of research fellowship, research fellows – junior research fellow, senior research fellow, research associate etc; Examples of fellowships – Prime Ministers Research Fellowship, ICMR JRF, CSIR-UGC JRF, DBT-JRF, TATA Innovation Fellowships, DST- INSPIRE, DBT- Ramanujan fellowships etc.

Global funding agencies/Research fellowships worldwide – overview of international funding agencies, how to apply to global funding agencies, examples such as Fulbright Program, United States India Educational Foundation (USIEF), British Council Fellowship, Humbolt Research Fellowship etc.

Semester I
Practical- I (SIPZOCCP511)
Based on Core Course-1 (SIPZOCC511)

1. Study of Animal type:
   Earthworm: Morphology, Digestive system, nervous system; mounting of setae, spermatheca, ovaries & nephridia
2. Study of Systematics and major features of:
   a) Protozoa: *Amoeba, Euglena, Paramoecium, Plasmodium*
   b) Porifera: *Leucosolenia, Euplectella, Euspongia*
   c) Coelenterata/ Cnidaria: Sea anemone, Madrepora, *Aurelia*
   d) Helminthes: *Planaria*, Liverfluke, Tapeworm, *Ascaris*.
   e) Annelida: Nereis, Earthworm, Leech
   f) Arthropoda: Crab, Scorpion, Limulus, Centipede, Millipede, Beetle
   g) Mollusca: *Chiton*, *Dentalium*, *Patella*, *Achatina*, *Mytilus*, Octopus,
   h) Echinodermata: Starfish, Brittle star, Sea urchin, Sea cucumber, Feather star
   i) Hemichordata: *Balanoglossus*
   j) Study of larval forms:
      Larvae of Helminthes (Miracidium, Redia, Cercaria, Metacercaria); Trochophore larva; Crustacean larvae; Ascidian tadpole, Echinoderm larvae and Tornaria larva
3. Temporary preparation of onion/garlic root tip cells to study stages of mitosis and calculate mitotic index
4. Study of mouth parts of cockroach and study of salivary glands of cockroach
5. Study of polytene chromosomes from salivary gland cells of Drosophila/ Chironomus larva
6. Temporary preparation of buccal smear to study sex chromatin in human Culture and maintenance of Fruit fly
7. Determination of sex in drosophila (morphological examination)

Semester I
Practical- II (SIPZOCCP512)
Based on Core Course-2 (SIPZOCC512)

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,
2. Benedict's test, Picric acid test, Mucic acid test, and Bial's test
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. Determination of acid value of fats/ oils
7. Determination of saponification value of fats/ oils
8. Reichert-Meissl (RM) number of fats
9. Study of Good Laboratory Practices (GLP): Globally Harmonized System (GHS), Application and relevance of GHS (Physical Hazards, GHS Health and Environmental Hazards); GHS for classification and labelling of chemicals, chemical hazards/pictograms, symbols, signal words, hazard statements; GHS Safety Data Sheet (SDS)/Material Safety Data Sheet (MSDS);

Chemical spillage/disposal, Fire safety and extinguishers.

10. Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining
11. Determination of pKa of a weak acid
12. Colorimeter: Selection of filter and determination of unknown concentration of solute

Note: There are no practical's based on Paper 3 (Biostatistics- SIPSZOCC513)

Semester I
Practical- IV (SIPZOELP511)
Based on DSE (SIPZOEL511)

1. Demonstration of aseptic technique: Work place for aseptic handling; packing glassware (flasks, test tubes, pipettes, petri dishes) for sterilization; aseptic transfer of liquids (Pipetting from flask to test tube).
2. Preparation of LB agar plate, slant, butt and demonstration of streaking technique using bacterial culture to obtain isolated colonies.
3. Determination of viable cell count in the given culture of bacteria by dilution and spreading technique.
4. Isolation of genomic DNA from the given strain of bacteria/ tissue and show the purity of the isolate by performing agarose gel electrophoresis.
5. To estimate the number of bacteria in the given culture by Nephelometry

Semester I
Practical- V (SIPZORMP511)
Based on RM (SIPZORM511)

Practical based on Research Methodology

1. Student will be provided with a sample research paper, whereby, the title, abstract, key words will be masked, and the student will be required to frame a title for that research paper, choose key words and write an abstract for the sample research paper.
2. Then, the student will be given the same sample research paper, however, now it will be unmasked and the student will be asked to compare the accuracy of their title, key words, and abstract with the sample research paper.
3. Students will be provided with a sample research paper, and the students will prepare a poster on a chart paper, for poster presentation of that research work. The poster must include the following: introduction, objectives, materials and methods, observation, results, conclusion and discussion, relevance/impact, bibliography.
4. Students will be provided with a sample research paper, and the students will prepare a power point presentation, for presentation of that research work. The presentation must include the following: introduction, objectives, materials and methods, observation, results, conclusion and discussion, relevance/impact bibliography.
5. Students will be provided with a sample research paper, and the students will write a review for that research paper. The review must include the following: overview of the research paper, advantages or impact of research paper, limitations or shortcomings of the research paper, future plan or extension of the research work.

6. Students will be given a research topic, and the students will write a research proposal, giving outline/scheme for execution of the proposed research work. The outline/scheme of the proposed research work must include: literature review, objectives, purpose and rationale, materials and methodology, results, conclusion and discussion, bibliography.

Semester II – Theory

A) Major

a) Mandatory Papers

Paper Code:
SIPZOCC521

Core course-1: Phylogeny & Systematics of Chordates, Developmental Biology and Evolution

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 phylogenetic and taxonomic studies.*
- *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.*

Unit 1: Protochordates and Chordates-I **15 Lectures**

1.1 : Phylogeny, salient features, classification up to classes (wherever applicable) of the following phyla
1.1.1 : Urochordata and its affinities
1.1.2 : Cephalochordata and its affinities
1.1.3 : Salient features and phylogeny of Ostracoderms
1.1.4 : Affinities of Cyclostomes:
1.1.5 : Overview of fish phylogeny
1.1.6 : Primitive tetrapods: Labyrinthodonts
1.1.7 : Crossopterygians: A blue print
1.1.8 : Dipnoi: A group that has failed to evolve as Amphibia
1.1.9 : Lissamphibia

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

2.1 : Phylogeny, salient features, classification up to classes (wherever applicable) of the following phyla:
2.1.1 : *Sphenodon*: a living fossil
2.1.2 : Extinct reptiles
2.1.3 : Adaptive radiation in Reptilia
2.1.4 : Warm blooded reptiles; Archaeopteryx: A connecting link between Reptiles and Aves
2.1.5 : Affinities of Aves and classification up to subclass
2.1.6 : Birds as glorified reptiles
2.1.7 : Egg laying mammals: A connecting link between reptiles and mammals
2.1.8 : Classification of mammals up to orders
2.1.9 : Walking gait: Plantigrade, Digitigrade and Unguligrade

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.

Unit 3: Developmental Biology **15**

Lectures

3.1 : Cell specialization: RBC, secretory cell, retinal rod cell

3.2 : Organizer and its role in embryonic development

3.3 : Primary embryonic induction

3.4 : Metamorphosis, Regeneration and Aging:

3.4.1 : Metamorphosis:

a) Progressive metamorphosis: Amphibian metamorphosis

b) Metamorphosis in insects – Types of insect metamorphosis; eversion and differentiation of imaginal discs; hormonal control of insect metamorphosis.

c) Retrogressive metamorphosis: Ascidian.

d) Programmed cell death

3.4.2 : Regeneration: Regeneration in Hydra; regeneration of salamander limbs

3.4.3 Aging: Senescence, life span and causes of aging

Unit 4: Evolution **15**

Lectures

4.1 : Concept of evolution and theories of evolution: Lamarckism, Darwinism, De Vries Mutation theory, Neo-Darwinism and other significant theories.

4.2 : Geological time scale

4.3 : Human evolution

4.4 : Population and Evolutionary genetics

4.4.1 : Gene pool, speciation

4.4.2 : Calculating allelic frequencies

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

4.4.4 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

a) Mandatory Papers

Paper Code: SIPZOCC522

Core course-2: Biochemistry and Tools & techniques in Biology

Learning objectives:

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

Unit 1: Metabolic pathways and integration of metabolism **15**

lectures

1.1 : Protein Metabolism

1.1.1 : 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

1.1.2 : Metabolism of ammonia: Urea cycle

1.2 : Metabolism of Nucleic acids

1.2.1 : Synthesis of ribonucleotides: A brief idea of de novo pathway and salvation pathway
1.2.2. Conversion of ribonucleotides to deoxyribonucleotides
1.2.3: Degradation of nucleotides

1.3 : Integration of Metabolism
1.3.1 : Energy demand and supply; integration of major metabolic pathways of energy metabolism
1.3.2 : Intermediary metabolism; organ specialization and metabolic integration
1.3.3 : Metabolism in starvation

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 Vmax and Km; 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: Principles and Applications of Chromatography **15**

lectures

3.1 :Planar chromatography (Paper chromatography and Thin layer chromatography): Preparation of stationary support, solvent, detection and measurement of components, applications; concept of method development and method validation in chromatography
High Performance Thin Layer Chromatography (HPTLC): Instrumentation, selection of operating conditions, analysis of data and application; standard operating procedure and calibration, use, care/maintenance of HPTLC

3.2 :Column chromatography:
Packing and operation of column, loading the column, eluting the column, collection of eluents, detection of eluent, applications
High Performance Liquid Chromatography (HPLC): Instrumentation, selection of operating conditions, analysis of data and application; standard operating procedure and calibration, use, care/maintenance of HPLC

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

3.4 :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

3.5 : Affinity chromatography:
Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedures and applications

3.6 : Gas chromatography:
Gas chromatography (GC): Instrumentation, selection of operating conditions, analysis of data and applications; standard operating procedure and calibration, use, care/maintenance of GC

Unit 4: **Principles and Applications of Electrophoresis** **15**

Lectures

4.1 : Electrophoresis:
4.2 : Theory and principle of electrophoresis
4.3 : Horizontal agarose gel electrophoresis
4.4 : Vertical polyacrylamide gel electrophoresis; standard operating procedure and calibration, use,
care/maintenance of electrophoretic units
4.5 : Pulse field electrophoresis
4.6 : Capillary electrophoresis
4.7 : Isoelectric focusing of proteins
4.8 : Two-dimensional electrophoresis

a) Mandatory Papers
Paper Code: SIPZOCC523

Core course-3: Bioinformatics

Learning objectives:

- *To gain insight of the potential of Bioinformatics – a field applying computer knowledge to study genomes.*

Unit 1: Bioinformatics- I **15**

lectures

1.1 : Gene experience, DNA microarray and Proteomics.
1.2 : Primary databases, Secondary databases.
1.3 : Gene experience: Introduction, Basic steps for gene expression.
1.4 : Microarray: - Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the
experiment, Two-colour microarray experiments.
1.5 : Tools for microarray analysis
1.6 : Microarray design, microarray experimentation, fabrication computational analysis of
Microarray data, Applications of microarray technology
1.7 : Proteomics:-Protein sequence information, composition, and properties,
physicochemical properties based on sequence, sequence comparison

Unit 2: Bioinformatics- II **15**

Lectures

2.1 : Protein Microarray and Phylogenetic analysis
2.2 : Proteomics classification; Tools and techniques in proteomics;
2.3 : 2-D gel electrophoresis, PAGE, isoelectric focusing, affinity chromatography, Mass

spectroscopy for protein analysis, MALDI-TOF, Electrospray ionization (EST), Tandem mass spectroscopy (MS/MS) analysis; tryptic digestion and peptide fingerprinting (PMF)

2.4: Protein Micro array in protein expression, profiling and diagnostics, drug target discovery.

2.5: Phylogenetic analysis:-

2.5.1 : Evolution, elements of phylogeny, methods of phylogenetic analysis

2.5.2 : Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools-Phylip, ClustalW.

2.6: Applications of Bioinformatics in various fields: Environment, biotechnology, molecular biology, neurobiology, agriculture, drug designing, biomedical genome medicines, medical microbiology.

b) Electives

Paper Code: SIPZOEL521

DSE: Biotechnology and Gene manipulation- II

Learning objectives:

- *To familiarize with the basic tools of genetic engineering involved in tailoring genetic information to delve into the genomes of organisms; designing cloning vectors and using DNA fragments as research tools.*
- *To procure knowledge of the biotechnological aspects dealing with degradation of xenobiotics that is foreign to our environment, and the effective utilization of biomass.*
- *To deal with the tools and techniques in Biology that has helped enhance our understanding of the various aspects of Biology.*

Unit 1: Microbial synthesis of commercial products **15**

Lectures

1.1: Organic acids and their commercial applications: Citric acid, gluconic acid, lactic acid

1.2: Antibiotics: Cloning antibiotic biosynthetic gene by complementation and other methods; synthesis of novel antibiotics and improving antibiotic production; Aminoglycosides and their uses

1.3: Polysaccharides:

1.3.1 : Bacterial polysaccharides: General properties and their commercial applications – Dextran, xanthan, alginate; genetic engineering for large scale production of xanthan gum and its modification

1.3.2 : Marine polysaccharides: General properties and their commercial application – Agar and agarose, Chitosan

1.4: Polyesters: Polyhydroxyalkanoates (PHA) – Biosynthesis of PHA; Biopol, a commercial biodegradable plastic

Unit 2: Enzyme technology in large scale production **15**

Lectures

2.1: Biotransformations

2.1.1 : Biocatalyst immobilization:

Methods of immobilization – Cross linking, supported immobilization, adsorption and ionic binding, covalent coupling, lattice entrapment

2.1.2 : Immobilized enzyme reactors: Batch reactors, Continuous reactors.

2.1.3 : Enzymes in diagnostic assays – Test strip systems; Biosensors**:** Principle, Working and types.

Unit 3: Environmental Biotechnology **15**

Lectures

3.1 : Biomass utilization:

3.1.1 :Production of single cell proteins by using biomass as raw material

3.1.2 :Commercial production of fructose and alcohol from biomass

3.2 : Bioremediation of xenobiotic compounds:

3.2.1 :Characteristics of xenobiotics in the environment

3.2.2 :Genetic engineering of biodegradative pathways: Manipulation by transfer of plasmid.

3.3 : Bioleaching of metals

3.3.1 :Biochemical mechanism of bioleaching.

3.3.2 :Types of bioleaching

3.3.3 :Methods for bioleaching: Tank and heap bioleaching

3.3.4 :Microorganisms used for bioleaching

Students Activity:

Visit to the industries/institutes involved in Biotechnology research:

To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based and Entrepreneurial approach.

Semester II

Practical – I

(SIPZOCCP521)

Based on Core course-1 (SIPZOCC521)

1. Study of Animal type:
   Fish (*Sciaena* – Dhoma or *Shark* – Mori): Morphology, Digestive system, Heart & Aortic arches, Urino-genital system, mountings of gills, scales.

2. Study of Systematics and major features of:
   a) Cephalochordata: *Amphioxus*
   b) Urochordata: *Ascidian*
   c) Agnatha: *Petromyzon*, *Myxine*
   d) Pisces: Shark, Sting ray, Mackerel, Hippocampus, Eel.
   e) Amphibia: *Caecilian*, Salamander, Frog, Toad, *Amphiuma*
   f) Reptilia: Turtle, Tortoise, Chameleon, *Phrynosoma*, *Hydrophis*, Crocodile, Gharial.
   g) Aves: Kingfisher, Kite, Vulture, Duck
   h) Mammals: Duck-billed platypus, Kangaroo, Shrew, Bat, Loris, Dolphin, Sea Cow (Dugong).

3. Determination of effect of stressors on heart rate of Daphnia.

4. Demonstration of isolation of limb bud and its Chorio-allantoic grafting.

Practical – II
(SIPZOCCP522)
Based on Core course-2
(SIPZOCC522)

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
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
9. Identification of lipids in a given sample by TLC
10. Separation of pigments from leaves or flowers by adsorption column chromatography 3.
11. Separation of amino acids by ion exchange chromatography using cation exchanger
12. Separation and identification of amino acids by two-dimensional paper chromatography
13. SDS-polyacrylamide slab gel electrophoresis of plasma proteins

Practical – IV
(SIPZOELP521)
Based on DSE
(SIPZOEL521)

1. Immobilize yeast cells in calcium alginate and prepare a bioreactor column to demonstrate invertase activity in the bioreactor column
2. To plot a growth curve for the microorganisms provided
3. Demonstrate the effect of media on growth curves of given microorganism, using two different media (minimal and enriched)
4. Quantitative estimation of DNA from a suitable tissue by Diphenylamine method
5. Quantitative estimation of RNA from a suitable tissue by Orcinol method
6. Molecular phylogeny: Construction of phylogenetic trees (using amino acid and nucleotide

Based on On-job training/Field Project (SIPZOOJ521) Practical based on Internship Report / On Job Training

Learning objectives:

- *To understand the inner workings of industries or research institutes in the field of animal sciences.*
- *To gain experience of hands-on work in a structured organization.*

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- Vertebrate Life: F.H.Pough, C.M.Janis, J.B.Heiser, 6th Ed. Pearson Education
- Functional Anatomy of Vertebrates. An evolutionary perspective. K.F.Liem, W.E.Bemis, W, F.Walker, L.Grande, 3rd Ed. Harcourt College Publishers 20
- The Life of Vertebrates: J.Z.Young, ELBS-Oxford Univ. Press
- A Text Book of Zoology; T.J.Parkar and W.A.Haswell, McMillan
- Chordate Zoology; E.L.Jordan and P.S.Verma, S. Chand & Company
- Biology of Invertebrates; J.A.Pechenik, 4th Ed, Tata McGraw Hill.
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- Analysis of Vertebrate Structure: Milton Hildebrand, Wiley International
- Life of Invertebrates; Russell, W.D. Hunter, McMillan
- Invertebrate Zoology: Bares, R.D., Saunders Publication
- Genetics; Daniel J. Fairbanks and W.R. Anderson. Wadsworth Publ.
- Prin. Of Genetics; Robert H. Tamarin; 7th Ed. Tata McGraw Hill
- Basic Human Genetics; Elaine Johansen Mange and Arthur Mange; Indian Reprint; 1997; Rastogi Publ.
- Genes and Evolution: A.P. Jha; MacMillon India
- Concepts of Genetics; William S. Kluge;, M.R.Cummings, Pearson Edu.
- Developmental Biology; Scott F. Gilbert, Sinauer Associates Inc.
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- Biology of Developing System; Philip Grant; Holt Saunders International Ed.
- Evolution; M. W. Strikberger, CBS Publ.
- Cytology and Genetics; Sumitra Sen and Dipak Kumar Kar, Narosa Publ.
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- An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
- Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
- Elementary Practical Organic Chemistry Part I: Small Scale

Preparations. 2nd Ed. Arthur I. Vogel. CBS
- Douglas A.Skoog, Principles of Instrumental Analysis, Saunders College Publishing
- Dr.P.D.Sethi, HPTLC High Performance Thin Layer Chromatography
- D.J.David, Gas Chromatographic Detectors, John Wiley & Sons
- Raymond P.W.Scott, Chromatographic Detectors Design Function Function and Operation
- James W.Robinson, *Practical Handbook of Spectroscopy*, Crc Press

SIPZOCC513 and 523:

- Rastogi, Veer Bala (2010) Fundamentals of Biostatistics Ane's Student Edition. New Delhi: Ane Books Pvt.
- Arora, P.N., Malhan, P.K. (2009) Biostatistics. Pune: Himalaya Publishing House
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- Susan R. Barnum, Biotechnology – An Introduction, Vikas Publishing House
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- R. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers
- Martin Fransman, GerdJunne, AnnemiekeRoobeek (Ed), The Biotechnology revolution?, Blackwell Scientific Publishers
- Terence Cartwright, Animal Cells as Bioreactors, Cambridge Univ. Press
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- T. A. Brown, Gene Cloning – An Introduction, 3rd Edition, Nelson Thornes
- Bob Old and S. B. Primrose, Principles of Gene Manipulation, 5th Edition, Wiley Blackwell Publishers
- U. Satyanarayan, Biotechnology, 2007 Reprint, Uppala Author Publisher Interlink

Additional Reading:

- The song of the cell – an exploration of medicine and the new human - Siddhartha Mukherjee

- The laws of medicine – field notes from an uncertain science - Siddhartha Mukherjee
- The Emperor of Maladies – Biography of Cancer - Siddhartha Mukherjee
- The Gene – an intimate history - Siddhartha Mukherjee

SIPZORM511:

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- Research Basics - Spikard James,
- Research methods - Mcburney, Donald,
- Research methodology in medical and biological sciences - Peter Laake, Benestad
- The craft of research - Wayne Booth
- Research design: Qualitative, Quantitative and Mixed Methods Approaches - John Crewel
- Introducing Research Methodology: A Beginner's Guide to Doing a Research Project - Uwe Flick
- Research Methods A Practical Guide for Students and Researchers - Willie Tan
- A Manual for Writers of Research Papers, Theses, and Dissertations, Ninth Edition: Chicago Style for Students and Researchers (Chicago Guides to Writing, Editing, and Publishing - Kate L. Turabian
- Writing scientific research articles - Margaret Cargill
- Writing a Postgraduate Thesis or Dissertation - Hammond, Michael

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M.Sc Part I – Zoology Syllabus (Autonomous)

Choice Based Credit System (With effect from academic year 2022-23)
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%):

For Core Course 1 and 2:

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.

For Core Course 3: (Assignments 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.

For Department Specific Elective (DSE): (Assignments marks: 25):

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%):

For Core Course 1 and 2:
Marks: 60
Duration: 2.5 hours
Theory question paper pattern:

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

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 weight age of the topic and by taking into account the Blooms Taxonomy for evaluation.

For Core unit 3:

- There shall be two 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 weight age of the topic and by taking into account the Blooms Taxonomy for evaluation.

Marks: 30
Duration: 1.5 hours

For Department Specific Elective:

Marks: 50
Duration: 2 hours
Semester End Assessment Practical:

For Core Units 1 and 2: Marks: 50 Duration: 5 hours

For Core Unit 3: No practical exam

For Department Specific Elective: Marks: 25 Duration: 2 hours

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