AC/4.8.18/RS 2

SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022
(Autonomous)

Faculty: Science

Program: M.Sc.-II

Subject: ZOOLOGY

Specialization: BIOTECHNOLOGY-ANIMAL PHYSIOLOGY

Academic Year: 2018 – 2019

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

Semester III and Semester IV
(Credit Based Semester and Grading System, with effect from academic year 2018-19)

Preamble

"You cannot inquire into reality if you are not courageous. Hence, courage comes first andeverything else follows."

Academic Autonomy signifies a paradigm shift to academic freedom which is instrumental in promoting 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 focuses on the need to furnish them with skills and understanding essential to make them self-sufficient and build a future.

This syllabus is an arena for students to explore the bridge between science and society by contemplating the life processes/ physiological processes that sustain life, and the technological advancements in Biology through Biotechnology that have raised the standard of living.

This syllabus is a product of the valuable inputs and ideas from the professors of Zoology at SIES College, Sion (West) and other board members from outside the institution. It was approved by the Board of Studies (Ad hoc) in the subject of Zoology, in the meeting held on 16th June 2018 at the institution's department of Zoology.

By implementing this course we expect to fulfil the aspirations of students who want to pursue careers in fields relating to applied medicine, healthcare, nutritional sciences, pharmaceuticals, etc. and those who want to venture into hard core research, eventually benefitting the society in whole.

Dr. Satish SarfareChairman,
Board of Studies in the subject of Zoology

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

THEORY				
Course name and code	**Unit**	**Topic Headings**	**Credits**	**Lectures/ week**
SEMESTER III				
Paper I: Basics of Industrial and Environmental Biotechnology - I				
SIPSZOBT31	1	The implications of recombinant DNA technology of commercial products and microbial synthesis	**4**	**1**
	2	Large scale culture and production from recombinant microorganisms and genetically engineered animal cells		**1**
	3	Medical Biotechnology		**1**
	4	Environmental Biotechnology- I		**1**
Paper II: Genetic Engineering Techniques and its applications				
SIPSZOBT32	1	Genome Management and Analysis	**4**	**1**
	2	Manipulation of Gene expression in Prokaryotes		**1**
	3	Bioinformatics		1**1**
	4	Animal Biotechnology and Human therapies		**1**
Paper III: Comprehensive Physiology- I				
SIPSZOPHY33	1	Levels of response and Nutritional Physiology	**4**	**1**
	2	Dynamics of Physiological fluids- Circulation		**1**
	3	Physiology of Mobility		**1**
	4	Neurotransmission Physiology		**1**
Paper IV: Environmental and Applied Physiology - I				
SIPSZOPHY34	1	Stress and Water as Environmental factors	**4**	**1**
	2	Oxygen as Environmental factor		**1**
	3	Environmental Radiation		**1**
	4	Enzymes and Body fluids as Clinical diagnostic tools		**1**
PRACTICAL				
SIPSZOBTP31	1	Based on **SIPSZOBT31**	**2**	**4**
SIPSZOBTP32	2	Based on **SIPSZOBT32**	**2**	**4**
SIPSZOPHYP 33	3	Based on **SIPSZOPHY33**	**2**	**4**
SIPSZOPHYP 34	4	Based on **SIPSZOPHY34**	**2**	**4**
		Total	**24**	**32**

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

THEORY				
Course name and code	**Unit**	**Topic Headings**	**Credits**	**Lectures/ week**
SEMESTER IV				
Paper I: Basics of Industrial and Environmental Biotechnology - II				
SIPSZOBT41	1	Microbial synthesis of commercial products	**4**	**1**
	2	Large scale culture and production for Industrial Biotechnology		**1**
	3	Agricultural Biotechnology		**1**
	4	Environmental Biotechnology- II		**1**
Paper II: Genome Management, Manipulation, Regulations and Patents in Biotechnology				
SIPSZOBT42	1	Genome Management	**4**	**1**
	2	Manipulation of Gene expression in Eukaryotes		**1**
	3	The Human Genome Project		1**1**
	4	Regulations and Patents in Biotechnology		**1**
Paper III: Comprehensive Physiology- II				
SIPSZOPHY43	1	Physiology of Respiration and Nitrogen Metabolism	**4**	**1**
	2	Dynamics of Physiological fluids- Composition		**1**
	3	Physiology of Continuity of Life		**1**
	4	Endocrine regulation, Sensory and Effector Physiology		**1**
Paper IV: Environmental and Applied Physiology - II				
SIPSZOPHY44	1	Pressure as an Environmental factors	**4**	**1**
	2	Temperature as an Environmental factor		**1**
	3	Radiation and Physiology of Biological Rhythms		**1**
	4	Physiological tools for Clinical diagnostic		**1**
PRACTICAL				
SIPSZOBTP41	1	Based on **SIPSZOBT41**	**2**	**4**
SIPSZOBTP42	2	Based on **SIPSZOBT42**	**2**	**4**
SIPSZOPHYP 43	3	Based on **SIPSZOPHY43**	**2**	**4**
SIPSZOPHYP 44	4	Based on **SIPSZOPHY44**	**2**	**4**
		Total	**24**	**32**

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

Programme: Master of Science, M.Sc. Part 2 – Zoology

"That is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer."
- Jacob Bronowski

The characteristic Post-graduate attributes comprising of Programme Outcomes, Programme SpecificOutcomes 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 andreceive instructions clearly. • Develop presentation skills to present complex information in a clear, lucid andconcise 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 logicalconclusion. • Inculcate the ability to facilitate coordinated effort as a group or team in the interests of common cause and recognize the contribution of team members.
PO6 *(AttitudeLevel)*	**Self-directed and Lifelong Learning *(U, Ap, An)*** • Demonstrate the ability to work independently and take responsibility for onesactions. • 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

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 co-evolution 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) (Biotechnology-Oceanography and Fishery Science)**
PSO1	**Conceptual Understanding and Emerging Applications *(R, U, Ap, An)*** • Inculcate conceptual and coherent understanding of Oceanography and Fishery Science, and demonstrate a broad understanding of different aspects of Oceanography and to learn about the general features of the earth's surface under water. • Understand the in-depth concepts of different areas of Oceanography and Fishery science such as, Aquaculture, Fish processing technology, Marine Biotechnology, Marine Toxicology, Fish Pathology, Marine Biodiversity and Conservation, so as to recognize the current scenario and apply appropriate methodologies with cutting edge tools/techniques to seek solutions to emerging problems faced by mankind. • Demonstrate the relevance of the procedural subject knowledge that creates different types of professionals related to the disciplinary/subject area of zoology, including professionals engaged in research and development, teaching and government/public service.
PSO2	**Analytical reasoning and Scientific Inquiry *(U, An, E)*** • Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions. • Encourage the ability to 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 and Fieldwork *(R, U, E, C)*** • Understand and apply standard operating procedures as per Good Laboratory Practices so as to develop laboratory skills and qualities required for successful career in teaching, research, industry, etc. • Demonstrate awareness regarding animal ethics, human ethics, conservation of flora and fauna, so as to promote safe environment and ecosystem, in the pursuit of disciplinary knowledge.

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 2

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

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

Biotechnology-Animal Physiology
Semester III – Theory

Course Code: SIPSZOBT31
Course Name: Basics of Industrial and Environmental Biotechnology – I
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: The implications of recombinant DNA technology of commercial products and microbial synthesis	**CO1:** • The objectives of this course are to introduce the students to the field of microbiology and application of microbes on industry. • To train the students about microbial growth, methods for fermentation technology, effluent treatment and enzyme immobilization. • To prepare and sensitize the students to scope for research, the increasing for skilled. • In agriculture, recombinant DNA has improved plant growth by increasing nitrogen fixation efficiencies, by cloning bacterial genes, and inserting them into plant cells. • . In agriculture, recombinant DNA has improved plant growth by increasing nitrogen fixation efficiencies, by cloning bacterial genes, and inserting them into plant cells. Other plants have been engineered to be resistant to caterpillar, pests, and viruses by inserting resistant genes into plant genomes. • To make students aware of moral and ethical issues associated with GMOs	*R, U, Ap, An*	*PO1, PO2, PO7* *PSO1, PSO2*
Unit 2: Large scale culture and production from recombinant microorganisms and genetically engineered animal cells	**CO1:** • Keep abreast with the current trends in this fast-moving field of Biotechnology, which 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	*R, U, Ap, An*	*PO1, PO2, PO7* *PSO1, PSO2*

	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.		
Unit 3: 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 4: Environmental Biotechnology-I	**CO4:** • 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: SIPSZOBT32
Course Name: Genetic Engineering Techniques and its applications
The study of this course will accomplish the following outcomes:

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

Unit 1: 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*
Unit 2: Manipulation of gene expression in prokaryotes	**CO2:** • Students will learn about the Experimental Manipulation of Gene Expression and a wide range of host systems in which to clone and express a gene of interest • Students will also gain insights about the parameters required for increasing protein stability and production	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 3 Bioinformatics	**CO3:** • 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. • 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*
Unit 4: Animal Biotechnology and Human therapies	**CO4:** • Student will learn theoretical and practical concepts of animal biotechnology. • The subject covers animal molecular biology, recombinant DNA technology, production of transgenic animals, reproductive biotechnology, biotechnology in animal breeding and ethics. • Students will develop an understanding about the principles of various techniques used in human therapies like tissue engineering, xenotransplantation etc	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*

Course Code: SIPSZOPHY33
Course Name: Comprehensive Physiology- I
The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Levels of response and Nutritional Physiology	**CO1:** • Students will acquire knowledge related to nutritive and feeding patterns • Students will gain knowledge related to membrane physiology, its functional aspects at molecular level and different transport mechanisms across the cell membrane • Students will get introduce to topics such as neuronal and hormonal regulation of secretion of digestive enzymes and also learn about the hunger drive theories. • Introduction to Balanced diet	*R, U, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 2: Dynamics of Physiological fluids - Circulation	**CO2:** • Students will learn about the comparative study related to circulating fluids in animals and different types of physiological hearts ranging from annelids to vertebrates • Students will learn about the cardiac physiology and its regulation with respect to hormone and exercise	*R, U, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 3: Physiology of Motility	**CO3:** • Students will learn about the biochemistry of contractile proteins responsible for contraction and relaxation and physiology of non- muscular contractile elements. • Students will get introduced to sliding filament theory and mechanism of regulation of contraction by calcium ions • Students will introduce with comparative physiology of muscle in different invertebrates	*R, U, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 4: Neurotransmission Physiology	**CO4:** • Student will understand the physiology of neuronal systems such as membrane potential , ion channels and types of synaptic transmission • Students will gain insights about different neurotransmitters its role in nerve conduction and also learn about memory and learning	*R, U, An*	*PO1, PO2* *PSO1, PSO2*

Course Code: SIPSZOPHY34
Course Name: Environmental and Applied Physiology – I
The study of this course will accomplish the following outcomes:

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

Unit 1: Stress and Water as Environmental factors	**CO1:** • Student will understand about the basics related to environmental stress, biochemical adaptations and strategies and degrees of ionic regulation • Students will also learn about the role of salt glands	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 2: Oxygen as an Environmental factor	**CO2:** • Students will learn about the role of oxygen as an important environmental factor for all living organisms and different modes of adaptations in invertebrate and vertebrates	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 3: Environmental Radiation	**CO3:** • Students will gain knowledge related to solar spectrum and biomolecules involved in perception and trapping of solar radiation • Students will learn about the impact of ionizing radiations at cellular and molecular levels	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 4: Enzymes and Body Fluids as Clinical Diagnostic Tools	**CO4:** • Students will study about the role and nature of various enzymes and body fluids as clinical diagnostic tools	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, 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.

Biotechnology-Animal Physiology

Semester III – Practical

Course Code: SIPSZOBTP31 and SIPSZOBTP32
Course Name: Practical I & II based on **SIPSZOBT31 and SIPSZOBT32**

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

SIPSZOBTP31 and SIPSZOBTP32	• 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: SIPSZOPHYP33
Course Name: Practical III and Practical IV based on **SIPSZOPHY33 and SIPSZOPHY34**

Course	Course outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOPHYP33 SIPSZOPHY34	• Students will learn • Students will learn about the factors affecting the activity of enzyme and the mechanisms of enzyme regulation. • Students will learn the theories of enzyme kinetics • Using a compound microscope , students will learn to dissect and observe striated patterns of muscle fibers and measure the length of contracted sarcomeres • Students will learn about the different types of muscle fibers • To gain knowledge on effect of change in Physico-chemical parameters of water on respiratory rate of fish • To gain knowledge on effect of hypoxia on anaerobic metabolism in fish • To learn about osmoregulation and adaptive behavior in fish • This study will aim to compare hematological parameters by using improved Hemocytometer amongst different animal groups and their clinical significance	An, U, E An, U, E	*PO1, PO2* *PSO1,PSO2, PSO3*

Biotechnology-Animal Physiology
Semester IV – Theory

Course Code: SIPSZOBT41
Course Name: Basics of Industrial and Environmental Biotechnology – II
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 learn about the antibiotic production by microorganisms which are one of the more interesting features, particularly from a medical and commercial point of view. • They will also learn about the organic acid, polysaccharides and polyesters productions and their applications	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 2: Large scale culture and production for Industrial Biotechnology	**CO2:** • Students will learn about Biotechnology as a tool which provides base for adapting and modifying the biological organisms, products, processes and systems found in nature to develop processes that are eco-efficient and products that are not only more profitable but also more environment-friendly.	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 3: Agricultural Biotechnology	**CO3:** • Students will learn about concept of nitrogen fixation and component of Nitrogenase, hydrogenase and the processs of nodulation, also about its genetic engineering • Students will gain information about the concept of microbial insecticides and genetic engineering of bacillus thurinigiensis and cloning of thuiringiotoxin gene • Students Process behind developing insect , virus , herbicide resistant plants	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 4: Environmental Biotechnology-II	**CO4:** • Students will learn about environmental biotechnology with respect to bioabsorption and bioleaching of metals	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*

Course Code: SIPSZOBT42
Course Name: Genome Management, Manipulation, Regulations and Patents in Biotechnology
The study of this course will accomplish the following outcomes:

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

Unit 1: Genome Management	**CO1:** • 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. • Comprehend the role of cloning vectors and their applications in genome management.	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 2: Manipulation of gene expression in eukaryotes	**CO2:** • Gain an in-depth knowledge of the application of recombinant DNA technology for the production of genetically engineered animal cells to obtain commercial products for human use. • Understand the significance of manipulation of gene expression (this case in eukaryotes) and comprehend the role of promoters of prokaryotes in genetic engineering.	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 3: The Human Genome Project	**CO3:** • Students will be introduced to topics such as scope and goals of human genome , genetic linkage maps, polymorphic dna markers, RFLP and its uses • Mapping human diseases and positional cloning and its limitations	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*
Unit 4: Regulations and Patents in Biotechnology	**CO4:** • Students will learn about regulatory agencies, regulatory requirements and process behind regulating environmental release of GEO and also learn about patenting and fundamental research	*R, U, Ap, An*	*PO1, PO2, PO4* *PSO1, PSO2, PSO4*

Course Code: SIPSZOPHY43
Course Name: Comprehensive Physiology- II
The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: Physiology of Respiration and Nitrogen Metabolism	**CO1:** • Students will gain insights about the physiology of respiration, respiratory pigments ,its neural regulation and how does various modifying agents influence or affect oxygen consumption • Students will also learn about the nitrogen metabolism	*An, U, R*	*PO1, PO2* *PSO1, PSO2*

Unit 2: Dynamics of Physiological fluids - Composition	**CO2:** • Students will learn about the dynamics of physiological fluids composition • Also study about comparative excretory organs and its integrated functioning for nitrogen excretion and osmoregulation • Also learn about comparative physiology of vertebrate kidney	*An, U, R*	*PO1, PO2* *PSO1, PSO2*
Unit 3: Physiology of Continuity of Life	**CO3:** • Students will learn about selfish genes, maternal dna , endocrine regulation of reproduction in invertebrates and also about comparative account of vertebrate gonadotropins and gonadal steroids	*An, U, R*	*PO1, PO2* *PSO1, PSO2*
Unit 4: Endocrine regulation, Sensory and Effector physiology	**CO4:** • To explain the roles of the endocrine system in maintaining homeostasis, integrating growth and development • Comparative Endocrinology emphasizes on many complexities of vertebrate and invertebrate endocrine systems at the sub-molecular, molecular, cellular, and at an organismal level of analysis	*An, U, R*	*PO1, PO2* *PSO1, PSO2*

Course Code: SIPSZOPHY44
Course Name: Environmental and Applied Physiology – II
The study of this course will accomplish the following outcomes:

Unit	**Course Outcome (CO)**	**Cognitive Level**	**Affinity with PO/ PSO**
Unit 1: Pressure as an Environmental factor	**CO1:** • This course introduces students to the role of environmental factors like pressure in influencing animal life and how animals respond to fluctuations in these factors to save themselves	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 2: Temperature as an Environmental factor	**CO2:** • This course introduces students to the role of environmental factors like temperature in influencing animal life and how animals respond to fluctuations in these factors to save themselves	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 3: Radiation and Physiology of Biological Rhythms	**CO3:** • To gain insights of the biological rhythms – the internal clock that help maintain steady state conditions in animals essential for its survival	*R, U, An*	*PO1, PO2* *PSO1, PSO2*
Unit 4: Physiological Tools for Clinical Diagnostics	**CO4:** • This course introduces students to the field of diagnostic immunology techniques and enzymes as biomarkers. • To gain knowledge related to clinical diagnostics for different physiological functional tests	*Ap, E*	*PO1, PO2* *PSO1, PSO2, PSO3, PSO4*

	associated with different diseases.		

Biotechnology- Animal physiology

Semester IV – Practical

Course Code: SIPSZOBTP41 and SIPSZOBTP42
Course Name: Practical I & II based on **SIPSZOBT41 and SIPSZOBT42**

Course	Course outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOBTP41 and SIPSZOBTP42	• 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. • Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing agarose gel electrophoresis- a very well sought after technique in molecular cloning. • Considering the commercial and clinical applications, demonstrate the Western blotting for the given sample of protein- a technique used to detect, characterize and quantitate proteins.	*R, U, An, Ap, E*	*PO2, PO5, PO6* *PSO1, PSO2, PSO3*

Course Code: SIPSZOPHYP43
Course Name: Practical III based on **SIPSZOPHY43**

Course	Course outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOPHYP43	• To determine urea, creatinine in human serum sample • To determine serum content of uric acid, cholesterol • To learn immunotechniques such as Ouchterlony and Single radial immunodiffusion to study antibody antigen reaction • To study the influence of sub lethal dose of ammonia with reference to following parameters such as level of excretory ammonia, level of hepatic and brain glutamate dehydrogenase and level of amino acid content of muscle, gill, brain, liver • To study effect of administration of carbon	*U, An, E, Ap*	*PO1, PO2* *PSO1, PSO2, PSO3*

	tetrachloride with reference to the level of activity of hepatic enzymes		

Semester III – Theory

Paper Code: SIPSZOBT31
Basics of Industrial and Environmental Biotechnology - 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.*
- *To procure knowledge of the biotechnological aspects dealing with degradation of xenobiotics that are foreign to our environment, and the effective utilization of biomass.*

Unit 1: The implications of recombinant DNA technology of commercial products and microbial synthesis **15 Lectures**

1.1 : The implications of recombinant DNA technology:
*****1.1.1: General account on applications of biotechnology
*****1.1.2: Commercialization of biotechnology and biotech companies1.1.3:
Prospects of novel food technology
1.1.4 : Economics of microbial biotechnology
1.1.5 : Areas of significant public concern: Antibiotic resistance marker gene, transfer of allergies,pollen transfer from GM plants, social, moral and ethical issues associated with GMOs

1.2 : Amino acids and their commercial use:
Production strain, process of L-glutamate, L-aspartate, L-phenylalanine, L-tryptophan

Unit 2: Large scale culture and production from recombinant microorganisms and genetically engineered animal cells **15 Lectures**

2.1 : Large scale culture and production from recombinant microorganisms:2.1.1:
Batch fermentation
2.1.2 : Fed batch fermentation
2.1.3: Continuous fermentation
*****2.1.4: Maximizing the efficiency of fermentation process2.1.5:
Harvesting, disrupting and downstream processing

2.2 : Large scale culture and production from genetically engineered animal cell cultures:2.2.1:
Design of bioreactors for large scale animal cell culture: Batch, Fed batch
2.2.2 : Mammalian cell lines and their characteristics
2.2.3: Media for the cultivation of mammalian cells
*****2.2.4: Commercial products produced with mammalian cell culture

Unit 3: Medical Biotechnology **15 Lectures**

3.1 : Subunit vaccines:
*****3.1.1: Subunit vaccine production against viruses: Herpes simplex, Bovine foot and mouth diseasevirus
3.1.2 : Peptide vaccines: Synthetic drugs (engineered proteins)
3.1.3 : Genetic immunization: DNA vaccines, Antisense DNA, Therapeutic ribozymes3.1.4:
Live recombinant vaccines
3.1.5 : Attenuated vaccines against Cholera, *Salmonella sp*.
3.1.6 : Vector vaccines: Vaccine directed against viruses – Rabies virus G-protein, Hepatitis Bsurface antigen
3.1.7 : Anti-idiotypic vaccine for cancer treatment

3.2 : Monoclonal antibodies (mAbs) and therapeutic applications:
3.2.1 : mAbs for prevention of rejection of transplanted organs3.2.2:
Treatment of bacterial blood infection
3.2.3 : Human monoclonal antibodies
3.2.4 : Hybrid human-mouse monoclonal antibodies
3.2.5: HIV therapeutic agents
3.2.6: Anti-tumour antibodies

Unit 4: Environmental Biotechnology – I 15 Lectures

4.1: Biomass utilization:
4.1.1 : Microorganisms in lignocellulose degradation
4.1.2 : Isolation of prokaryotic and eukaryotic cellulase gene4.1.3:
Manipulation of cellulase gene
4.1.4: Production of single cell proteins by using biomass as raw material4.1.5:
Commercial production of fructose and alcohol from biomass 4.1.6:
Improvements of fructose and alcohol production
4.1.7: Fuel ethanol from biomass

4.2 : Bioremediation of xenobiotic compounds:
4.2.1 : Characteristics of xenobiotics in the environment
4.2.2 : Characteristics of aerobic microorganisms for degradation of organic pollutants
4.2.3 : Genetic engineering of biodegradative pathways: Manipulation by transfer of plasmid, manipulation by gene alteration
*****4.2.4: Degradation of xenobiotic compounds: Petroleum products, n-alkanes, alkenes, cycloaliphatic compounds, aromatic hydrocarbons, polyaromatic hydrocarbons, chlorinated organiccompounds (aliphatic and aromatic)

*** Topics for Seminars**

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 III – Theory

Paper Code: SIPSZOBT32
Genetic Engineering Techniques and its applications

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 researchtools.*
- *To gain insight of the potential of Bioinformatics – a field applying computer knowledge to study genomes.*
- *To recognize the relevance of recombinant DNA technology in making animals with manipulated genes – transgenic animals that can be potential biofactories for production of biopharmaceuticals.*

Unit 1: Genome Management and Analysis **15 Lectures**

1.1: The basic tools of genetic engineering:
1.1.1: Chemical synthesis of DNA: Oligonucleotide synthesis by Phosphoramidite method; synthesisof genes
*1.1.2: DNA Sequencing: Maxam-Gilbert method, Sanger's dideoxynucleotide method; by using bacteriophage M13; by Primer walking
1.1.3: Polymerase chain reaction and its advantages

1.2 : Cloning vectors:
*****1.2.1: General purpose plasmid vectors: pUC19, pBR322 (Bacterial vectors)1.2.2:
Bacteriophage and cosmid vectors
1.2.3: Yeast artificial chromosomes (YACs)

1.3 : Analysis of Genome/ Proteome:
1.3.1 : DNA fingerprinting/ physical mapping/ pulsed field gel electrophoresis1.3.2:
Analysis of the proteome
1.3.3: Analysis of mRNA transcripts

Unit 2: Manipulation of gene expression in prokaryotes **15 Lectures**

2.1: Promoters of gene expression in prokaryotes:
2.1.1: Prokaryotic gene expression 2.1.2:
Isolation of functional promoters
2.1.3: Promoter selection with *E.coli* plasmid pBR316
*****2.1.4: Promoter selection with plasmid pKO1
2.1.5: Gene expression from strong and regulatable promoters

2.2: Expression of cloned genes in prokaryotes: 2.2.1:
Increasing protein production and secretion
*****2.2.2: Inclusion bodies and fusion proteins
2.2.3: Unidirectional tandem gene arrays 2.2.4:
Translation expression vectors
2.2.5: Increasing protein stability

Unit 3: Bioinformatics **15 Lectures**

3.1: Uses and applications of computers in biological sciences
***3.2:** DNA profiling: cDNA and ESTs (Expressed sequence tags)
3.3 : Basic research with DNA microarrays and its application in healthcare
3.4 : Biomedical genome research and pharmacogenomics
3.5 : Random amplified polymorphic DNA (RAPD)
3.6 : Human genomic variation: SNPs (Single nucleotide polymorphisms), SNPs and disease;QTL (Quantitative trait loci) and its relation to SNPs
3.7 : Satellite DNA and its types

Unit 4: Animal Biotechnology and Human therapies **15 Lectures**

4.1: Animal Biotechnology:
*****4.1.1: Transgenic animals and their applications: Mice as model system for human diseases and astest case model; cows, pigs, sheep, goats as biopharmaceuticals; transgenic insects and birds
4.1.2: Recombinant DNA technology to prevent animal diseases
4.1.3: Conservation biology: Embryo transfer
4.1.4: Regulation of transgenic animals and patenting genetically engineered animals

4.2 : Human therapies:
4.2.1 : Tissue engineering: Skin, liver, pancreas
*****4.2.2:Xenotransplantation
4.2.3: Antibody engineering
4.2.4: Cell adhesion based therapies: Integrins, inflammation, cancer and metastasis
4.2.5: Targeted gene replacement for correcting a mutated gene
4.2.6: Site directed mutagenesis

Topics for Seminars

Semester III – Theory
Paper Code: SIPSZOPHY33
Comprehensive Physiology- I

Learning Objectives:

- *To give a comprehensive and deep understanding of the vital processes occurring in organisms thatmake life possible.*
- *To gain an understanding of how a cell – the basic functional and structural unit of life is equipped to respond to its milieu.*
- *To understand how animals fulfil their energy demands by devising different means to procure andutilize nutrients from their surroundings by studying nutritional physiology.*
- *To appreciate the transformation of the transport system (circulatory system) found in animals as they became more complex in their anatomy.*
- *To understand physiology of movement and locomotion, one of the characteristics that separateanimal kingdom from the plant kingdom.*
- *To study neurotransmission physiology helping animals to be sensitive and respond to the world inwhich they live.*

Unit 1: Levels of response and Nutritional Physiology **15 Lectures**

1.1: Levels of Physiological response: Molecular, membrane, organ and organism
1.1.1 : Physiological response at molecular level
1.1.2 : Membrane physiology: Functional consequences of molecular composition and arrangement;transport across cell membrane – *Diffusion, ***** active transport, pump; uniports, symports and antiport, co-transport by symporters and antiporters

1.2 : Physiology of food capture and processing:
1.2.1 : Nutritive patterns: Origin of nutritive types
1.2.2: Feeding patterns:
a) Large particle feeding
b) Surface nutrient absorption
1.2.3: Digestion:
a) Bulk movement and peristalsis
b) Comparative biochemistry of digestion
c) Neural and hormonal regulation of secretion of digestive enzymes1.2.4:
Regulation of nutritional intake:
a) Hunger drive, glucostatic and hepatostatic theories of hunger drive
b) Adaptation of gut to metabolic rate and diet
*c) Balanced diet: A human perspective

Unit 2: Dynamics of Physiological fluids - Circulation **15 Lectures**

2.1: Circulation of body fluids:
2.1.1 : a) Circulating fluids: Cytoplasm, hydrolymph, hemolymph, lymph and blood
b) Circulatory mechanisms and fluid compartments; movement of body fluids by somatic muscles; hemolymph and open systems
2.1.2 : Pressure and flow in vertebrate circulatory system
2.1.3 : Physiological types of hearts with special reference to arthropods, annelids, molluscs,tunicates and vertebrates : Pacemakers and specialized conducting fibers2.1.5: Selective distribution of blood flow

2.2 : Cardiac Physiology:
2.2.1 : Neurohormonal regulation of cardiac amplitude and frequency
2.2.2 : Effects of exercise on cardiac vascular physiology: A human perspective

Unit 3: Physiology of Motility **15 Lectures**

3.1: Physiology of Movement and Locomotion:
*3.1.1: Biochemistry of contractile proteins
3.1.2 : Physiology of non-muscular contractile elements: Axoplasmic movement, chromosome involvement
3.1.3 : Physiology of skeletal muscle fibre:
a) Actomyosin complex
b) Source of energy for muscle contraction
*c) Sliding filament theory
d) Excitation of contraction and mechanism of regulation of contraction by calcium
e) Mechanism of relaxation
3.1.4 : Comparative Physiology of invertebrate muscle:
a) Polyneural innervation in anthropod muscle
b) Insect non-oscillatory postural muscle

c) Resonant flight and tymbal muscle in insects
d) Catch muscle and delayed relaxation

Unit 4: Neurotransmission Physiology **15 Lectures**

4.1: Physiology of neuronal system:
4.1.1 : Excitable membranes:
a) Membranes potential
b) Ions as current carriers: Protons, calcium, potassium, structure of cation-permeable channels andchloride channels
4.1.2 : Synaptic transmission:
a) Electrical transmission
b) Chemical transmitters: Neuropeptide, FMRF-amide family, Gastrin, CCK family, Hypothalamicpituitary factors
4.1.3 : Integrative Neurophysiology:
Neurons, interneurons, neural circuits, networks, primitive nervous systems, nerve nets, central pattern generators in invertebrates, chordate nervous system; central nervous system processing;
*memory and learning

*** Topics for Seminars**

Semester III – Theory

Paper Code: SIPSZOPHY34
Environmental and Applied Physiology - I

Learning Objectives:

- *To equip with the knowledge of the role of environmental factors like stress, water, oxygen and environmental radiations in influencing animal life and how animals respond to fluctuations in these factors to save themselves.*
- *To introduce a branch of physiology dealing with physiological tools for clinical diagnosis of pathological conditions in humans.*

Unit 1: Stress and Water as Environmental factors **15 Lectures**

1.1: Environmental stress, homeostasis and strategies of biochemical adaptations:
1.1.1: Basic concept of environmental stress:
a) Plastic and elastic strain
*b) Stress resistance, stress avoidance and stress tolerance1.1.2:
Homeostasis and biochemical adaptation:
a) External and internal environment
b) Multiple control system
c) Strategies of biochemical adaptations

1.2 : Water and solute problem:
1.2.1 : Preservation of intracellular solvent capacity
1.2.2: Strategies and degrees of ionic regulation 1.2.3:
ATPase, the model regulatory enzyme
1.2.4: Key role of GDH reaction
*1.2.5: Salt glands in Animal kingdom

Unit 2: Oxygen as Environmental factor **15 Lectures**

*__2.1:__ Oxygen and origin of life
__2.2 :__ Oxygen dependencies in living organisms
__2.3 :__ Anoxia adaptations in invertebrates
__2.4 :__ Adaptations of vertebrates during prolonged diving
__2.5 :__ Oxygen debt in vertebrate muscle

Unit 3: Environmental Radiation **15 Lectures**

__3.1 :__ Radiation as an environmental parameter:
3.1.1 : The solar spectrum
3.1.2 : Biomolecules involved in perception and trapping of solar radiations: Chlorophyll, Bacteriorhodospin, Rhodospin and Vitamin A; adaptations of animals to the absence of solar radiations
3.1.3 : Effects of ionizing radiations at cellular and molecular level3.1.4:
Phenomenon of radioprotection

Unit 4: Enzymes and Body Fluids as Clinical Diagnostic Tools **15 Lectures**

__4.1 :__ Enzymes as diagnostic tools:
4.1.1 : Plasma specific and non-plasma specific enzymes
4.1.2: Diagnostic importance of LDH
4.1.3: Enzyme in diagnosis of myocardial infarction
4.1.4: Enzymes in liver diseases and toxicity
4.1.5: Enzymes in muscle disease
4.1.6: Enzymes in cancer

__4.2 :__ Body fluid parameters as diagnostic tools:
4.2.1 : Physiological fluids as diagnostic tools:
Routine blood tests; plasma: Changes in composition in disease; Serum: Urea-N, creatinine, uricacid, proteins, bicarbonates, Na^+, K^+, Cl^-
4.2.2 : Glucose tolerance test, glycosylated haemoglobin
4.2.3 : Lymph and cerebrospinal fluid: Changes in composition in disease
*4.2.4: Urine composition/ constituents as a diagnostic tool: Routine urine tests, Urea-N, creatinine,uric acid, tests for proteinuria, albuminuria, Glycosuria, chyluria (for filariasis)

*** Topics for Seminars**

Semester III – Practical
SIPSZOBTP31 and SIPSZOBTP32

Based on SIPSZOBT31 and SIPSZOBT32

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 totest tube).

2. Preparation of LB agar plate, slant, butt and demonstration of streaking technique using bacterialculture to obtain isolated colonies.

3. Determination of viable cell count in the given culture of bacteria by dilution and spreading technique.

4. Using mini-prep method isolate plasmid DNA from the given strain of bacteria and show thepurity of the isolate by performing agarose gel electrophoresis.

5. To estimate the number of bacteria in the given culture by nephelometry.

Semester III – Practical
SIPSZOPHYP33 and SIPSZOPHYP34

Based on SIPSZOPHY33 and SIPSZOPHY34

1. Determination of activities of digestive enzymes viz. Amylase, Pepsin, Trypsin, Lipase, etc. indifferent animals (Cockroach).

2. Study of effect on the activity of any enzyme of the various factors like pH, temperature, activator,inhibitor.

3. Determination of K_m of a given enzyme.

4. Total RBC, WBC and differential WBC count: A comparative study of fish, goat and humanblood.

5. Routine human blood tests like RBC, WBC, differential WBC, haemoglobin content and bloodsugar. Prepare a report as required by a pathological laboratory.

6. Observation of decreasing PO_2 of water on the respiratory rate of fish.

7. Effect of decreasing PO_2 of water on the lactic acid content in muscle.

8. Estimation of salt loss and gain in an aquatic animal when it is transferred to a salt-free mediumand to a natural medium.

9. Preparation of glycerinated muscle fibre and study of its properties.

10. Effect of different concentrations of sodium chloride on the diameter of RBCs and determinationof concentration isotonic to blood.

Semester IV – Theory

Paper Code: SIPSZOBT41
Basics of Industrial and Environmental Biotechnology - II

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 know about enzyme immobilization techniques for obtaining products of commercial use.*
- *To realize the role of Biotechnology in agriculture and environment management in benefitting mankind.*

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:
a) Bacterial polysaccharides: General properties and their commercial applications – Dextran, xanthan, alginate; genetic engineering for large scale production of xanthan gum and its modification
*****b) Marine polysaccharides: General properties and their commercial application – Agar andagarose, Chitosan

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

Unit 2: Large scale culture and production for Industrial Biotechnology **15 Lectures**

2.1: Biotransformations
2.1.1: Selection of biocatalyst: Screening and use of novel existing biocatalyst2.1.2:
Genetic modification of existing biocatalyst (Indigo biosynthesis) 2.1.3: Biocatalyst immobilization:
Methods of immobilization – Cross linking, supported immobilization, adsorption and ionic binding,covalent coupling, lattice entrapment
2.1.4: Immobilized soluble enzymes and suspended cells2.1.5:
Immobilization of multi-enzyme systems and cells
*2.1.6: Immobilized enzyme reactors: Batch reactors, continuous reactors
2.1.7: Analytical enzymes: Enzymes in diagnostic assays – Test strip systems and Biosensors (Electrochemical and optical type)

Unit 3: Agricultural Biotechnology **15 Lectures**

***3.1:** Nitrogen fixation

3.2 : Nitogenase: Components of nitrogenase; Genetic engineering of nitrogenase cluster

3.3 : Hydrogenase: Hydrogen metabolism; genetic engineering of hydrogenase gene

3.4 : Nodulation: Competition among nodulation organisms; genetic engineering of nodulation gene

3.5 : Microbial insecticides: Toxins of *Bacillus thuringiensis*, mode of action and use of thuringiensistoxins, thuringiensis toxin gene isolation, genetic engineering of *Bacillus thuringiensis* strains and cloning of

thuringiotoxin gene

3.6 : Developing insect resistant, virus resistant and herbicide resistant plant

3.7 : Algal products: Fuels from algae, marine natural products and their medical potential (anticancer, antiviral compounds; antibacterial agents)

Unit 4: Environmental Biotechnology - II **15 Lectures**

4.1: Bioabsorption of metals (Recovery from effluents)
*****4.1.1: Bioabsorption by fungi, algae, moss and bacteria
4.1.2: Mechanism of bacterial metal resistance and genetic engineering for specific proteins 4.1.3: Bioreactors for bioabsorption: Packed bed, fluidized bed, rotating disc, single blanket, sequential reactors
4.1.4: Phytoremediation and its use in biotechnology

4.2 : Bioleaching of metals
4.2.1 : Biochemical mechanism of bioleaching
4.2.2: Extraction from mixtures
4.2.3 : Types of bioleaching
4.2.4 : Methods for bioleaching: Tank and heap bioleaching
*****4.2.5: Microorganisms used for bioleaching

*** Topics for Seminars**

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 IV – Theory

Paper Code: SIPSZOBT42
Genome Management, Manipulation, Regulations and Patents in Biotechnology

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 know about the basics of Human Genome Project, and Regulations and Patents in Biotechnology.*

Unit 1: Genome management **15 Lectures**

1.1 : Basic tools of genetic engineering:
1.1.1 : Gene transfer techniques: Protoplast fusion, calcium phosphate, precipitation, electroporation,liposome, ligand mediated, gene gun or biolistic approach, viral mediated
1.1.2 : Selection and screening of recombinants
*****1.1.3: Nucleic acid probes and hybridization, Southern blotting and Northern blotting1.1.4: Immunological assays for identification of gene product; Western blot

1.2 : Cloning vectors:
1.2.1 : Retrovirus and SV40 vectors
1.2.2 : Special purpose vectors: Expression vectors, secretion vectors, shuttle or bi-functional vectors,single

stranded phage and phagemids

Unit 2: Manipulation of gene expression in eukaryotes **15 Lectures**

2.1: Eukaryotic gene expression
***2.2:** Introduction of DNA into fungi: Yeast and filamentous fungi (fungal transformation)
2.3 : Heterologous protein production in yeasts
2.4 : Heterologous protein production in filamentous fungi
2.5 : Cultured insect cell expression systems: Baculovirus transfer vector
***2.6:** Mammalian cell expression systems: Human Papova BK virus shuttle vector

Unit 3: The Human Genome Project **15 Lectures**

***3.1:** The human genome; scope and goals of the human genome project**3.2:**
Genetic linkage maps, chromosome walking, restriction mapping **3.3:**
Polymorphic DNA markers
3.4 : Restriction fragment length polymorphism (RFLP) and its uses
3.5 : Physical maps, Sequence tagged sites
3.6 : Integrating genetic linkage and physical maps
***3.7:** Mapping human diseases
3.8 : Positional cloning: Getting closer to a disease causing gene
3.9 : Testing for exons
3.10 : Limitations of positional cloning

Unit 4: Regulations and Patents in Biotechnology **15 Lectures**

4.1: Regulating recombinant DNA technology

***4.2:** Regulatory requirements: Safety of genetically engineered foods, chymosin, tryptophan,bovine somatotropin

4.3 : Regulating environmental release of genetically engineered organisms (GEO); Ice minus *Pseudomonas syringae*

4.4 : Regulatory agencies and laws for product regulation

4.5 : Risk assessment: How much risk?

***4.6:** Open field tests of GEO

4.7 : Development of policy for human gene therapy

4.8 : Patenting biotechnology inventions:
4.8.1 : What constitutes the patent?
4.8.2: Patent process
4.8.3: Conditions to be satisfied for an invention to be patentable: Novelty, inventiveness, usefulness4.8.4: Patenting in different countries; types of inventions that are not patentable in India
4.8.5: What is Paris convention? Principal features of Paris convention4.8.6:
Patenting multicellular organisms
4.8.7: Patenting and fundamental research

*** Topics for Seminars**

Semester IV – Theory

Paper Code: SIPSZOPHY43

Comprehensive Physiology - II

Learning Objective:

- *To acquire deep understanding of the life processes dealing with oxygen utilization, nitrogen metabolism, water balance, chemical messengers and also continuity of life by learning about the techniques used to treat infertility.*

Unit 1: Physiology of Respiration and Nitrogen Metabolism **15 Lectures**

1.1: Respiration:
*1.1.1: Transition from water to land: Vertebrates and invertebrates
1.1.2 : O_2 consumption, RQ, and modifying agents: Activity, temperature, salinity, photoperiod, development, hibernation, animal size and metabolism
1.1.3 : Respiratory functions of blood: *Respiratory pigments, respiratory acidosis and alkalosis,alkali reserve
1.1.4 : Control and co-ordination of respiration

1.2 : Nitrogen Metabolism:
1.2.1 : Amino-N Metabolism, nucleic acid metabolism, nitrogenous waste products1.2.2:
Ammonia toxicity and detoxification pathways
*1.2.3: Ammonotely, ureotely, purinotely, uricotely, Storage excretion
1.2.4: Patterns of detoxification pathways in eggs and during metamorphosis; phylogenetic patterns

Unit 2: Dynamics of Physiological fluids - Composition **15 Lectures**

2.1: Dynamics of fluid composition:
2.1.1: Body fluid composition: Water, solute and intracellular regulation2.1.2:
Cutaneous evaporation; respiratory evaporation
2.1.3 : Integrated functioning for nitrogen excretion and osmoregulation: Contractile vacuole, coelomoducts, flame cells, green gland, malpighian tubules, invertebrate nephridia and vertebratenephron
2.1.4 : Comparative physiology of vertebrate kidney
*2.1.5: Kidney stones and kidney transplants: A human perspective

2.2 : Transfusion, blood replacement: A human perspective

2.3 : Haemodialysis and peritoneal dialysis: A human perspective

Unit 3: Physiology of Continuity of Life **15 Lectures**

3.1: Physiology of Reproduction:
3.1.1 : Selfish gene, evolution of gametes, maternal DNA
3.1.2 : Endocrine regulation of reproduction in invertebrates: Molluscs, crustaceans, insects3.1.3:
Comparative account of vertebrate gonadotropins, gonadal steroids
*3.1.4: Interaction of steroid hormones and nervous tissue
3.1.5: Human intervention in Reproduction:
a) Contraceptives, MTP, Treatment of Infertility
b) Assisted Reproduction Techniques: IFV, GIFT, ICSI, ZIFT, DI, AID

Unit 4: Endocrine regulation, Sensory and Effector physiology **15 Lectures**

4.1: Physiology of endocrine regulation:
4.1.1 : Specificity; membrane bound receptor system; cytosolic receptor system
4.1.2 : Invertebrate endocrine system: Lower invertebrates, annelids, molluscs, crustaceans, insects 4.1.3: Regulated supply of hormones: Feedback – Direct and indirect hypothalamo-hypophysial axis,pineal-pituitary gland, thyroid and adrenal gland, G-E-P (Gastro-entero-pancreatic) cells, renal hormones, cardiac hormones, prostaglandins

4.2 : Sensory and effector physiology:
4.2.1 : Sensory Physiology: Structural and functional classification, modality intensity, sensorycoding
4.2.2 : Various receptors: Chemoreception, mechanoreception, electroreception, thermoreception, *photoreception
*4.2.3: Physiological effectors: Cnidoblasts, bioluminescent systems, chromatophores, electricorgans

*** Topics for Seminars**

Semester IV – Theory

Paper Code: SIPSZOPHY44
Environmental and Applied Physiology- II

Learning Objectives:

- *To equip with the knowledge of the role of environmental factors like temperature, pressure in influencing animal life and how animals respond to fluctuations in these factors to save themselves.*
- *To introduce a branch of physiology dealing with physiological tools for clinical diagnosis of pathological conditions in humans.*
- *To gain insight of the biological rhythms – the internal clock that help maintain steady-stateconditions in animals essential for it survival.*

Unit 1: Pressure as an Environmental factor **15 Lectures**

1.1: Fundamental effects of pressure on biological systems
1.2 : Rate of enzyme action with respect to pressure
1.3 : Effect of pressure on weak bonds and the consequences for higher orders of Protein structure**1.4:** Effects of pressure on cellular processes viz., transcription, translation and gene regulation **1.5:** Strategies of enzyme adaptations to pressure in marine organisms: FDPase and PK

Unit 2: Temperature as Environmental factor **15 Lectures**

2.1: Temperature regulation/ response to temperature fluctuations:
2.1.1 : Thermal limits of survival
2.1.2 : Temperature and structural effects with response to biological molecules and biological membranes
2.1.3 : Temperature and rate effects: Temperature dependent E~S affinity, lipoprotein enzymes2.1.4: Thermal resistance of dormant and active cells
2.1.5: Ectothermy and endothermy
2.1.6: Endothermy in invertebrates
2.1.7: Biochemical adaptations of ectothermy: Antifreeze substances, Heat shock proteins

Unit 3: Radiation and Physiology of Biological Rhythms **15 Lectures**

3.1: Physiology of biological rhythms and timings:
3.1.1 : Temporal organization of cells
3.1.2 : Circadian rhythms; synchronization of circadian rhythms3.1.3:
Dormancy in fresh water and terrestrial animals
3.1.4 : Preparatory phases, induction of dormancy, arousal from dormancy, entrainment and dormancy
3.1.5 : Diapause in insects: Induction, factors affecting and termination of diapause; diapause and endocrine functions
*3.1.6: Photoperiodism
3.1.7: Biological clocks

Unit 4: Physiological Tools for Clinical Diagnostics **15 Lectures**

4.1 : Antibodies as diagnostic tools:
4.1.1 : RIA of GnRH, gonadotropins, T3, T4, TSH, HCG, Insulin
*4.1.2: ELISA for detection of HCG, diagnosis of Amoebiasis, Typhoid, HIV
4.1.3: Monoclonal antibodies as diagnostic tools: Detection of HCG, Diagnosis of STD, Streptococcal throat infections, Herpes and Cancer

4.2 : Organ Function Tests as diagnostic tools:
*4.2.1: Liver function tests and toxicity tests
4.2.2: Pancreatic function tests
4.2.3: Gastric function tests
4.2.4: Kidney function tests

*** Topics for Seminars**

Semester IV – Practical
SIPSZOBTP41 and SIPSZOBTP42

Based on SIPSZOBT41 and SIPSZOBT42

1. Immobilize yeast cells in calcium alginate and prepare a bioreactor column to demonstrateinvertase activity in the bioreactor column.

2. Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standard digestsprovided.

3. Demonstrate the Western blotting technique for the given sample of protein.

4. To plot a growth curve for the microorganisms provided.

5. Demonstrate the effect of media on growth curves of given microorganism, using two differentmedia (minimal and enriched).

Semester IV – Practical
SIPSZOPHYP43 and SIPSZOPHYP44

Based on SIPSZOPHY43 and SIPSZOPHY44

1. Determination of urea, creatinine in blood: Human/goat.

2. Determination of serum content of uric acid, cholesterol: Human/goat.

3. Effect of injection of insulin/ glucagon on the blood sugar and liver glycogen in rat/ mouse.

4. Routine urine tests and preparation of report as per pathological laboratory.

5. Performance of Ouchterlony technique to demonstrate immunodiffusion.

6. Demonstration of single radial immunodiffusion of antibody and antigen.

7. Influence of sublethal (50-60 ppm) ammonia (as liquor ammonia/ ammonium hydroxide/ ammonium chloride) on a suitable fish exposed to ammonia stress for 3/7/15 days with reference tothe following parameters:

a) Level of excretory ammonia

b) Level of activity of hepatic and brain glutamate dehydrogenase

c) Level of amino acid content of muscle, gill, brain and liver

8. A survey based project to study physiological diagnostic tools with the help of a local pathological laboratory/ hospital.

9. Effect of administration of carbon tetrachloride in rat/ mice with reference to the following parameters:

a) Total lipid and free fatty acid content of liver

b) Free fatty acid content of plasma

c) Level of activity of the following enzymes: AspAT, AlaAT, ACP, LDH, SDH and ATPase

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Practical Examination Question Paper PatternSemester III – Practical (SIPSZOBTP31)

Based on SIPSZOBT31

Time: 5 hours **Marks: 50**

Q.1 Determination of viable cell count in the given culture of bacteria by dilution and spreading technique. **(Day 1)** **25**

OR

Q.1 Using mini-prep method isolate plasmid DNA from the given strain of bacteria and show the purity of the isolate by performing Agarose gel electrophoresis. **(Day 1)** **25**

Q.2 To demonstrate aseptic techniques: **15**
a) Work place for aseptic handling
b) Packing glassware (flask, test tube, pipette, petri dish) for sterilization
c) Aseptic transfer of liquids (pipetting from flask to test tube) **(Day 2)**

Q.3 Viva **05**

Q.4 Journal **05**

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Semester III – Practical (SIPSZOBTP32)Based

on SIPSZOBT32

Time: 5 hours **Marks: 50**

Q.1 Preparation of LB agar plate, slant, butt and demonstration of streaking technique using bacterialculture to obtain isolated colonies. **(Day 1)** **25**

Q.2 Estimate number of bacteria in the given culture by Nephelometry. **(Day 2)** **15**

Q.3 Viva **05**

Q.4 Journal **05**

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Practical Examination Question Paper PatternSemester III – Practical (SIPSZOPHYP33)

Based on SIPSZOPHY33

Time: 5 hours **Marks: 50**

Major Question: **25**

Q.1 Prepare an extract of salivary gland/ stomach/ intestine/ liver. Using this extract as an enzymesource, determine the activity of amylase/ trypsin/ pepsin/ lipase. Submit a report to the examiner.

OR

Q.1 Demonstrate the effect of pH/ temperature/ activator/ inhibitor on the activity of salivaryamylase.

OR

Q.1 Calculate and compare total RBC/ total WBC/ differential WBC of any two animals (human/ goat /fish).

Minor Question: **15**

Q.2 Determine K_m of the given enzyme with the help of suitable graph.

OR

Q.2 Demonstrate the effect of ATP and Mn^{++}/ ATP and Mg^{++}/ ATP and KCl/ ATP and $CaCl_2$ and NaCl on glycerinated fiber. Submit a report.

Q.3 Viva **05**

Q.4 Journal **05**

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Semester III – Practical (SIPSZOPHYP34)Based on SIPSZOPHY34

Time: 5 hours **Marks: 50**

Major Question: **25**

Q.1 Set up an experiment to demonstrate the effect of decreasing PO_2 on the lactic acid content of fish muscle. Compare it with control fish and submit a report.

OR

Q.1 Estimate salt loss and salt gain in fish when it is transferred to salt free medium and naturalmedium.

OR

Q.1 Demonstrate the effect of different concentrations of sodium chloride on the diameter of RBCsand determine the isotonic concentration for blood cells by using oculometer.

Minor Question: **15**

Q.2 Prepare a report from the given parameters of routine blood tests. Interpret the result and submitthe report.

OR

Q.2 Set up an experiment to demonstrate the effect of decreasing PO_2 of water on respiratory rate of fish by counting opercular movement and estimation of oxygen in water.

Q.3 Viva **05**

Q.4 Journal **05**

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Practical Examination Question Paper PatternSemester IV – Practical (SIPSZOBTP41)

Based on SIPSZOBT41

Time: 5 hours **Marks: 50**

Q.1 Demonstrate the effect of medium on growth curves of given microorganism using enriched media. **(Day 1)** **25**

OR

Q.1 Demonstrate the effect of medium on growth curves of given microorganism using minimal media. **(Day 1) 25**

Q.2 Immobilize yeast cells in calcium alginate, prepare beads and keep them overnight in activation medium. (**Day 1)** **15**

Q.3 Viva **05**

Q.4 Journal **05**

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Semester IV – Practical (SIPSZOBTP42)Based

on SIPSZOBT42

Time: 5 hours **Marks: 50**

Q.1 Prepare a bioreactor column to demonstrate invertase activity in the bioreactor column. **(Day 2)** **25**

Q.2 Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing Agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided. **(Day 2)** **15**

OR

Q.2 Demonstrate Western blotting technique for the given sample of protein. **(Day 2)** **15**

Q.3 Viva **05**

Q.4 Journal **05**

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Practical Examination Question Paper PatternSemester IV – Practical (SIPSZOPHYP43)

Based on SIPSZOPHY43

Time: 5 hours **Marks: 50**

Major Question: **25**

Q.1 Demonstrate the effect of insulin/ glucagon on the blood sugar/ liver glycogen in the given rat/mouse. Submit a report.

OR

Q.1 Estimate the content of urea/ uric acid/ creatinine/ bilirubin/ cholesterol from the given bloodsample. (ANY TWO)

Minor Question: **15**

Q.2 Demonstrate Ouchterlony technique to show immunodiffusion.
(Result to be observed on the subsequent day)

OR

Q.2 Demonstrate Single radial immunodiffusion of antigen and antibody. Plot a graph.

Q.3 Viva **05**

Q.4 Journal **05**

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Semester IV – Practical (SIPSZOPHYP44)Based on SIPSZOPHY44

Time: 5 hours **Marks: 50**

Major Question: **25**

Q.1 Show the influence of sublethal dose of ammonia (50-60ppm) on a suitable fish exposed toammonia stress for 3/7/15 days with reference to the following parameters:

a) Level of excretory ammonia and

b) Activity of hepatic and brain glutamate dehydrogenase

OR

c) Level of amino acid content of muscle/ gill/ brain/ liver

OR

Q.1 Report the effect of administration of carbon tetrachloride on rat/ mouse with reference to the following parameters:

a) Total lipid and free fatty acid content of liver

b) Free fatty acid from plasma

c) Level of hepatic AST and ALT

d) Level of hepatic LDH and SDH

Q.2 Project **15**

Q.3 Viva **05**

Q.4 Journal **05**

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Scheme of Examination

The performance of learners will be evaluated in two parts for the Theory component of the Course:
1. Internal Assessment with 40% marks
2. Semester End Examination (written) with 60% marks
The Practical component of the Course will be evaluated by conducting Semester End Practical Examination of 50 marks.

Internal Assessment Theory (40%)
It is the assessment of learners on the basis of continuous evaluation as envisaged in the Credit Based System by way of participation of learners in various academic and correlated activities in the given semester of the program.
Seminar Marks: 20
Evaluation will be conducted on the basis of Seminar/ Presentation given by the student on a topic chosen from the syllabus for each paper. The marking scheme shall be:

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

Assignment Marks: 20
Evaluation will be conducted on the basis of Research paper review / Book review / Poster presentation / Abstract writing / Preparation of Standard Operating Procedure or Calibration of Instruments / Role play or Skit on topic relevant to the paper / Report on Industry or Field Visit or Writing an article relevant to the paper etc.

Semester End Assessment Theory (60%)
Marks: 60
Duration: 2 hours
Theory question paper pattern:

- There shall be five questions of 12 marks each. On each unit there will be one question andthe 5th question will be based on the entire syllabus.
  OR
  There shall be four questions of 15 marks each, each question based on one unit.
- All questions are compulsory with internal choice within the questions.
- Questions may be subdivided and the allocation of marks depends on the weightage of thetopic.

Semester End Assessment Practical
Marks: 50
Duration: 5 hours

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