SIES College of Arts, Science and Commerce – Autonomous

Sion (West), Mumbai – 400 022

NAAC Reaccredited 'A' Grade (CGPA: 3.51/4.00)

Best College Award – University of Mumbai

Syllabus for

Faculty: Science

Program: M. Sc.

Course: ZOOLOGY

Biotechnology-Animal Physiology

Semester III and Semester IV

(As per Credit Based Semester and Grading System with effect from academic year 2018-2019)

M. Sc. Zoology Syllabus (Autonomous)
Biotechnology-Animal Physiology
Semester III and Semester IV
(Semester Based Credit 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 and everything 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 Sarfare
Chairman,
Board of Studies in the subject of Zoology

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

Theory				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
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
SIPSZOBT32	1	Genome Management and Analysis	4	1
	2	Manipulation of gene expression in prokaryotes		1
	3	Bioinformatics		1
	4	Animal Biotechnology and Human therapies		1
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
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	Based on SIPSZOBT31 (Practical I)		2	4
SIPSZOBTP32	Based on SIPSZOBT32 (Practical II)		2	4
SIPSZOPHYP33	Based on SIPSZOPHY33 (Practical III)		2	4
SIPSZOPHYP34	Based on SIPSZOPHY34 (Practical IV)		2	4
		Total	**24**	**32**

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

Theory				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
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
SIPSZOBT42	1	Genome Management	4	1
	2	Manipulation of gene expression in eukaryotes		1
	3	The Human Genome Project		1
	4	Regulations and Patents in Biotechnology		1
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
SIPSZOPHY44	1	Pressure as an Environmental factor	4	1
	2	Temperature as Environmental factor		1
	3	Radiation and Physiology of Biological Rhythms		1
	4	Physiological Tools for Clinical Diagnostics		1
Practical				
SIPSZOBTP41	Based on SIPSZOBT41 (Practical I)		2	4
SIPSZOBTP42	Based on SIPSZOBT42 (Practical II)		2	4
SIPSZOPHYP43	Based on SIPSZOPHY43 (Practical III)		2	4
SIPSZOPHYP44	Based on SIPSZOPHY44 (Practical IV)		2	4
		Total	**24**	**32**

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 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 companies
1.1.3: 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 process
2.1.5: 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 disease virus
3.1.2: Peptide vaccines: Synthetic drugs (engineered proteins)
3.1.3: Genetic immunization: DNA vaccines, Antisense DNA, Therapeutic ribozymes
3.1.4: 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 B surface 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 organs
3.2.2: 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 gene
4.1.3: Manipulation of cellulase gene
4.1.4: Production of single cell proteins by using biomass as raw material
4.1.5: 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 organic compounds (aliphatic and aromatic)

***marked topics for Seminars**

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 research tools.
- 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; synthesis of 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 electrophoresis
1.3.2: 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 as test 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

***marked 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 that make 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 and utilize 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 separate animal kingdom from the plant kingdom.
- To study neurotransmission physiology helping animals to be sensitive and respond to the world in which 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 enzymes
1.2.4: 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, mollusca, tunicates and vertebrates

2.1.4: Pacemakers and specialized conducting fibers
2.1.5: 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 and chloride channels
4.1.2: Synaptic transmission:
a. Electrical transmission
b. Chemical transmitters: Neuropeptide, FMRF-amide family, Gastrin, CCK family, Hypothalamic pituitary 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

***marked 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 tolerance
1.1.2: 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 level
3.1.4: 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, uric acid, 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 proteinurea, albuminurea, Glucosurea, chyluria (for filariasis)

***marked 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 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. 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.

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. in different animals (Cockroach).

2. Study of effect on 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 human blood.

5. Routine human blood tests like RBC, WBC, differential WBC, haemoglobin content and blood sugar. 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 medium and 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 determination of 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 and agarose, 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 biocatalyst
2.1.2: 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 cells
2.1.5: 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 thuringiensis toxins, 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

***marked topics for Seminars**

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 blotting
1.1.4: 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, usefulness
4.8.4: Patenting in different countries; types of inventions that are not patentable in India
4.8.5: What is Paris convention? Principal features of Paris convention
4.8.6: Patenting multicellular organisms
4.8.7: Patenting and fundamental research

***marked 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 continuity of life with a knowledge 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 products
1.2.2: 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 regulation
2.1.2: 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 vertebrate nephron
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, insects
3.1.3: 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, sensory coding
4.2.2: Various receptors: Chemoreception, mechanoreception, electroreception, thermoreception, *photoreception
*4.2.3: Physiological effectors: Cnidoblasts, bioluminescent systems, chromatophores, electric organs

***marked 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-state conditions 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 enzymes
2.1.4: 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 rhythms
3.1.3: 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 diapauses; 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, Diagnostic 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 ***marked 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 demonstrate invertase 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 digests provided.

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 different media (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 (treatment as in "Fundamentals of Practical Clinical Biochemistry pp 34-38, 40-43).

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 to the 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 Pattern
Semester 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 bacterial culture 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 Pattern
Semester 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 enzyme source, 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 salivary amylase.

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 natural medium.

OR

Q.1 Demonstrate the effect of different concentrations of sodium chloride on the diameter of RBCs and 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 submit the 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 Pattern
Semester 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 Pattern
Semester 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 blood sample. (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 to ammonia 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.

Marks: 40
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: **10 marks**
- Quality of Presentation: **10 marks**
- Presentation skills: **10 marks**
- Question-Answer discussion: **10 marks**

Semester End Assessment Theory (60%)

Marks: 60
Duration: 2 hours
Theory question paper pattern:

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

Semester End Assessment Practical

Marks: 50
Duration: 5 hours

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