SYLLABUS

for

MASTER OF SCIENCE
IN
HUMAN PHYSIOLOGY

under

NEP syllabus

VIDYASAGAR UNIVERSITY
MIDNAPORE – 721102
WEST BENGAL

Effective from 2025-2026 Academic Session

Preamble

Human Physiology is one of the important interdisciplinary subjects in teaching, training, and learning, which are important in terms of human resource development as well as community development. Human Physiology is the life phenomena at all levels, from molecules to cells, with special emphasis on the human body. It is that branch of knowledge that appliesthe principles of physics, chemistry, and the methods of mathematical analysis and computer modeling to understand natural phenomena of the human body. The major focus of Human Physiology is the analysis of various aspects of the functions of biological molecules and organisms. The techniques and methodologies of Human Physiology have wide applications in the biological, medical, and related sciences. Students with a Master's in Human Physiology have job opportunities in universities, colleges, schools, industries, medical centers/colleges, research institutes, and other Government and non-government organizations.

Eligibility Criteria:

A candidate shall be held eligible for admission to the One/Two-Year course for the Master's degree in Human Physiology under the Faculty of Science, if the candidate has passed the 3-year B.Sc. Hons under CBCS/ 3-year B.Sc. (Single major) under NEP / 4 years B.Sc. under NEP in Physiology.

General Instructions:

1. The Post Graduate Course of Human Physiology is divided into four semesters, each of 275 marks. There are eleven (11) theory papers (09 Compulsory + 02 Elective) and six (06) practical papers (four (04 Compulsory + 02 Elective) in four semesters. There will be 04 Elective Papers to be chosen optionally by the students, and the optional types are five (05).
2. Each semester consists of Theory and Practical papers of 50 marks (4 Credits) each, consolidating to 275 marks (22 Credits). Each paper is divided into two Units of 25 marks (2 Credits) each.
3. The Elective Papers will be taught in the Second and Third semesters each.
4. Each Theory Paper will have a workload of 50 Lectures, each of 60 minutes duration, distributed in Units. Each Practical Paper will have a workload of 75 periods, each of 60 minutes duration.

5. Students have to carry out an individual project of 100 marks in the final semester. The project will be evaluated by the project report submitted and the seminar presented by the students.

Course/Programme Outcomes

Upon completion of the course, students will be able to:

This MSc programme in Human Physiology will provide students with the necessary knowledge and skills to undertake a career in research, either in industry or in an academic setting. The training provided will give students the breadth and depth of scientific knowledge in the important, newly developed area of Human physiology.

1. General science training of students- provide an intellectual training that enables students to develop a rigorous scientific approach in synthesising information and concepts, exercising evaluative judgement, and making arguments about human physiology. To provide a thorough training in written and verbal communication of scientific information and ideas.To generate in students an appreciation of the importance of the application of human physiology in academic, industrial, economic, environmental, and social contexts.

2. Specific scientific skills- equip students with practical skills that will prepare them for a futurecareer as a worker or researcher in this important interdisciplinary area.

3. Transferable skills - equip students with a broad range of general skills that will transfer to the future workplace.

4. Knowledge base for students- provide students with an advanced background in Human physiology, which will be of particular relevance to the medical, pharmaceutical, and biotechnological industries. Students also receive training in medicinal aspects of drug design and can specialise in a more biological or biochemical area as part of their industrially related research project. Additionally, the project will prepare students to continue with postgraduate research in the form of a PhD or to work in or in association with industry

5. Benefit to students of active research- harness the research expertise of staff in the School of Biosciences to provide a stimulating and current input into teaching and to provide students with training in current research practice.

6. The learning environment - provide an attentive, supportive, and formative environment for the academic and personal development of our students. To provide high-quality education and training through a systematic approach to quality assurance.

Core Structure of PG-NEP Syllabus of Human Physiology

Items	**Semester I: 275 Marks 22 Credits**		**Semester II: 275 Marks 22 Credits**		**Semester III: 275 Marks 22 Credits**		**Semester IV: 275 Marks 22 Credits**		**Total Marks: 1100 Marks 88 Credits**	
	Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical
Marks	175	100	175	100	175	100	125	150	650	450
Credits	**12+2**	**08**	**12+2**	**08**	**12+2**	**08**	**8+2**	**12**	**52**	**36**

Semester	**Course code**	**Topic of syllabus**	**Marks distributed**	**Total marks**	**Credit**
Semester I	DSC-T1	Unit -1: Biomolecules and Metabolic Physiology Unit-2: Physiology of excitable cells and higher functions of brain	25 25	50	4
	DSC-T2	Unit -1: Biomedical instrumentation and Electrophysiology Unit -2: System Physiology including Physiological Homeostasis	25 25	50	4
	DSC-T3	Unit -1: Research Methodology, Ethics, and Biostatistics Unit -2: Computer Application in Biology and Bioinformatics	25 25	50	4
	DSC-P1	Unit -1: Biochemical experiments Unit -2: Bio-Analytical Techniques and Microbiological Studies	25 25	50	4
	DSC-P2	Unit -1: Biostatistics & Computer Applications in Biological Problems Unit -2: Growth monitoring and Human Experiments, including Exercise Physiology, and Ergonomics Experiments	25 25	50	4
		Indian Knowledge System	25	25	2

		Vidyasagar: Life & Philosophy	-	-	Compulsory and non-credit
				Total: 275	**Total: 22**
Semester II	DSC-T4	Unit -1: Community Health, Nutrition (201.1) & Sensory Physiology Unit -2: Biophysical principles & Nanoscience	25 25	50	4
	DSC-T5	Unit -1: Molecular Biology & Biotechnology (402.2) & Unit -2: Cell biology (402.1)	25 25	50	4
	DSE-T1	Special Elective paper Unit -1: (A/B/C/D/E) (303) Unit -2: (A/B/C/D/E) (303)	25 25	50	4
	DSC -P3	Unit -1: Physiological Experimentation on the biological system Unit -2: Biotechnological, Environmental Physiology, Pharmacological experiments	25 25	50	4
	DSE-P1	Special Optional paper Practical Unit -1: (A/B/C/D/E) (303) Unit -2: (A/B/C/D/E) (303)	25 25	50	4
		Field visit/Industry visit/ Case study/Hands-on practical/ Skill enhanced course	25	25	2
				Total: 275	**Total: 22**
Semester III	DSC-T6	• Endocrinology (401.1) • Reproductive Physiology (401.2)	25 25	50	4
	DSE-T2	Special Optional paper Unit -1: (A/B/C/D/E) (403) Unit -2: (A/B/C/D/E) (403)	25 25	50	4
	MOOC	Functional Foods and Nutraceuticals	50	50	4
	DSE-P2	Special Optional paper Practical Unit -1: (A/B/C/D/E) (403) Unit -2: (A/B/C/D/E) (403)	50	50	4
	DSC-P4	Unit -1: Histological, cytological and Toxicology Experiments Unit -2: Histochemistry	50	50	4
		Social service/ Community engagement	25	25	2
				Total: 275	**Total: 22**
Semester	DSC-T7	Unit -1: Human Immune System	25	50	4

IV		Unit -2: Microbes-Human Interaction	25		
	DSC-T8	Unit -1: Environmental Physiology, Toxicology, Pharmacology (201.2) Unit -2: Sports, exercise Physiology, and ergonomics (202.1)	25 25	50	4
		Research Project/Dissertation	100	100	8
		Internship/Capstone project/ Applied field & Incubation/ Entrepreneurship/Start-up proposal or practice	50	50	4
		Intellectual Property rights (IPR)/Skill-enhanced course	25	25	2
				Total: 275	**Total: 22**

Semester I

(Theory: 175 + Practical: 100)

(Total Marks: 275, 22 Credits)

Paper: DSC-T1 **Credit: 4; Full marks: 50**

Unit -1: Biomolecules and Metabolic Physiology **F.M. 25**

Learning Objectives: To develop knowledge and understanding regarding concepts of biocatalysts; cellular biochemical energetics; structural features and nature of interactions of several biomolecules in physiological processes; metabolic processes governing physiological systems and the interrelationships among the different metabolic pathways.

Scope of employability: After studying the Course, there would be numerous options available to a student. They can stay in Higher Education and it would be a prospective route into research and working in industry. Or he/she could apply his/her scientific knowledge to a range of other careers, including patent law, teaching or science communication.

I. **Bioenergetics and biological oxidation:** Bioenergetics and biological oxidation: first and second laws of thermodynamics, entropy and enthalpy, Kinetics and thermodynamics - concept of free energy, coupling of metabolic energy changes, biological energy transfer, group transfer, Redox potential, aerobic oxidases, mixed function oxidases, anaerobic dehydrogenases including iron-sulfur clusters and cytochromes; Entropy Enthalpy compensation in biomolecular interactions, Fokker Planck equation. oxidative phosphorylation, Mitochondrial Electron Transport chain: electron transport and its carriers- complex I, II, III, IV; Q cycle, extra-mitochondrial electron transport chains;– chemiosmotic theory, determination of P:O ratio, Mitchell's Hypothesis—experimental verification, ATP synthase and its structure, Boyer's binding change model; mechanistic proton translocation, substrate level phosphorylation in aerobic and anaerobic systems, ATP yield – energy conversion and conservation, importance of coupled reactions, ionophores in uncoupling oxidation and phosphorylation. Oxidative phosphorylation and metabolic homeostasis.

II. **Enzymology/Enzyme kinetics, catalysis, isolation and applicability**: Kinetics versus thermodynamics; Michaelis-Menten approach and Linear transformations in enzyme kinetics; Enzyme catalysis; Kinetics of competitive, noncompetitive and uncompetitive inhibition; Allosteric modulation and sigmoid kinetics; Reversible covalent modification; Regulatory enzymes and their roles; Multi enzyme system; Ribozymes and abzymes;

Isoenzymes and their roles in vivo; Regulation in Enzyme synthesis; Enzyme Purification and Assay; Industrial and clinical applications of enzymes, Enzyme engineering.

III. **Three dimensional structures of proteins:** Shape of a protein, participation of amino acids, primary, secondary, tertiary and quaternary structures of proteins, bonds and interactions stabilizing the structure, Ramachandran plot, common fibrous and globular proteins, protein aggregation and protein folding, role of molecular chaperones in protein folding; misfolding of proteins, protein folding in cellular physiology, its significance. Protein ligand binding.

Protein trafficking, targeting, and degradation: Signal hypothesis; Protein glycosylation at endoplasmic reticulum and Golgi complex; ER chaperons; post-translational modification of proteins; Targeting of mitochondrial, chloroplast, peroxisomal, and nuclear proteins; Transport of eukaryotic protein across membranes; Protein import by receptor-mediated endocytosis; Protein degradation; Disorders of protein transport.

IV. **Biomolecules of physiological importance:** Regulation of synthesis of non-essential amino acids, Branched-chain amino acids (BCAAs) metabolism, Amino acid pathway in Pharmacognosy; cytoplasmic de novo synthesis of palmitate, microsomal desaturation and elongation of fatty acids; synthesis of arachidonate, prostaglandins, leukokotrienes, sphinglolipids, phosphoglycerides, cholesterol; synthesis of informational molecules (acetyl-choline, catecholamines, GABA, serotonin, histamine). Regulation of purine and pyrimidine biosynthesis.

Integrated metabolism: Integration of carbohydrate, protein, and fat metabolism, Amphibolic nature of TCA cycle: cataplerosis and anaplerosis; Critical roles of vitamins and minerals in cellular metabolism and energy production.

Hormones and Metabolism: Metabolic actions in target tissues: signaling and co-ordination actions of hormones in regulating metabolism, pituitary, GI, pancreatic, thyroidal, adrenal and parathyroid hormones in carbohydrate, protein, lipid and mineral metabolisms. Hormonal actions for maintaining blood glucose and blood calcium levels. Endocrine aptitude in body mass management: Leptin, Ghrelin, Cortisol, estrogen, Neuropeptide Y, Peptide YY, etc.

Unit-2: Physiology of excitable cells and higher functions of brain

F.M. 25

Learning Objectives: This unit highlights the structural and functional properties of excitable cells. This unit also emphasises the higher brain functions and understanding of the fascinating processes driving human thought, cognition and behaviour and the disorders related to nervous system malfunction.

Scope of employability: Research and teaching.

I. **Nerve cells and neural circuitry**: Axon growth and guidance, establishment of axon-dendrite polarity in developing neurons, growth cones as sensory transducer and motor structure, nerve growth factors, axoplasmic flow and molecular mechanism of transport in axon, excitation of nerve fibre, Glial control of neuronal development, Molecular basis of Charcot-Marie-Tooth neuropathy.

Skeletal and cardiac muscle: muscle proteins, properties and locations, muscular contraction– interaction of filaments in vitro and in vivo, coupling of mechanical and chemical events at the cross-bridge, muscle energetics, muscle mechanics – mechanical transients, pathophysiology of muscle contraction – muscular dystrophy, Mc-Addis diseases.

Smooth muscle: molecular structure of contractile components, types, contraction mechanism, excitation–contraction coupling, mechanical properties and energetics, innervation and transmitter actions.

Overview of synaptic transmission: electronic microscopic and molecular basis of synaptic transmission – electrically operated and chemically operated, different type of synapses, molecular structure of synapse – pre synaptic grid, intra membranous proteins, release of neurotransmitters – interaction of vesicular membrane proteins, pre-synaptic membrane proteins and cytosolic proteins, postsynaptic events – IS spike and SD spike, neuro-modulation at synapse, integrative functions of synapse, principal neurotransmitter systems – acetylcholine, epinephrine and norepinephrine, dopamine, serotonin, glutamate, glycine, GABA, opioid peptides, purinergic transmitters, nitric oxide, neurosteroids.

Neuromuscular transmission: structure, active zone, quantal release–exocytosis, endplate potential, conductance changes, nicotinic Ach receptor, MEPP, Diseases of neuromuscular junction- Congenital forms of Myasthenia gravis, Lambert–Eaton syndrome, Drugs acting in neuromuscular junction.

II. **Spinal cord as a control system**: Anatomical and histological organization of spinal cord, functions of spinal cord, feedback regulation of spinal motor functions.Segmental and inter segmental interactions: myotatic reflex, inverse myotatic reflex, flexor reflex, crossed extensor reflex, propio-spinal reflex, role of descending tracts in regulation of muscle tone, posture and spinal reflexes, γ – loop, autogenic inhibition.

Higher functions of cerebrum: Association cortex, Short-term and long-term habituation and sensitization of Gill withdrawal reflex in Aplysia, conditioning and learning–classical conditioning, conditioning variables, exters – interoceptive conditioning, classical conditioning techniques, instrumental conditioning – operant conditioning, Intracranial self-stimulation behaviour, discrimination learning, maze learning, Aversion learning.

Regulatory functions of cerebellum: Cerebellar cortical neural circuitry, feed-back regulation of deep cerebellar nuclei, functional regions of cerebellum, functions of cerebrocerebellum, spinocerebellum and vestibulo-cerebellum. Cerebellar control on muscle tone – α–γ switch, role of cerebellum on voluntary movements, motor and extra-motor predictive functions, cerebellar lesions – deficits in movements, Cerebellum and motor learning

Limbic system control on emotion and behaviour: Neural circuit of limbic system, Papez circuit, fear and rage, Sham rage, Kluver–Bucy syndrome, Septal rage, Uncinate fits.

Basal ganglia as a motor control system: Neural circuits and feedback loops of basal ganglia, functions and regulation of muscle tone and movements, role of medium spiny neurons, basal ganglia mechanisms of reward-oriented eye movement, Dysfunctions of basal ganglia: pathophysiology of Parkinsonism.

III. **Memory**: Short-term and long-term memory, declarative and non-declarative memory, neuroanatomy of memory, cellular and molecular basis of memory, amnesia, Korsakoff's syndrome, memory for learned fear in mammals, transcription factors in long-term memory and synaptic plasticity, role of CA1 NMDA receptor-dependent synaptic plasticity in spatial memory.

Neural control of sleep: Sleep and arousal: thalamocortical mechanisms, genesis of REM–NREM cycle, sleep–active and passive processes, sleep changes with age, physiological changes during sleep, REM sleep – tonic and phasic components, neural and biochemical basis, Sleep-dependent memory consolidation, sleep disorders- Sleep apnea, narcolepsy, Polysomnogram

IV. **Neural basis of circadian rhythm**: Suprachiasmatic nucleus- cytoarchitecture, electrophysiology, pharmacology, metabolism, Circadian rhythms in man, circadian timekeeping system in Drosophila, Molecular basis of circadian rhythm, alterations in environmental time – Jet lags.

Characteristics of circadian clock: zeitgebers, free running clock, Entrainment–criteria for entrainment, masking mechanism of entrainment, Structural elements of oscillatory physiological system- pacemaker, multiple pacemakers.

Special Environment of the central nervous system: CSF as a hydraulic shock absorber, mechanism of secretion and absorption of CSF, blood–brain barrier – cellular and muscular basis, ultrastructural features of endothelial cells of brain capillaries, tight junctions of the blood-brain barrier, neuropathological changes in hydrocephalus, specialized properties and solute transport in brain capillaries.

Paper: DSC-T2 **Credit: 4; Full marks: 50**

Unit-1: Biomedical instrumentation and Electrophysiology F.M. 25

Learning Objectives: The main objective is to introduce the basic biomedical engineering technology, explain the canonical structure of biomedical instrumentation systems, as well as the principles and applications of biomedical instruments. This will help the students to understand, design and evaluate systems and devices that can measure, test and/or acquire biological information from the human body.

Skill development/Job opportunity: i) **Radiologists:** diagnose and treat a variety of injuries andillnesses with medical imaging procedures like MRI, PET, SPECT, X-rays and

ultrasounds. ii) **Clinical Research Coordinator or Assistant:** They can conduct clinical trials and biomedical applications that abide by clinical practice guidelines, along with biomedical investigation, all underthe direction of Doctors (Cardiologist, Ophthalmologist, Nephrologist and Physiotherapist) and Physicians.

Basic concept of instrumentation: General constraints in the design of biomedical instrumentation systems, regulation of biomedical devices, bioelectric signals, biological signal recording systems, and classification of biomedical equipment. Transistor characteristics, Transistor as Amplifier, Cascade Amplifiers, DC coupling, Field effect Transistors, Light sensitive semiconductor devices, Oscillators -Phase shift, Wein Bridge, Relaxation Oscillators, Operational Amplifiers. **Biomedical recorders:** Introduction, physics, instrumentation and biomedical application of cardiac pacemakers, defibrillators and transducers. **Blood flow meters:** History, types, principles and biomedical application of Electromagnetic, Ultrasonic, NMR, and Laser Doppler. **Blood gas and Hb analyzers:** Basic knowledge, instrumentation, principle and clinical application of **s**pirometry, respiratory gas analyzers, blood pH, blood pCO_2, blood pO_2 analyzer,Oximeter and Digital Haemoglobinometer. **Ultrasonic imaging system:** Basic ideas, principles and clinical application of echocardiogram, PET, SPECT, CAT, MRI, fMRI. **Optometry:** Basic concepts, principles and biomedical applications of A, B, M scan. **Biomedical telemetry:** Overview, principles, instrumental design and clinical application of wireless telemetry, single and multi-channel telemetry system. **Measurement of radiation and its biomedical application:** History, principles, instrumentation, detection and measurement of different types of radioisotopes through ionization chamber, G.M. counter, proportional counter, liquid scintillation counter. **Audiometers:** Basic knowledge, design and working mechanism of audiometers, Speech audiometers. **Haemodialysis machine:** General concept, working principle and clinical application of haemo-dialyzer. Artificial and bio-engineered kidney. **Biomedical application of transducers:** Overview, design, and clinical application of transducersfor body temperature, pulse sensors, and respiration sensors. **Physiotherapy and electrotherapy instruments:** Short description of generation, circuit diagrams and testing of electrotherapy instruments, working principles, usage, and safety implications for human beings. **Electrical Safety and Medical Equipment:** Physiological Effect of Electrical Current, Shock Hazards from Electrical Equipment, Methods of Accident Prevention. Classification of Medical Equipment's. Instrumental protection: Mode of Protection.

Electrophysiology:

ECG and its Potential Development: Electrophysiology of heart, electrocardiogram (ECG), ECG lead configuration, source of ECG voltage - dipole theory, vector analysis of ECG, changes of ECG potential in different cardiac abnormalities- myocardial ischemia and infraction, hypertrophy, different types of arrhythmias; vectorcardiogram. **EEG and its brain potentials:** Electroencephalogram (EEG), source and mechanism of formation of rhythmic pattern of EEG, characteristics of EEG waves, Surface electrodes, 10-20

international system of electrode placement, Bipolar and referential montages, Sine wave calibration, Impedance, Amplification of signal, Frequency filters, Signal analysis, clinical applications in sleep studies and epilepsy. Event related potential (evoked potential)- types, characteristics and significance. **Basic Electromyography and Nerve Conduction Studies:** Definition, Type of recording procedure. **Intramuscular Electromyography (IEMG)-** uses, advantages and disadvantages. Infection control Surface electromyography- silver/silver chloride disc electrodes, electrodes montages, Advantages of bipolar derivation, Differential amplification of signal, Frequency filters, Signal to noise ratio, Signal analysis for amplitude and frequency.

Unit -2: System Physiology (301.2) including Homeostasis **Marks: 25**

Learning Objectives: This unit highlights the understanding of systems physiology as the computational and mathematical modeling of complex biological systems and focuses on complex interactions within human systems, using a holistic approach. Special emphasis has been given tothe cardiovascular and respiratory system.

This course also addresses the relationship between structures and function along with levels of organization of the human body and how homeostasis of human body is maintained by regulating constant internal environment of body systems.

Scope of employability: Research and teaching.

I. **System as a basic unit in physiology:** Different systems in physiological process, interaction of different systems in normal and stress conditions, principles of system theory as applied in physiology: Orientation to system approach – characterization and prediction of problems, synthesis and analysis, system characterization, special features of linear systems, time variance and non-linearity, representation of non-linearity to linear equation, representation of chaos.

II. **Cardiac physiology and Control of Cardiovascular System:**

Cardiac function: Cardiac myocyte, Excitation-contraction coupling; Regulation of Cardiac output in normal and abnormal conditions; Cardiac output curve, Venous return curve; Regulation of cardiac function; Cardiac failure – causes, circulation dynamics in cardiac failure; Mechanics of cardiac valves.

***Microcirculation*:** Functional properties of capillaries, transcapillary exchange, flow- and diffusion-limited transport from capillaries, capillary filtration; vasoactive role of the capillary endothelium;

Peripheral circulation and its control: vascular smooth muscle, basal vessel tone and myogenic regulation. Extrinsic control of peripheral blood flow. Regional circulation: cerebral, coronary circulation in health and disease; Regulation of circulation in special situation: hemorrhage, exercise

Cardiovascular control system– spinal cord, medulla, hypothalamus and cerebral cortical

areas in the cardiovascular regulation, cardiovascular reflexes, baroreceptor, ventricular stretch receptors, chemoreceptors.

III. **Respiratory system:** Cells of airways and alveoli, cells for mucous production, alveolar cells, surfactant; Control of respiration – respiratory centers, origin of respiratory rhythm, central and peripheral chemoreceptors, chemical control of breathing, breath holding; Non-respiratory functions of the lung- lung as a secondary lymphoid tissue, adaptive immune response, filtration, detoxification of foreign substances, processing of hormone and vasoactive substances; Respiration in neonates and children- the lung before birth, events at birth, neonatal lung function, development lung function in childhood; Some respiratory problems: pulmonary oedema-etiology and mechanism of pulmonary oedema, pulmonary collapse and atelectosis, pulmonary embolism, respiratory distress syndrome, sudden infant death.

IV. **Physiological Homeostasis**

The internal environment and homeostasis: Different internal environments, general mechanism of homeostasis. The control system: physiological control system, components of control system, regulatory mechanism of control system. Sensors, multiple sensors, set point.

The Autonomic control system: Metabotropic and ionotropic receptors in autonomic nervous system, the autonomic nervous system in the regulation of internal environment and homeostasis.

Excretory system: methods of study of tubular functions, tubular transport mechanism and trans-tubular potential, Role of Kidney in the regulation of ionic, osmotic, acid and base balance of the body fluid, control of extracellular fluid volume.

Gastrointestinal systems: Cholesterol homeostasis, immune function of GI tract, Physiology of gastrointestinal disorders, assessment of gastric, pancreatic and intestinal functions in different patho-physiological conditions.

Regulation of body temperature: interaction of different systems in body temperature regulation, role of receptors and hypothalamic thermostat, abnormalities of body temperature regulation.

Blood and body fluids: Mechanism of blood volume regulation in sudden loss of blood. Haemostasis: Types and mechanism of blood hemostasis. Anticoagulation: Types of anticoagulant and anti-clotting mechanism. Abnormalities of homeostasis: Blood disorders; Lymph: Lymphatic flow and pump; interstitial fluid: its pressure regulation, fluid dynamics, Edema.

Homeostasis in extreme environments: hypobaric and hyperbaric environment, Acute Mountain Sickness (AMS), extreme hot and cold environment, Altered G – force on human body, artificial gravity, zero gravity, space travel on human body.

Homeostasis in stress: Neuroendocrine system in stress, free radicals, reactive oxygen species (ROS). Reactive nitrogen species (RNS), reactive sulfur species (RSS), Effect of free radicals on different biomolecules, cellular homeostasis against oxidative stress, antioxidant defense mechanism.

Paper: DSC-T3 **Credit: 4; Full marks: 50**

Unit -1: Research Methodology, Ethics and Statistics **Marks: 25**

Learning Objectives: This unit will encompass the methodology and theory of statistics as applied to problems in the field of life sciences. The course will provide students with a basic understanding and application of statistics as a tool for testing hypothesis and experimental design for research studies**.**

Scope of employability: The scope of employability for Research Methodology, Ethics, and Statistics is broad, spanning academic research, data analysis, market research, policy-making, and product development across various sectors. Individuals skilled in these areas are essential for applying scientific methods, ensuring ethical practices, and deriving meaningful insights from data, making them valuable in roles such as data analysts, researchers, statisticians, and consultants in fields from healthcare to technology and business.

I. Research Methodology:

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. **Problem Identification and Formulation**: Research Question – Investigation Question – Measurement Issues – **Hypothesis:** Qualities of a good Hypothesis –Null Hypothesis and Alternative Hypothesis. Hypothesis Testing – Logic and Importance. **Research Design:** Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. **Experimental Design:** Concept of Independent and Dependent Variables. **Qualitative and Quantitative Research:** Qualitative research – Quantitative research – Concept of measurement, causality, generalisation, replication. Merging the two approaches. **Data Analysis:** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test, including testing the hypothesis of association. **Interpretation of Data and Paper Writing**: Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism**. Use of tools/techniques for Research:** methods to search for required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism. **Literature Review and Technical Reading:** New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar. **Effective Search:** The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While

Reading, Reading Mathematics and Algorithms, Reading a Datasheet. **Attributions and Citations:** Giving Credit Wherever Due. **Citations:** Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in Books and Dissertations, Dedication or Acknowledgments.

II. Human Interface and Ethics:

Basics of Ethics: Contribution of Philosophers and Moral Thinkers from India and the World. Ethics in Private and Public Relationships. Role of Family, Society and Educational Institutions in Inculcating Values. Human Values-Lessons from the Lives and Teachings of Great Teachers. Administrators and Reformers, Dimensions of Ethics, Determinants and Consequences of Ethics in Human Actions, Essence. **Probity in Governance:** Concept of Public Service, Information Sharing and Transparency in Government, Philosophical Basis of Governance and Probity, Utilization of Public Funds, Challenges of Corruption, Quality of Service Delivery, Work Culture, Right to Information, Codes of Ethics, Codes of Conduct, Citizens' Charter.

III. Statistics

Correlation- Product-moment correlation, partial correlation, multiple correlations. Testing of hypotheses: null hypothesis, levels of significance, errors of inference, one-tailed and two-tailed tests.

Regression - simple and multiple linear regressions.

Correlations involving qualitative variables –biserial r, point biserial r, phi coefficient, tetrachoric r, contingency coefficient.

Nonparametric statistics: Definition, Importance of Nonparametric statistics, Difference between Parametric and Non-parametric statistics; Chi-square tests, application of chi-square in testing the normality of a distribution, G test. Kendal's rank correlation coefficient, Sign Test, Wilcoxon's signed rank test, Wilcoxon's composite rank test, Median test, Mann-Whitney U test.

Analysis of variance: types of ANOVA, models of ANOVA; Post-hoc multiple comparison tests - t test, Scheffe's F test, Gabriel's SS-STP; Kruskal-Wallis non-parametric ANOVA, Mann-Whitney U test.

Multivariate analysis– growth and classification of multivariate technique, factor analysis; Experimental design, application of statistical method in research, formulation of research problems,art of dissertation writing.

Unit -2: Computer Application in Biology and Bioinformatics Marks: 25

Learning Objectives: This unit provides basic knowledge of computer hardware and software, and the learners can develop skills of programming for solving biological science-oriented problems. The student will be able to learn the importance and application of bioinformatics.

Skill development/Job opportunity: The scope of employability for Computer Application and Bioinformatics graduates is vast, spanning the healthcare, pharmaceutical, biotechnology, and research sectors. Graduates can pursue roles such as Bioinformatics Analysts, Computational Biologists, Genomics Data Scientists, and Bioinformatics Software Developers, analysing biological data for drug discovery, personalised medicine, and scientific advancements. The increasing demand for these skills, particularly in data analysis and AI, ensures high growth and diverse opportunities.

I. Computer Application

Number system and data representation – binary, octal, hexadecimal; simple binary arithmetic; representation of characters; ASCII code. **Problem solving and flow charts** – symbols, structure, methods of drawing of flowcharts,application in biological problems. **Principles of programming in BASIC or C**: simple programs for solving biological problems and statistical analysis of biological data. **Simulation and modelling of different physiological parameters** - cardiovascular functioning, Neural circuitry, immunological system, biochemical pathways, drug design, etc. **Word processor**: Basic operation and its application in biological sciences; **MS Excel**: Basic operation and its application in biological sciences; **MS PowerPoint**: Steps of PowerPoint presentation, slide preparation for biological items. Basic concept of email. **Internet:** components of the Internet, www, searching biological information from the Internet, library-searching technique, LAN.

II. Bioinformatics:

Concept of bioinformatics - field of application, common biological databases. **Database management**: idea about database management in bioinformatics, structure of database- PDB, NDB, PubChem, Chem Bank, basic concept of derived databases, sources of primary data and basic principles of the method for deriving the secondary data, organization of data, contents and formats of database entries. **Major Bioinformatics Resources**: NCBI, EBI, ExPASy, RCSB and knowledge of various databases and bioinformatics tools available at these resources, organization of databases: data contents and formats, purpose and utility in Life Sciences, open access bibliographic resources and literature databases**:** open access bibliographic resources related to life sciences viz., PubMed, BioMed Central, Public Library of Sciences (PloS).

Paper: DSC-P1 **Credit: 4; Full marks: 50**

Unit -1: Biochemical experiments **Marks: 25**

Learning Objectives: To train the students by hand-on experiments on biochemistry to pursue metabolic heath assessment and analysis.

Scope of employability: May be the biochemical analyst in any pathological laboratories or biological research in different research institutes.

1. Preparations of buffers, physiological solutions, molecular solutions, determination of pH, preparation of tissue homogenate.
2. Blood analysis: estimation of blood glucose: Nelson-Somogyi method, Hagedorn-Jensen method, Glucose estimation by Glucose oxidase method
3. Protein estimation by the Lowry method.
4. Blood calcium and blood lactate estimation.
5. Estimation of total cholesterol content of blood.
6. Estimation of the triglyceride content of blood.
7. Total non-protein nitrogen estimation.
8. Estimation of urea, uric acid, creatine, and creatinine.
9. Enzyme activity: effect of pH and temperature on enzyme activity.
10. Determination of Substrate concentration on enzyme activity, Measurement of Km.
11. Alkaline phosphatase, bilirubin, free fatty acids, SGOT and SGPT (transaminases) for liver function test

Unit -2: Bio-Analytical Techniques and Microbiological Studies Marks: 25

Learning Objectives: To train the students on bio-analytical methods relating to isolation and assay of biomolecules associated to diverse physiological processes. Additionally, training to be provided to the students on microbiological culture and analysis techniques to detect microbes.

Scope of employability: May be the biochemical analyst in any pathological laboratory or institute. May be a teacher, demonstrator or technician in biochemical research laboratory.

A. Bio-Analytical Techniques

1. Separation and identification of amino acids by paper chromatography at two different solvents.
2. Separation and identification of amino acids by thin-layer chromatography
3. Identification of sugars by thin-layer chromatography.

4. Separation and identification of components from plant extracts by thin-layer chromatography.
5. Electrophoresis of serum proteins.
6. Separation of protein by polyacrylamide gel electrophoresis (PAGE).
7. Separation of DNA by gel electrophoresis.

B. Microbiological Studies

a. Preparation of media and cultivation of bacteria, molds, yeasts and their isolation from natural sources.

b. Microbial morphology – Gram staining, acid-fast staining, spore staining, staining of molds, yeast, and determination of microbial dimensions.

c. Isolation of pure culture from mixed bacterial culture by streaking, spread plate, and pour plate.

Paper: DSC-P2 **Credit: 4; Full marks: 50**

Unit -1: Biostatistics and Computer Applications in Biological Problems

Marks: 25

Learning Objectives: To train the students to employ bio-statistical methods to biologicalproblems and draw proper interpretation for any given issue.

Scope of employability: May be a statistical analyst in any institute. May be a teacher, demonstrator in any biological research laboratory.

Biostatistics:

- Computation and significance of Kendall's rank correlation coefficient between two ordinal variables.
- Computation and significance of the partial correlation coefficient between two variables.
- Computation and significance of the multiple correlation coefficient between a continuousmeasurement variable and two other continuous measurement variables.

- Computation and significance of point biserial r between a continuous measurement variable and a genuinely dichotomous qualitative variable.
- Computation and significance of the phi coefficient between two genuinely dichotomous variables
- Computation and significance of the contingency coefficient between two qualitative variables having more than two classes.
- Testing the goodness of fit of a continuous frequency distribution with the best-fitting normaldistribution by Chi-square test and the G test.
- Computation and significance of one-way model I analysis of variance and multiple comparison t- test and Scheffe's F test.
- Computation and determination of significance of the goodness of fit by chi-square test fromt provided data
- Computation and determination of significance by the Wilcoxon signed rank test, Wilcoxon composite rank test, Median test, and Mann-Whitney U test from provided data.
- Computation of models: linear regression equation of one variable on another.

Computer Applications in Biological Problems:

- Programming with BASIC or C for solving biological problems:

- Arrangement of biological data – ascending order, descending order, highest value, lowest value.
- Evaluation of nutritional status- computation of calorie, BMI, BSA; Study of growth rate.
- Computation of frequency and percentage distribution of different Physiological parameters in different age groups, in different communities, percentage distribution of blood groups.
- Operation of Ms Excel: tabulation of biological data, computation of different groups of data, making charts with Ms Excel: bar diagram, line diagram, pie diagram for representing biological data.
- Operation of word processor: text presentation, editing, formatting, and printing.
- Operation of MS PowerPoint: making slide for any biological topic, editing, slide show.
- Bioinformatics: study of the structure of biomolecules – primary and secondary structure, tools for sequence analysis

Unit -2: Growth monitoring and Human Experiments, including Exercise Physiology, and Ergonomics Experiments **Marks: 25**

Learning Objectives: To develop knowledge and understanding regarding the assessment of nutritional status by measurement of different anthropometric parameters, as well as to identify the individuals or population groups at risk of becoming malnourished.

1. Assessment of the nutritional status of an infant (birth to 36 months) from the standard growth curve and determination of the stage of malnutrition.
2. Growth monitoring and nutritional assessment: assessment of nutritional status of boys and

girls of different ages of a community (2 to 20 years) from standard stature for age, height, weight, and BMI for age curves.

3. Assessment of nutritional status from MUAC, head circumference, skin fold (triceps and subscapular) in infancy, pre–school and school children.
4. Determination of the onset of puberty from the velocity growth curve of stature of school children.
5. Determination of grades of malnutrition of children by the Gomez classification and the Waterloo classification.
6. Determination of grades of malnutrition by percentile value and Z – Z-score of height, weight of children using standard data.
7. Assessment of nutritional status of adult males and females from triceps and subscapular skin folds.
8. Assessment of nutritional status from measurement of food intake by 24 – 24-hour recall method and the food frequency questionnaire method.
9. Assessment of nutritional status from anthropometric measures and anthropometric indices, such as BMI, Body surface area, ponderal index, Dugdel nutritional index, waist-hip ratio, and obesity index.
10. Study of pulse rate with the variation of static workload.
11. Study of blood pressure with the variation of static workload.
12. Study of pulse rate as an effect of dynamic exercise.
13. Study of blood pressure as an effect of dynamic exercise

❖ Indian Knowledge System Credit: 2; Full marks: 25

Introduction to Indian Knowledge System: Definition, basic concept and scopes of IKS, Archaeological Sources of IKS- Prehistoric period's evidences. Ancient Indian Literature and Scriptures (Vedas, Vedangas, Puranas, etc). The basics of Panini's Grammar and its extensive application in Languages. An Indian framework for establishing valid knowledge and its applicability in today's society.

Introduction to Ancient Indian Political and Economic System: Concept of Kingship: Duties and Responsibilities of a King. Indian Economy: Taxation, savings, expenditure. Indus Valley Civilization- Various aspects of Vedic civilization. Dharma and darshan- Vedic Dharm and Shad Darshan

Introduction to Ancient Indian Mathematics, Astronomy and approach to Health: Salient features of Ancient Indian Mathematics. Astronomical Instruments (Yantras)- Application of Physics and Chemistry. Ayurvedic approach to health, food intake methods, Disease management, elements and wellness application of Botany and Medical Science.

Development of scientific thoughts in ancient India: Development of Science and Technology in ancient India. Astronomy: Aryabhatta and Varahmihir. Mathematics: Shulvasutra and Baksali manuscript, Formulation of Arithmetic, Algebra and trigonometry. Life Sciences: Life science in Plants, Anatomy, Physiology, Ayurveda, Medicine, Microbiology, Surgery, Yoga and Meditation, etc.

Development of Engineering Science and Technology in India: Agriculture, Metallurgy. Various Industries- Silk Industry, Cotton Industry and Shipbuilding. Indian Fine Arts, Cave

architecture.

Vidyasagar: Life and Philosophy **Compulsory and Non-Credit**

Semester-II

(Theory: 175 + Practical: 100)
(Total Marks: 275, 22 Credits)

Paper: DSC-T4 **Credit: 4; Full marks: 50**

Unit -1: Community Health, Nutrition and Sensory Physiology **Marks: 25**

Learning Objective: This unit highlights the concept, determinants and risk factors regarding community health and disease. It also emphasises the role of National health policies and Non-Govt and International organisations in health promotion. It provides a basic concept of population genetics and describes the genetic predisposition of diseases

Through this course, the learners will be familiarized with the electrophysiology of heart and brain as well as their different anomalies. It will give anunderstanding about the structure and functions, sensory transduction, neural pathways and role of sensory system (taste, olfaction, hearing and vision).

Skill development/Job opportunity: In future, they serve as a Certified Nutrition Specialist, Clinical Dietician, Dietetic Technicians, Health Coach, Health Educators and Community Health Workers, Holistic Nutritionist, Licensed Nutritionists, Nutrition Specialities.

After completion of the course on auditory system, the students may get engaged as an ENT and Audiometry Technician, Assistant of Speech Pathologist and Audiologist, Speech Language Pathologist, Speech Therapist, and Clinical Specialist.

Community Health

I. **Concept of community health and disease:** community structure, definition and concept of health and diseases, dimension of health, health system, health situation in India; diseases: causation and prevention of diseases, mode of intervention, epidemic and endemic forms of diseases, epidemiological triad, web of causation, high - risk group, prevention of communicable diseases, prevention of non - communicable diseases, control of malaria, kala-azar, diarrheal disorders and endemic iodine deficiency disorders, physiologists as health counsellors.

Vulnerable sections in the society and their health care: health and diseases in infant/children/girlchild/old persons, women in the reproductive age, rural/tribal population, health problems of old ages.

National health policy/programme, role of non-govt. and international organizations: national health policy, role of WHO, UNICEF, UNDP, FAO, UNESCO, ILO, WORLD BANK, Red Cross, CARE, national health programmes, alternate health care planning.

II. **Population genetics:** basic concept of population genetics- allele and genotype frequencies, gene

pool, Hardy-Weinberg law in trait inheritance, eugenics, genetic counselling: prospective and reproductive study.

Genetic predisposition of diseases: role genetic predisposition to common disorders: cancer, coronary heart diseases, diabetes, mental disorders, mutations in chromosome – variation caused to chromosome number and arrangement, monosomy, trisomy, polyploidy, chromosome deletion, duplication, inversion and translocations, fragile sites, genetics and evolution.

Mental health: definition of mental health, characteristics of mentally healthy person, parent-child relationship and mental health, types of mental illness / causes, remedial measures for mental illness, problems of mental health in India, mental problems of old age.

Nutrition

III. **Nutrition in infancy, children:** Nutritional requirement in adults, nutritional requirements of nutrients during infancy. Breast feeding: Role of nutritional and others factors, advantages of breast feeding, Drug transfer during breastfeeding**;** Physiology of lactation, nutritional requirements, factors affecting the volume and concentration of breast milk. Formula feeding: Types and importance, advantages and disadvantages. Infant milk substitute (IMS) act 1992: Its application and significance. Nutritional requirement of pre- term babies.

Nutrition and adult health: Different food groups and nutrients: Role of dietary fibres, food additives and artificial sweeteners. Food borne illness and diseases: Cause, factors, prevention and treatment. Classes of nutraceuticals and its clinical application. Food processing: principles pasteurization, chemical methods, dehydration methods, vacuum and modified atmosphere packaging, irradiation technology. Role of probiotics, prebiotics, functional foods and their physiological significance. Transgenic foods and its importance; drug-nutrient interaction, nutritional epigenomics. Nutrient sensing: role of sensing transcription factors and dietary signaling routes, genomics and transcriptomics.

IV. **Feeding problems**: Food allergies: General mechanism of action, cause of cow's milk protein allergy, lactose intolerance. Infant diarrhea, constipations; nutritional requirement of pre-school and school children; Nutrition related problems of children: Childhood obesity, dental caries. Nutritional requirement and problem of adolescents: anorexia nervosa (AXN), bulimia nervosa (BMN) and binge eating disorder (BED). Premenstrual syndrome (PMS) and its nutritional therapy.

Role of nutrients in pregnancy: Physiological changes during pregnancy, Maternal factors effecting pregnancy outcome: maternal age, pre-pregnant weight, weight gain during pregnancy, lifestyle factors. Birth weight standards, nutritional requirements during pregnancy, problems in pregnancy- morning sickness, nausea and vomiting, constipation, edema and leg cramps, heart burn, excessive weight gain.

Sensory Physiology

V. **The visual system**: ultrastructure of retina, Retinal neural circuitry, Photoreceptor potential –

genesis of potential in light and dark phase, recording of potential, molecular mechanism of phototransduction process; electroretinogram (ERG) – characteristics, physiological and clinical significance; visual pathway, primary visual cortex – topographic map, organization of infruts;effect of striate cortex lesions in primatedspatio- temporal organization of retinal and other visual neurons; chromatic properties of retinal, LGB and striatal cortical neurons; binocular and stereoscopic perception.

VI. The auditory system: Basic idea about the anatomy and physiology of auditory system. Ultra-structure of cochlea and Organ of Corti. Mechanism (General and Molecular) of sound transmission in auditory system; Theory of sound transmission. Auditory path way: Ascending and descending auditory pathway, the primary and secondary auditory cortical areas. Auditory Potentials: resting and stimulus related potentials: Endocochlear potential, cochlear microphone potential, summating potential, auditory nerve potential. Functions of auditory system: frequency analysis of sound by cochlea and intensity coding of auditory system.

VII. The olfactory system: structure of olfactory receptor; olfactory receptor potential – characteristicsand molecular mechanism of transduction, elctro-olfactogram, olfactory pathways – olfactory bulb, central olfactory connections; coding of olfactory information, anosmia and dyssomnia

VIII. Taste system: receptor organs – distribution, ultramicroscopic structure and innervations; taste qualities, taste receptor potential – molecular mechanism of transduction; taste pathway, sensory processing, abnormalities of taste.

Unit-2: Biophysical principles and Nanoscience **Marks: 25**

Learning Objectives: This unit highlights the relation between physical principles and biological systemsand explains how biophysical principles are deeply related to physiology. It is designed to describe the physiological mechanism on the basis of physical laws and the bio-application of different physical principles.

Skill development/Job opportunity: i) Laboratory technicians: They will be able to perform various procedures in a laboratory and also maintain laboratory equipment, assist lead scientists with their duties, collect and analyze samples or substances and standardize different test. **ii) Research associates:** They monitor the progress of research projects and perform different tests and studies.

I. Viscosity of liquids and gases: Flow-pressure relation of blood in blood vessels, viscoelasticity, physics of blood flow, laminar and turbulent flow, Viscosity coefficient; Newtonian and Non-

Newtonian fluids, significance of Reynolds' number in hemodynamics, models for flows of liquids: Bernoulli and Poiseuille's equations and their applications. Observation of Hagen-Poiseuille's law in certain physiological conditions.

Haemodynamics of the cardiovascular system: Fluid dynamics blood flow, blood pressure, resistances to flow in different regions of the circulation; effects of gravity and external acceleration on circulation. Haemodynamics in different phases of the cardiac cycle, stroke volume, cardiac output related to Ohm's law, heart sounds, mechanical power of heart.

II. **Mechanics in breathing:** Physical basis of lung compliance, physics of alveoli, surface tension, Laplace's Law, airway resistance, pulmonary vascular resistance, Work of breathing, Boyle law, Dalton and Henry's laws of partial pressures in gas mixtures, gas exchange: Fick's law of diffusion, ventilation, perfusion.

Physics of speech and vision: Phonation (Physiology, types, cycles and mechanism) and physics of voice production, articulation; Basics physics of light and vision, focusing elements of eye, retina, the light detector of eye,

III. **Thermodynamics:** Laws of thermodynamics (Zeroth law, 1^{st}, 2^{nd} and 3^{rd} Law)and living organism, enthalpy, entropy, efficiency, and thermodynamic system model, adiabatic process, concept of energy in biological system in the light of thermodynamics, Gibbs (Josiah Willard Gibbs) free energy**,** living body as a thermodynamics system, Carnot's cycle.

Light and Associated Phenomena: Ultraviolet light (UV Light) and its effects on living system, photo reactivation, light and its clinical application as therapeutic treatment, Bioluminescence (physics, distribution, cellular mechanism) and its modern application.

Microwaves, Electromagnetic field, and Gravitational fields on living systems: Their source, victims to exposures, penetration, propagation and biological effects on target organ.

IV. **Basics physics of Ultrasound: Sources, emission and reception of ultrasound,** Propagation equation, reflection and refraction at surfaces, diffraction, absorption and attenuation mechanisms. Ultrasound therapy: Physiological and clinical approaches of ultrasound therapy. Transducer: Introduction, properties and the principle of transducers, physics of transducer beam patterns.

Electricity and crystal with biological matter: History, symmetry in crystals, lattices and unit cells, classes of crystal systems, application of piezoelectricity, ferroelectricity.

Methods in biophysical analysis: Basic knowledge, methods and application (Biomedical research and clinical) of Single neuron recording, brain activity recording, stimulation of brain, circular dichroism, optical rotary dispersion, Raman spectroscopy, X-ray diffraction.

Nanoscience

Fundamentals of Nanoscience: Introduction to Nanoscience and Nanotechnology, Nanoscale material, implications for Physics, Chemistry, Engineering and Biology, and Motivation for

Nanotechnology study. History and development of Nanoscience and Nanotechnology.

Structures, Types, and Classification of Nanostructures:

Definition of a Nano system. Nano-structures: various types of nano-structures and nano-crystals, Nano-wires, Ultra-thin films, Multi-layered materials. Types of Nanocrystals: One Dimensional (1D), Two Dimensional (2D), Three Dimensional (3D) nanostructured materials. Quantum theory of nanomaterials: Development of quantum theory of nanomaterials: Quantum dots, Quantum wire, Quantum core/shell structures.

Properties of Nanomaterials: Elucidation of the structure: chemistry, and properties of Nano-structured materials. Variation in properties of micro and Nanomaterials. Mechanical, electronic, optical, magnetic, and thermal properties of nanomaterials.

Nanotechnology and its Biological Applications: Emergence of Nanotechnology, Challenges in Nanotechnology; Carbon age: New form of carbon (from Graphene sheet to CNT); Biochemical sensor.

DSC-T5 Credit: 4; Full marks: 50

Unit -1: Molecular Biology and Biotechnology 25(15+10)

Learning Objectives: The objective of this unit is to enable students to learn about the molecular nature and functioning of key structural elements of cells and genetic materials, thereby developing a basic understanding of the molecular explanations for physiological interactions.

Scope of employability: After studying the 'Molecular Biology' syllabus, there are plentiful options available to a student. They can stay in higher education, and it is a best route to clinical and industry-related research. This scientific knowledge can also be applied to a range of other careers, including teaching, science communication, or industry.

I. **Chromosome structure and organization:** Morphology, structural organization and function of chromosome; Euchromatin and heterochromatin, hyperchromatism and hyperchromatism; DNA double helix and DNA geometry and topology; B, A, and Z forms of DNA. Chromosomalrearrangement in health and diseases.

II. **DNA synthesis, processing and repair:** Unit of replication, replication origin, and replication fork, DNA polymerases, unwinding proteins, prokaryotic and eukaryotic replications, reverse transcription, DNA repair - excision, reversal, recombination (homologous and site-specific recombination) and sos repairs eukaryotic genomic organization – C value paradox, repetitive sequences, tandem-gene cluster, gene amplification, coding and non-coding sequences,oncogenes.

III. **Classical genetics:** Mendelian principles: dominance, segregation, independent assortment; Concept of gene: allele, multiple alleles, pseudo-allele, complementation tests; extension of Mendelian principles- codominance, incomplete dominance, gene interaction, pleiotropy, genomicimprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters, recombination-homologous and non-

homologous recombination including transposition, linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, extra chromosomal inheritance: inheritance of Mitochondrial and chloroplast genes, maternal inheritance; pedigree analysis, lod score for linkagetesting, genetic disorders, karyotyping; structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, ploidy and their genetic implications.

IV. **RNA synthesis and their processing and modifications:** Transcription factors and machinery including RNA polymerases, eukaryotic and prokaryotic transcription, different types of RNA andmRNPs organization of transcriptional units, induction, repression, locus control regions, attenuation.; exons, introns, post transcriptional modification (RNA processing) – cleavage and splicing, RNA editing, capping, polyadenylation, different forms of RNA in gene expression, regulation of gene expression in prokaryotic and eukaryotic system. RNA transport, localization and function.

V. **Genetic code, protein synthesis, processing and transport of proteins:** genetic code, codon and anticodon interactions, translation in eukaryotic and prokaryotic organisms- Initiation, elongation and termination factors and translational proof-reading. Regulation of Translation-global vs mRNA- specific. Translation inhibitors, glycosylation of protein, signal hypothesis and membrane trigger hypothesis, post translational modifications, amino acid sequencing in proteins. Protein trafficking and transport.

VI. **Mutations:** Chromosomal aberrations, gene mutations, inborn errors of metabolism types, mutant types – Spontaneous, induced, lethal, conditional, reversion, mutagenic suppression, biochemical, gain of function, loss of function, germinal vs somatic mutants, insertional mutagenesis, deletion,duplication, translocation, transposition, ploidy.

Biotechnology

Learning Objectives: To develop in-depth knowledge about basic principles, skill development of tools and techniques employed in biotechnology. Also the target is conceptual developments regarding major achievements in biotechnology.

I. **Cloning vector:** biology of cloning vectors- plasmids, cosmids, lambda phage, single stranded DNA phages, M-13 phage, animal viruses, Ti-plasmid, BAC, YAC, how to choose a right type ofvector.

II. **Genetic engineering and biotechnology:** Restriction endonucleases, recombinant dna technology; transformation, transfection, microinjection and shot gun method; genetic mapping; transposons and their uses in genetic manipulation, screening in gene cloning: blue-white screening, eukaryotic and bacterial gene knock-out, vector based recombinant protein expression, 2 and 1-D gel electrophoresis, protein sequencing, site-directed mutagenesis; genomic library, c- DNA cloning. transgenic animal, gene targeting, mobile genetic element, general recombination, restriction mapping; RFLP, RAPD, AFLP techniques.

III. **Stem cells and tissue culture:** stem cell for therapeutics - diseases like diabetes, heart disease etc, reproductive cloning and its applications, transgenesis and transgenic animals, cloning modelas- DOLLY; animal cell culture**:** primary cell lines, cell clones, organ culture; cell types in culture, cell environment- nutritional requirements, substrates; cell characterization-karyotyping, growth rates, isoenzymes and differentiation- normal and transformed cells; brief history of the human genome project, utility of the project, future challenges of the project.

IV. **Methodology in genetics and biotechnology:** fermentation and their use, biofermenter, agarose gel electrophoresis, southern, northern and western blotting and hybridization techniques, autoradiography, immune -autoradiography, gene toxicity testing, DNA finger printing and foot printing; dot-blot; nucleic acid sequencing; polymerase chain reaction. RT-PCR, nested PCR, FISH, GISH, immune fluorescence microscopy, flow cytometry, microarray technology, bioinformatics, genomics, proteomics and computational biology.

Unit -2: Cell biology **F.M.-25**

Learning Objectives: To develop detailed knowledge regarding cell structures, subcellular organelles and their functions, cellular interactions, life cycle, signaling and coordination. Moreover in-depth understandings to be developed on pathological conditions and cell-based technology.

I. **Cells:** Evolution of cells, the nature, classification, and functions of cells.

The plasma membrane: structure and functions of plasma membrane, the membrane proteins and lipids, membrane fluidity and dynamic nature of plasma membrane, membrane transport, electrical properties of membranes, regulation of intracellular transport, membrane pumps, active transport,ion channels, osmosis, membrane and lipid bilayer protein diffusion.

II. **The cytoskeleton:** function and structure of cytoskeleton and its role in motility, roles of microtubules, microfilaments and intermediate filaments, cilia and flagella.

Subcellular organelles and cellular interactive structures: endomembrane system, endoplasmic reticulum, golgi complex, lysosome, vesicular trafficking (secretion and endocytosis), the endocytic pathway: phagocytosis, mitochondria-peroxisome-chloroplast: protein sorting; cellular interactions: with extracellular materials, with other cells; tight junctions, gap junctions, integrin and plasmadesmata, nucleus, cell wall.

III. **Cell signaling and signal transduction:** Basic ideas about cell signaling, quorum sensing, bacterial chemotaxis, light signaling in plants, plant and bacterial two-component systems, extracellular messengers and their receptors, G protein–coupled receptors and their second messengers, calcium as intracellular messenger, protein-tyrosine phosphorylation,

interrelationship among different signaling pathways, nitric oxide as intercellular messenger, programmed cell death: apoptosis

IV. **Cell cycle and differentiation:** *In vivo* cell cycle control and their regulation, M phase, meiosis and gamete formation, recombination and genetic variability, DNA repair, cancer and oncogenes; fertilization and early development, stem cell biology, embryonic stem cells and cloning, cellular differentiation, epigenetic control, cell culture, fluorescence activated cell sorting.

DSE-T1 Full marks: 50 Credits-4

Special Elective paper (A/B/C/D/E)

A. Microbiology and Immunology F.M. 25

Unit -1: Advanced Studies in Microbiology

Learning Objective: To develop advanced knowledge regarding microbial survival in nature under different environmental conditions, their interactions with hosts and their specific importance in several aspects on earth.

I. **Microbial Ecology:** microorganisms in nature, methods in microbial ecology, the carbon, nitrogen, sulphur and iron cycles, leaching of ore, bio-hydrometallurgy, heavy metal transformation, microbial interaction in nature: biofilm and quorum sensing.

Microorganisms as environment protectors: applications in combating pollution: biodegradation of petroleum and xenobiotic, bioremediation; applications in agriculture: bio-fertilizer, bio-pesticides, bio-herbicides, and bio-insecticides,

II. **Host-microorganism interactions:** host parasite relationship, normal microbial flora of humans, germ-free animals and its importance, transmission of microorganisms, infection, infection mechanisms, microbial pathogenecity and virulence, determining etiology and host factors, gut microorganisms as physiological control system: stress management, immunity.

III. **Microbial metabolism:** Types of metabolism, energy production, catabolism of carbohydrates, Respiratory ETS and ATP synthase, The Kreb's Cycle, metabolic diversity - anoxygenic and oxygenic photosynthesis, chemolithotrophy, hydrogen and sulphate reduction, fermentations, fermentative diversity, Alternative of glycolysis, hydrocarbon transformation, amino acids and nucleotide biosynthesis.

Autotrophic-CO_2 fixation: the calvin cycle, reductive Acetyl-Coenzyme A pathway,reverse citricacid and hydroxy - propionate cycle, Carbon fixation processes: Carbon fixation in C_3 plant, C_4 plantsand in CAM plants.

IV. **Nitrogen fixation:** Early discoveries in nitrogen fixation**,** nitrogen cycle, phases and importance, nitrogen fixing bacteria, Nitrogen fixation mechanism, Anaerobiosis and nitrogen fixation, Nitrogenase and nitrogen fixation, genetics and regulation of N_2 fixation.

Unit-2: Cellular and Molecular Immunology

Learning Objective: To develop advanced and in-depth knowledge about the reaction processes adopted by several components human defense system to develop immunity against infections.

I. B-cell and T-cell structure and function: Structure of B cell and T-cell, B-cell co-receptor complex and T-cell coreceptor (CD3, CD4 & CD8), B cell development, maturation and activation/ signal transduction, immunoglobin superfamily, T-cell development and maturation, immunological synapse, T-cell activation / signal transduction, the co-stimulatory signals, T-cell memory.

II. The Major Histocompatibility Complex and Antigen processing –The structure and function of class I and II MHC molecules, endogenous and exogenous pathway of antigen processing and presentation, polymorphism, HLA typing.

III. Immunological tolerance and apoptosis (programmed cell death): Immunological basis of graft rejection, immunosuppressive therapy, T cell anergy, types of programmed cell death – death-receptor mediated apoptosis, mitochondrion-dependent apoptosis, alternative cell death pathways; Fas-dependent apoptosis in DCs, caspase and Bcl-2 protein families, anti-apoptotic Bcl- 2 and Bcl-xL, BH3-only protein in DCs, apoptosis and Alzheimer's disease.

IV. Antibody diversity and cytokines in immune regulation –genetic rearrangement, generation of antibody diversity, class switching, general properties of cytokines, cytokine receptor families, mechanism of cell activation, monokines, lymphokines, Interferon, tumour necrosis factors, chemokines, interleukins; cytokine-antagonists, and cytokine related diseases

B: **Biochemistry, Molecular Endocrinology and Reproductive Physiology**

Unit-1: Advanced Studies in Biochemistry

Learning Objectives: This special course will give an in-depth knowledge of biochemical processes through the underlying molecular mechanisms as well as an understanding of chemical and molecular processes that occur in and between cells and its advanced applied areas.

Skill development / Job opportunity: They may be a Laboratory Technician, Molecular biologist, biochemist, Medical Technologist and cell biologist.

I. **Biomembrane and Cell Biology:** The molecular organization of biomembranes: Heterogeneity, asymmetry and fluidity; Membrane proteins and their functions; Role of cholesterol and fatty acid in membrane fluidity, Lateral and Transverse diffusion, FRAP and

FLIP; Membrane asymmetry and its implications in health and disease. Supramolecular membrane structure. Membrane permeability. Membrane transport. Receptor-mediated endocytosis; clathrin-independent and - dependent endocytosis.

Sub-Cellular organelles-structure and function. Cytoskeleton-Role in motility, intracellular transport, mitosis. Microtubular structure and dynamics. Extracellular Matrix-assembly; their role in integrating cells into tissues and cell-cell interactions. Cell cycles-Restriction point/check point of cell cycle and Quiescent cells; CDK complexes; Cell differentiation and transformation. Cell and tissue culture-concepts and techniques; Clone and hybridization of mammalian cells and its application. Apoptosis and its mechanism.

II.Biomolecules: Polysaccharide chemistry; Glycoprotein and peptidoglycans - conformation and significance. Protein conformation; Super-secondary structure-Domains and motifs; Protein folding-assisted protein folding (Chaperones); Misfolding and diseases; Determination of amino acid sequences in proteins; Myoglobin and haemoglobin - structural and functional study. Structural aspects of lipid: lipid-linked proteins. Determination of nucleotide sequence in DNA; Structural polymorphism of DNA and RNA; secondary and tertiary structure of tRNA; MicroRNA; DNA-RNA hybrids.

Metabolic Biochemistry: Molecular concept of bioenergetics. Energetics of metabolic cycles. Regulation of Glycogen metabolism; Glycoprotein biosynthesis. Regulation of fatty acid and cholesterol biosynthesis; Formation of prostaglandins, prostacyclins and thromboxanes. Metabolism of lipoproteins. Regulation of purine and pyrimidine biosynthesis. Integration of different metabolic pathways. Metabolic regulation in starvation and after a meal. Photosynthesis- Photosystems I and II; Hill reaction, Photosynthetic electron transport chain, and photophosphorylation; C3 and C4 pathway and its regulation; Photorespiration. Nitrogen fixation- Nitrate assimilation and nitrogen fixation; The nitrogenase complex; Regulation of nitrogen fixation – influence of ATP/ADP ratio; Identification and repression of *nif* gene.

III. **Enzymology, Advanced Nutritional and Clinical Biochemistry:** Acid-base catalysis, covalent catalysis. Site-directed mutagenesis of enzymes. Mechanism of action- chymotrypsin, DNApolymerase, and aspartic proteases. Reversible covalent modification- glutamine synthase and phosphorylase, and irreversible covalent modification of proteases. Allosteric behaviour of aspartate transcarbamoylase and phosphofructokinase. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthase complex. Isoenzymes of lactate dehydrogenase. Antioxidant enzymes and their role. The mechanistic role of nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B12 in enzyme catalyzed reactions. Methods for isolation, purification and characterization of enzymes.

Molecular mechanism of vitamins, trace elements and minerals. Sucrose consumption and intolerance; lactose intolerance; Special role of the non-starch polysaccharides. Nutritive value ofproteins and its determination; Amino acid imbalance. Nutritional aspects of the vitamins and minerals, Protein calorie deficiency status.

Disorders of carbohydrate, amino acid and lipid metabolism, Disorders related to Protein energy malnutrition, Starvation, Obesity. Food borne diseases and their prevention, Porphyrins and Gout,Atherosclerosis, Obesity, Diabetes Mellitus, and Functional tests of kidney and liver. Naturally occurring Anti-nutrients. Food borne toxicants- Protease inhibitors; Hemagglutinin; Oxalates, Phytates. Food allergens. Analytical techniques in nutritional biochemistry.

Clinical significance of Serum lactate dehydrogenase, Serum alkaline phosphatase, Serum alpha hydroxybutyrate dehydrogenase, Serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, Serum creatine phosphokinase, serum and erythrocyte cholinesterases, Serum isocitrate dehydrogenase, serum amylase, serum aldolase, serum glucose-6-phosphate dehydrogenase.

IV.Analytical Biochemistry: Buffers and their mechanism of action; Determination of pKa. Chromatography. Molecular weight determination of macromolecules by gel filtration chromatography, gel electrophoresis and ultracentrifugation. HPLC and FPLC. Isotopic tracer techniques and autoradiography. Spectrophotometry. Principles of optical rotatory dispersion and circular dichroism and X-ray diffraction and their applications in structure determination. Principle and application of NMR spectroscopy in Biology. Differential and density gradient centrifugation; analytical ultra-centrifugation; Electron microscopy –Transmission and scanning. Freeze fracture techniques. Fluorography. Phosphor-imaging applications. FACS, AFM, Confocal Microscopy, Mass (MALDI and LC), Live cell microscopy, FRAP.

Developmental, Stem Cell and Cancer Biology: Gametogenesis (Meiosis, Oogenesis, Spermatogenesis); Cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation and cell migration. Molecular events of embryogenesis. Cell-cell communication and molecular signaling in development - Concepts of induction and competence, epithelial-mesenchymal interactions, role of FGF-RTK pathway, JAK-STAT, Hedgehog family, Wnt family, TGF-β superfamily, Notch pathway and developmental signals from extracellular matrix.

Development of model organisms -Drosophila, Xenopus, Zebra fish, Chick, Mouse, *C. elegans*, Human.

Adult stem cells; Cancer stem cells; Stem cell markers; Applications of stem cells, Cultivation ofstem cells; Mechanism of carcinogenesis; Cancer cells- characteristics and genetics, Mutation and cancer; Viral and cellular oncogenes; Molecular nature and activation of oncogenes Oncogenes as transcriptional activators. Tumor suppressor genes - Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Suppression of tumor suppressor genes. Apoptosis and oxidative stress in cancer. Immune mechanism of tumor cell killing. Immuno-diagnostics (methods). Different Therapeutic approaches to cancer.

Unit 2: Molecular Endocrinology and Reproductive Physiology F.M. 25

Learning Objectives: This special course encompasses a detail understanding of advanced endocrinology and reproductive physiology at cellular and molecular levels as well as about the

disorders of endocrine system and reproduction

Skill development / Job opportunity: Student may establish as a researcher, Scientist, Clinical endocrinologist. May be health worker, reproductive physiologist.

Module-I

Genetic control of hormone formation and Hormone Receptor: Expression of a protein hormone encoding gene, signal hypothesis, cellular processing of pro hormones, regulation of geneexpression for protein hormone, generation of biologic diversification.
Models of hormone receptors- fixed model and mobile model receptor –their location; different pathways with special reference to growth factor signaling pathway, Cytokine activated JAK/STAT signaling pathways.
Measurement of hormones: Immunoassay –, ELISA-techniques, advantages of ELISA over RIA, RIA-assay protocol; Immunometric assay (IRMA) and immune- chemiluminometric (ICMA) assay, intra-assay and inter- assay variation
Thymus and Prostate as endocrine gland: General history of thymus, bioactive molecules of thymus, role of thymic hormones –thymosin a.b4,THF-g2.thymopoietin-their role on different physiological system. General structure, different bioactive molecules of prostate having endocrinefunction, role of prostatic biomolecules on different physiological systems.

Module-II

Molecular basis of Endocrinopathy: Immune-endocrine system- current development of the interaction of immune- and endocrine system, influence of immune system on endocrine activities,influence of endocrine hormones on immune system

Hormonal role in apoptosis and cancer: Hormonal aspect of apoptosis in physiological system,Germ cell apoptosis, lymphoid apoptosis. Molecular endocrine tumor biology, multiple endocrine

neoplasia, molecular pathogenesis in pancreatic and gut endocrine tumors, endocrine-responsivecancer, hormonal approach in the treatment of cancer.

Module-III

Molecular aspect of Sex Differentiation
Location of SRY-gene and its critical period of expression, specific cell type engaged in SRY-gene expression, downstream genes regulation by SRY-gene like AMH gene, aromatase gene. AR-gene, 5a-reductase gene, Sox-9 gene and Z-gene.

Gametogenesis and Gonadal Steroidogenesis: Spermatogenesis cycle and its hormonal control, Folliculogenesis and hormonal control- endocrine and paracrine regulation, first and second meiotic arrest and its withdrawal mechanism for oocyte development, luteinization and luteolytic.Gonadal steroidogenesis- autocrine, paracrine and endocrine regulation, regulation of expression of genes encoding steroidogenic enzymes

Assessment Makers for Reproductive system: Gonadal cholesterols, gonadal ascorbic acid, gonadal acid and alkaline phosphates activities, gonadal steroidogenic key enzymes activities, sperm motility

Module-IV

Stress and Reproduction: Stress and pituitary gonadotropin, stress and cytokines, oxidative stressand reproductive activities.

Reproductive Immunology: in male and female

Assisted Reproduction Technology (ART): Difference between infertility and sterility, infertility assessment in male and female, role of ART in infertility management, intrauterine insemination (IUI), in vitro fertilization (IVF), intra cytoplasmic sperm injection (ICSI), super ovulationtechnique, subzonal insemination, gamete intra-fallopian transfer (GIFT), Oocyte and embryo culture, oocyte and pre-embryo classification, micro manipulation of human gametes, zygote and embryo.

C : Biophysics and Electrophysiology with Structural Biology

Unit 1: Biophysical Principles, Molecular Biophysics and Advanced Methods in Biology F.M. 25

Learning Objectives: In the present unit involves the application of physical techniques to achieve an understanding of life processes at a molecular level and helps to achieve a mechanistic understanding of biological processes.

Skill development / Job opportunity: They may be appointed as Laboratory Technician, Microbiologist, Pathologist, Medical Technology Developer, and Biological Engineer

I. **Physical laws and its advanced application in biology**- Principle of least action, Classical mechanics, including Newton's laws, Lagrange's equations, Hamilton's equations. Laws of fluid motion: Stokes law, Navier–Stokes equations and Faxén's laws.

Atomic Structure &Bonding: The electronic structure of atom, Ionic bond, Covalent bonds, Hydrogen bonds Van der Waals forces, Electric dipoles, Polarization and induced Dipoles, Casimir interactions, Molecular interaction: strong and weak interactions. Inter-atomic potentials for strong bonds, Interatomic potential for weak bonds, Non-central forces, Bond energies.

General understanding of quantum mechanics: Pauli Exclusion Principle, Ionization

energy, electron affinity and chemical binding, Electronegativity and strong bonds, secondary bonds.

Quantum chemistry: Wave theory of light, Planck's quantum theory, photoelectric effect, de Broglie's postulate, Heisenberg uncertainty principle, Schrodinger wave equation, Atomic orbital models, the wave equation, molecular orbitals, the LCAO method, the overlap method, coulomb and resonance integrals, the hydrogen molecule, charge distributions, approximate methods.

II. **Advance Thermodynamics:** Basics of Thermodynamics: Laws of thermodynamics and living organisms, types of thermodynamic processes; pressure thermodynamics; finite time (or end reversible) thermodynamics, Equation of State, Thermodynamics of combustion, Thermodynamic equilibrium and Irreversible thermodynamics, Carnot's Heat engine, Isothermal expansion, Adiabatic expansion, Thermodynamic efficiency, the entropy function, Residual entropy, Bond enthalpy and bond energies.

Kinetics of Molecules & Reactions: Velocity, Order and Molecularity of a chemical reaction, Kinetic equations for zero, first, second & third order reactions, Determination of order of the reaction, Arrhenius equation, Activation energy and Rate constant, Effect of temperature on reaction rates, Consecutive reactions and Chain reactions. Collision& transition state theories of reaction rate, Catalysts, Mode of action of catalysts.

Principles of kinetics and molecules in biology: Diffusion: History of diffusion, physics, basic model of diffusion: diffusion flux, Graham's laws of diffusion, Ficks law and equation, Onsager's equations, Einstein's mobility and Theorell equation formula, Diffusion in porous media, Diffusion coefficient in kinetic theory of gases. Osmosis: Mechanism of osmosis, Role in living things, Factors: Osmotic gradient and pressure; Surface tension: Definition, angle of contact, interfacial tension, capillary rise, determination of surface tension, Factors affecting surface tension;Precipitation, Biological significance of precipitation,Colloids and their types, Kinetic and electrical properties of colloids, Stability of colloids, Gibbs-Donnan Equilibrium in living systems.

III. **Separation techniques:** Electrokinetic methods, principles, instruments design and biomedical application. Electrophoretic mobility (EPM), factors affecting EPM. Types of Electrophoresis: Zone electrophoresis, Gradient electrophoresis,2D electrophoresis, paper electrophoresis, High voltage electrophoresis (HVE), Pulse field Gel electrophoresis, Isoelectric focusing, Capillary electrophoresis, SDS- Polyacrylamide Gel Electrophoresis (PAGE).

Microscopy: Principle, instrumentation and application of Microscopy. Different types of Microscopy: Polarization microscopy, Fluorescence, Electron microscopy: Electron guns, Electron lens, High Voltage Electron Microscopy, Scanning Electron Microscopy (SEM), Scanning Transmission Electron Microscopy (STEM); Flowcytometry & cell sorting.

Spectroscopy: Basic principles: Significance of Extinction coefficient, Deviations from Beer's law, Absorption spectrum. Instrumentation and applications of UV-VIS absorption, IR and Raman, atomic absorption, Atomic absorption, Fluorescence and Phosphorescence: Fluorometry- Theory and Instrumentation, Applications, Fluorescence

spectra and study of protein structure, Florescence and energy transfer. Laser spectroscopy, nuclear magnetic resonance (NMR): Chemical shifts, spin-spin coupling. Electron spin resonance spectroscopy, acoustic spectroscopy; solvent perturbation; difference spectroscopy; Fourier transform techniques (FTIR); applications of laser and mass spectroscopy.

IV. **Protein structure and stability:** Amino acids and their characteristics: Structure of amino acids,peptides, polypeptides. Polypeptide chain geometrics, estimates of potential energy, results of potential energy calculations;Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Primary structure: peptide mapping, peptide sequencing automated Edman method and mass spectrometry. Secondary structure: Alpha, beta and loop structures and methods to determine Supersecondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites; Tertiary structure: Domains,folding, overview of methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes; Ramchandran plot.

Protein structure function relationship and engineering: Protein modification-thermal, enzymatic, physical, pressure, solvents, interactions; The random walk, Helix coil transition in protein. Compositions of nucleic acid, DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Leucine zipper, Zn-finger motifs, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers; Chargaff's rule in DNA, RNA base compositions, Covalent chain structure, secondary structure inferences from RNA sequence comparisons.

Unit 2: Advanced Cellular and Membrane Biophysics F.M. 25

Learning Objective: This unit will provide an understanding of the primary experimental and computational methods by which the structure, dynamics, transportation and interactions of biomolecules are elucidated, and their actions are simulated.

Skill development / Job opportunity: After knowing this information students will establish themselves as a researcher, Scientist, Applied biophysicist, or Clinical biophysicist. Medical biophysicist, Forensicbiophysicist and Clinical research coordinator.

I. **Biophysics of water:** Molecular structure, Association of water through H-bonding, Nature of hydrophobic interactions, physicochemical properties of water, State of water in bio-structures &its significance, Small-molecule solutes: Hydrophiles, Small-Molecule Solutes: Hydrophobes, Large Hydrophobic Solutes and Surfaces. The Influence of Ions: Structure-Making and Structure-Breaking, Long-Range Hydrophobic Interactions and the Role of Bubbles, Hydrophilic Surfaces. Protein Hydration: Specific roles of water in structure and function; involvement of bound water in catalytic action.

Cellular energetic and metabolic pathway: Energy requirements in cell metabolism, role and structure of mitochondria, high energy phosphate bond; control of metabolic flux, structure & role of mitochondria, High energy compounds in biological system, Oxidation-reduction reactions, ATP and phosphoryl group transfers, Free energy changes in redox reaction, redox potentials & its calculations by Nernst equation, standard electrode potentials & its determination, its relationship with e.m.f..

Overview of major metabolic pathways-Glycolysis, Krebs' cycle, oxidative phosphorylation, regulation of oxidative phosphorylation; electron transport chain, Constituents of ETC & their sequence (Complex I-IV) & location, inhibitors of ETC, Chemiosmotic theory, ATP synthase complex- structure and function, dicarboxylic acid shuttle, glycerol phosphate shuttle, P:O ratio.

II. Membrane structure and models: Membrane protein and lipid structure and their organization, comparison of different membrane models, Fluids mosaic model, liposome and its applications. Membrane permeability, transmembrane helices, hydropath Plot, Membrane asymmetry, Membrane fluidity. Membrane Channels, voltage gated channels, ligand gated channels, channel conductance.

Membrane potentials: Electric properties of membranes: electric double layer, Poisson-Boltzmann theory of electric double layer, Gouy-Chapman model of electric double layer, free energy of electric double layer. Cell surface charge, Resting membrane potential, Action potential, properties of action potential, Hodgkin-Huxely equation, Helmholtz-Smoluchowski equation; it's correction by Debye-Huckle theory. Membrane impedance and capacitance, Transmembrane potential, Zeta, stern and total electrochemical potential.

Membrane transport: Transport system with non-electrolytes and electrolytes. Transport with chemical reaction system: Primary and secondary active transport. Transports of molecules by simple and facilitated diffusion, Transport by flux coupling. Transport by phosphotransferase system, Transport by vesicle formation, Ionophores, epithelial transport, Liposomes in biology and medicine. Mechanisms of micro- and nano-vesiculation, influence of electrical properties of membranes and solvents on the vesiculation of membranes, endocytosis, exocytosis, fusion of vesicles, encapsulation of nano-particles and DNA.

III. Cell cycle and cell biology: Kinetics of cell growth, The Cell Cycle, Interphase-G1,S,G2,M molecular events at different cell cycle phases, A cytoplasmic clock times; Polypeptide Growth Factors & Control of cell proliferation, Mitosis & Cell division- Molecular mechanism, Events in mitosis, Role of mitotic apparatus, Cell Cycle Control.

Connection between the cell and its environment, Glycocalyx, Extracellular Matrix,collagen,

Elastin, Fibronectin, Lamin, Proteoglycans, Integrins, Cell Junctions, Desmosomes, Gap junction, Tight Junctions, Plasmodesmata; General principle of cell signaling, Paracrine, Autocrine, Endocrine &synaptic signaling, Heat Shock Proteins, G-Protein structure and role in signaling, Intracellular Cyclic AMP, Role Ca ++ in cell signaling, CAM Kinases, (Calmodulin/Ca++dependent protein kinases).

Molecular biology: Central dogma, genetic code, gene and operon, structure of DNA and RNA, plasmids, selectable markers, agarose gel, PCR, cloning PCR products, expression vectors, cell free translation, c- DNA libraries, genomic libraries, DNA micro arrays, DNA sequencing.

IV. Enzyme structure and kinetics: Enzymes, classification & structure, active site and its identification, mechanisms of enzyme action with special reference to chymotrypsin, carboxypeptidase and lysozyme, Enzyme kinetics, Michaelis-Menten equation, Inhibitors, steady state kinetics, Kinetics of single substrate reaction, kinetics of competitive, noncompetitive and uncompetitive inhibitors, Allosteric cooperative behavior, ligand protein interaction, Hill equation, Metalo-enzymes. Determination V , K , various graphical plots; Lineweaver-Burk, Eddie-Hofstee plot, Woolf plot.

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Enzymes as biocatalysts: Remarkable properties of Enzymes as Catalysts, Active sites, three- point attachment, Mechanism of enzyme action, Flexible enzymes, Induced-fit hypothesis, Catalytic efficiency of enzymes, Molecular dynamics & Transient states of Enzyme catalysis. Control of enzyme activity, feedback inhibition, kinetic behavior of allosteric enzymes, mechanism of allosteric interactions. Molecular dynamics & Transient states of enzyme catalysis.

D : Neurophysiology

Physiology of Neuron and Evolution of Brain **F.M. 25, 02 Credits**

I. Neuroscience: past, present and future; history and development of neuroscience, perspective of neuroscience – scope boundaries and present trends.

Evolution of human brain and its development: phylogenetic development of nervous system from invertebrate to mammals.

Development of human brain: embryological development of human brain, genesis of cerebral cortex.

II. **Neuron**: morphological and organization of neuron, axonal transport, myelin and myelinogenesis, evolution of human brain. **Neuroglial cells**: type, structure and physiological properties of neuroglial cell membranes, function of neuroglial cells, effect

of neuronal activity of glial cells. **Excitation and electrical properties of nerve fibers**: origin of membrane potential, electronic potential, action potential- voltage clamp and patch clamp analysis, voltage gated channels, conduction of impulses.

III. **Synaptic transmission**: chemical and electrical synapses, morphology and molecular organization of synapses, the neuron as a secretary cell, perikaryon, transport along axon, exocytosis and endocytosis at the synaptic terminal, molecular basis neurotransmitter release in the synaptic cleft, post synaptic events, initiation of impulse.

Neurotransmitter and neuromodulator: criteria for neurotransmitter, acetylcholine, GABA, glycine, serotonin, catecholamine, purine, peptides, nitric oxide, neuromodulators and their functions.

IV. **Ionotropic and metabotropic receptors**: ionotropic receptors- nicotinic acetylcholine receptor, GABA receptor, glycine receptor, purino receptor- AMPA, KA, NMDA, tACPD. Metabotropic receptors: GABA, mAchR, adrenergic receptors, Neurokinin A receptors, pharmacology of neurotransmitter- agonist and antagonists

Subsynaptic cell: subsynaptic density, electrophysiology of subsynaptic membrane- EPSP, IPSP, IS AND SD spike, second messenger control, second messenger and gene expression, the pinealocyte.

Plasticity of brain: plasticity of normal adult brain- reorganization in human cortex, cortical maps and experience, morphological changes, synaptic plasticity.

Unit 2: Development of Brain and Molecular Neurobiology **F.M. 25, 02 Credits**

I. **Sensory transduction**: chemoreceptors, photoreceptor and mechanoreceptor, contractile mechanism of muscle and neuromuscular junction, molecular mechanism of conteraction in skeletal, visceral and cardiac muscle, neuromuscular transmission in different types of muscle, EPP, MEPP. Pharmacology of N-M transmission.

II. **Genetics of brain**: Establishing AP axis in drosophila and vertebrate CNS, homeobox gene and early development of brain, POU genes neuronal differentiation, other genes in neuronal differentiation,

Epigenetics of the brain: the origin of neuron and gila, morphogenesis of neurons, growth cones, pathfiniding and neurotrophins, CAMs, morphopoietic field, functional sculpting.

III. **Neurochemical neoroanatomy** : Neural pathway carrying glutamate, glycine, GAVA, acetylcholine, dopamine, norepinephine, serotonin, endorphine, tachykinin, NO, CO, distribution of the receptors of these neurotransmitter.

Circulation of brain and Blood brain barrier.

IV. **Automatic nervous system**: Anatomy of ANS, functions of ANS, evolution of ANS- heart rate and BP responses to deep breathing, standing, passive heap-up lilt, valsalva maneuver, disautonomia.

Molecular neurobiology techniques: Restriction map, genomic gene library, cDNA gene library, fishing of gene in cDNA library, PCR, RT-PCR, site directed mutagenesis, gene targeting and knockout genetics.

E : Ergonomics and Sports Physiology

Unit 1 : General Sports Physiology F.M. 25

Learning Objectives: This special course includes different physiological and anatomical aspects of sports physiology. The learners will be able to acquire knowledge about the parameters which are related to the physical efficiency of the sports persons.

I. **Historical development of sports science**- International and Indian context, role of neuromuscular system in exercise, mechanics of muscle contraction, relationship of different typesof muscle fibers with different sports activities, fuel for exercising muscle: metabolism and hormonal control. Muscle strength and endurance – their role in sports activities. Bioenergetics of exercise- source and supply of energy for different types of sports.

II. **Maximal aerobic capacity** - direct and indirect methods of measurements, measurement of VO_2 in children, measurement of VO_2max during pregnancy; Cardio-respiratory changes during sportsperformance as well as during static and dynamic work.

Anaerobic capacity - threshold points- factors influencing them and their significance in differentsports, improving anaerobic capacity.

Fatigue - physical and mental fatigue, central and peripheral fatigue, measurements of fatigue, shortterm and long term fatigue. Muscle Soreness and Muscle Stiffness

III. **Evaluation of fitness level:** lung function tests, physical fitness tests, methods for evaluation of strength, power, flexibility, endurance, work capacity, agility, and balance.

Nutrition and sports performance: roles of carbohydrate, protein, and fat during different sport events, glycogen loading, vitamins and minerals in exercise, fluid requirements in exercise, fluid replacement in endurance sports, diets for different sports events, pre-game meal, spacing of meals.

IV. **Endocrine system and exercise:** importance of hormones in exercise and sports, endocrine effects on performance, pituitary- adreno cortical axis and stress theory, oxidative stress and its management, hormonal regulation of cellular hydration, endocrine

regulation of plasma volume, exercise influence on the biological clock mechanism. Hormonal control of substrate mobilizationduring exercise: - Muscle glycogen utilization, Blood glucose homeostasis during exercise,Hormone substrate interaction.

V. **Immunological system and exercise**: exercise and innate and humoral immunity, exercise induced change in antigen and antibody, exercise and cytokines.

Genetics and performance: life span and gender variability, muscular strength and endurance, motor performance, modeling twin and familial resemblance, responses to training, exercise and gene expression.

Unit 2: Applied Sports Physiology **F.M. 25**

Learning Objectives: This course encompasses different applied aspects of sports science. The students can learn methods of physical conditioning, selection of sport persons, doping sport injuryand its remedial measures and principles of sports biomechanics.

I. **Body composition**- methods and assessments, importance in sports performance, desired body weight in different sports, somatotyping -method of assessment, somatotype and sport performance, desirable body types for high level performance, sport selection and somatotype, somatotype modification.

Physical conditioning: importance, principle and methods of physical conditioning, aerobic andanaerobic training, adaptation to aerobic and anaerobic training, resistance training, strength,stability training, and high-intensity interval training (HIT), strength training, farklet training,periodizationofconditioningprogram..Aim and Concept of Periodization; - Preparatory Phase, Competitional Phase and Transitional Phase. Training Cycle: - Micro, Meso and Macro. Methods of Training: - Continuous Method, Interval Method, Repetition Method, Fartlek Training, Circuit Training, Plyometric, Training and Weight Training. Overtraining. Physiological adaptation in response to resistance training.Delayed onset of muscle soreness.

Selection of sportsman: guidelines for competitive sports, scope and involvement of tribal population in participation of different sports activities.

II. **Ergogenic aids in sports (doping)**: methods of study, tolerance limits, types of doping, problemsof doping, IOC guidelines. Types of drugs in sports field their use, health risks and testing procedure; - Stimulants, Anabolic steroid, Bite Blockers, Diuretics. Human growth hormone, Blood doping, Erythropoietin (EPO) & their use, health risks and mode of testing. Health hazardsand side effects of different dope substances. Banned methods of doping in sports. Special Aids toexercise training and performances.

Sports injury and treatment OR Injury Management in Sports: general causes, sports specific injuries, methods of treatments, protective equipments. Type of sports injuries. Soft tissue injuries and their management. Hard tissue injuries and their management. Overuse injuries and their management. Head injuries and their management. Injury

prevention.Sports injury assessment procedures, e.g., SOAP, HOPS, RICER.

Women in sports performance: women in athletics and sports, the female athlete triad, menstruation and other related factors, exercise and pregnancy. Bone mineral disorders in womenathlete.

III. **Exercise for the disabled: s**ports for disabled persons, importance, selection of event, method oftraining.

Psychological factors of sports: psychological fitness of general population mass, psychological factors, personality and motivation in sports, arousal, anxiety, and sport performance.

Yoga as exercise: Benefits of yoga physical and mental health, Effects of yoga in differentphysiological systems, therapeutic application of yoga, limitations of yoga.

IV. **Exercise and sports biomechanics:** basic concepts of kinematics and kinetics – vectors, motion

,degrees of freedom, force, moment of force, equilibrium, biomechanical considerations in reducing sporting injury rates, joints and its movements. Meaning of Kinetics and Kinematics. Types of motion – Linear, Curvilinear and Angular motions. Meaning, Definition and types of Levers. Mechanical advantage of different levers. Levers inside our body. Importance of kinesiology for games and sports. Muscular analysis of motor movement.

Center of gravity and its importance in sports.

Posture: static and dynamic posture, posture assessment, desirable postures for high level sport performance, modifying posture and technique to improve performance. Meaning of posture. Ideaand importance of a good posture. Poor postures and their causes, prevention and remedial measures. Common postural and foot deformities with their correction – Kyphosis, Lordosis, Scoliosis, Flat foot, Knock-knees and Bow leg.

Image analysis in sports performance: errors in motion analysis, planar video analysis, 3D motion analysis, data filtering. Movement analysis; - Concept and types of analysis; Biomechanical, Kinesiological and Cinematographic. Mechanical analysis of fundamental movements of human being – Walking, Running and Jumping. Mechanicalanalysis of different sports technique; Throwing and Jumping.

DSC -P3 **F.M 50 04 Credits**

Unit -1: Physiological Experimentation on the biological system F.M 25

A. Studies with Cardiac Muscle

Learning Objectives: To demonstrate the students the kymographic record on -induced changes in cardiac contractility and function to explain their nature of functions and the effect of agonist and antagonist drugs and electrolytes and other physical parameters on perfused amphibian heart.Perfusion of amphibian heart with Ringer solution, Studies on the heart rate and amplitude ofcontraction a) in normal Ringer solution b) in Ca^{++} free Ringer solution, c) in K^{++} free ringer solution.

1. Effect of gradient pressure on the perfused heart of amphibian.
2. Study on the heart rate and amplitude of contraction with excess amount of Ca^{++} and K^{+} on the amphibian perfused heart.
4 Effect of a) acetylcholine, b) adrenaline on the heart rate, amplitude of contraction in perfused amphibian heart in dose dependent manner.
5 Effect of stimulation of Vagus nerve on the perfused amphibian heart and the effect of atropine during stimulation.

B. Studies with Skeletal and Smooth Muscle and Bioassay

Learning Objective: To demonstrate the students the kymographic record on skeletal and smooth muscles to explain their nature of functions and the effect of agonist and antagonist drugs and electrolytes and other physical parameters on skeletal muscles as well as on smooth muscles.

Skill development/Job opportunity: i) Research assistant: Act as a research assistant at different experimental laboratory and Industry. ii)**Drug Developer:** Appointed at several pharmaceutical companies.

1. Preparation of physiological solutions like Perfusion fluid, Dale's fluid, Normal saline etc.
2. Experiments on isolated skeletal muscle (Isometric contraction):

   a) Effect of graded load b) Effect of temperature c) Summation and tetanus d) Effect of Acetylcholine
3. Experiments on isolated intestine of rat:

   a) Normal movement of isolated intestine, b) Effect of hypoxia, c) Effect of drugs like substances: i) Acetylcholine ii) Adrenaline iii) 5, hydroxy-tryptamine.
4. Experiments on isolated uterus of rat: Effects of drugs like Oxytocin.
5. Bioassay: Preparation of standard curves for acetylcholine and catecholamine through bioassay.

Unit -2: Biotechnological, Environmental Physiology, Pharmacological experiments

A. Biotechnological Experiments

a. Isolation of DNA and RNA and identification through agarose gel

b. Restriction endonuclease digestion of isolated DNA.

B. Environmental study

a. Measurement of illumination level, sound level in different environmental conditions.

b. Measurement of relative humidity, moisture content of the environment; assessment of thermal conditions.

c. Estimation of total hardness of water. .

d. Estimation of heavy metals like Pb, Hg in water by spectrophotometer method.

e. Estimation of selenium, Cadmium, Chromium, Arsenic, Fluoride, Copper and iron in water sample.

f. Estimation of silica in water sample.

g. Measurement of DO, BOD and COD in water sample.

h. Measurement of particulate pollutant in air of a specific area.

Effect of pollutants /toxicants on biological systems

i. Determination of LD 50, IC50.

j. Measurement of Oxidative Stress parameters – Malon-di-aldehyde (MDA), Reduced and Oxidized Glutathione (GSH, GSSG), Antioxidant enzymes (Catalase, Peroxidase, Superoxide dismutase).

Pharmacological experiments

Liver function tests

Renal function tests

DSE-P1 F.M. 50, 04 Credits

Elective Practical

A: Microbiology and Immunology

Unit :1 Microbiological Techniques F.M. 25

Learning Objectives: To get hand-on trainings on microbial growth, cultivation and experiments on several metabolic activities of microbes used as important markers for identification and analysis of microbial agents.

1. Fermentation of carbohydrates by bacteria: glucose, fructose, lactose, sucrose.
2. Production of acetyl-methyl carbinol by bacteria.

3. Production of indole by bacteria.
4. Determination of amylase activity of the supplied bacteria by hydrolysis of starch.
5. Determination amylase activity of the supplied bacteria by hydrolysis of starch.
6. Determination of catalase activity of the supplied bacteria.
7. Determination of urease activity of the supplied bacteria.
8. Determination of the protein hydrolysing ability of the supplied bacteria by preparing casein plate.
9. Isolation, purification and characterization of bacteria from soil sample.
10. Isolation, purification and characterization of bacteria from water sample.
11. Determination of the concentration of viable bacteria in supplied solution by plate count method.
12. Isolation and purification of microbial enzymes from yeasts.
13. Isolation of plasmid DNA from bacterial cells.
14. Separation, visualization and determination of molecular sizes of isolated DNAs by agarose gel electrophoresis.

Unit:2. Experimental Immunology **Practical F.M. 25**

Learning Objectives: To get training in basic immunological and cellular techniques important to express body defense mechanisms.

1. **Separation of different types of blood cells by Histopaque (gradients),** identification of (a) B-cells by rosetting (b) T-cells by rosetting (c) Macrophages, isolations of macrophages, B-cells, T-cells, polymorphonuclear cells
2. Isolation and culture of peritoneal cells from experimental animal
3. Preparation of antigen and development of antibody: Development of antibody in rabbits by injecting complete-incomplete Freund's adjuvant with BSA, Ouchterlony Double Diffusion (ODD), Single Radial Immune Diffusion (SRID), agglutination test, Haemolytic Plaque Assay.
4. Subcellular fractionation (a) mitochondria, nuclei etc. (b) centrifugation- differential and density gradient (sucrose, percoll, CsCl).
5. Endonuclease digestion of nuclei and analysis of DNA by Agarose Gel Electrophoresis, thermal melting of DNA.
6. Isolation of plasmid DNA: mini preparation, large-scale isolation.
7. Glassware decontamination, washing-sterilization, packing and sterile handling for animal cell tissue culture.
8. Media and reagent preparation, sterility checks, CO_2 incubator.

9. Maintenance of cell cultures.
10. Preparation of primary cell cultures (CEC).
11. Peripheral blood lymphocytes culture, demonstration of other tissue culture experiments.
12. Chick embryo fibroblast primary cell cultures and mouse choronic villus cells.
13. Induced ovulation in mouse, collection of oviducal eggs and in-vitro fertilization, culture in-vitro of mouse embryos to the blastocyst state.
14. Transferring foreign gene (e.g. chicken globin gene) into mouse fertilized eggs and transplantation to foster mother.
15. Microinjection or electroporation of ES cells with foreign DNA and transplantation to foster mother.

B: Biochemistry, Molecular Endocrinology and Reproductive Physiology

Unit:1 Biochemical Techniques **F.M. 25**

Learning Objectives: The objective of this unit is to learn the theoretical foundations for biochemical techniques used for the isolation, purification, and characterization of proteins, nucleic acids, carbohydrates and lipids, fundamental approaches for experimentally investigating biochemical problems and understand the applicability of the biochemical methods to realistic situations.

Skill development / Job Opportunity: Students have the opportunity join as a Laboratory Technician, Biochemist at several research and biochemistry laboratories. They also appointed as Sales Manager.

Methods of Protein Estimation:

1) Folin-Lowry's Method

2) Bradford Method

3) Ultraviolet Absorbance Method for Determination of Albumin-Globulin ratio.

B. Studies on General Enzymology

1) Effects of pH and temperature

2) Determination of Q_{10}

3) Effects of substrate concentration,

4) Determination of Km,

5) Determination of Vmax

C. Studies on Clinical Enzymology

1) Determination of tissue GOT and GPT.

2) Determination of serum ALP

3) Determination serum LDH

D. Microscopy

1) Fluorescence and phase contrast and Inverted microscopy

2) Study of cellular oxidative stress –MDA, GSH, GSSG, SOD, and Catalase, Gpx assay.

3) DNA fragmentation by Gel electrophoresis

Unit:2 Experiments on Endocrinology and Reproductive Physiology of Model Animals F.M. 25

Learning Objectives: The objective of teaching this unit is to demonstrate the experiments on model animals including assessing their biochemical parameters related to endocrinology and reproduction as well as hands on training on male reproduction related techniques.

Skill development / Job Opportunity: After complete these practical courses students have the opportunity join as a Research Assistant, Laboratory Technician, and Health officer at different Govt. and private sectors.

A. **Experiments on Model Animals**

a. Study of drugs (elicit hypo and hyper condition) on functional activities of thyroid, testis andovary

b. Experiments on thyroidectomy, adrenalectomy on gonadal functions- cholesterol, acid and alkaline phosphatase, ascorbic acid in gonads.

c. Study of experimental diabetes induced by alloxan, streptozotocin in experimental model animals - Assay of SGOT, SGPT, amylase, and glycogen, Glucose-6-phosphate dehydrogenase, blood sugar.

d. Experiment on thymectomy - T lymphocyte and macrophage isolation.

B. **Experiment on male reproduction**

a. Study of the effect of cryptorchydism on markers of male reproduction.

b. Study of sperm count, sperm motility, sperm morphology, sperm viability, Hypo-osmotic swelling, and effect of someanti-fertility drugs.

c. Study of castration (unilateral) on cholesterol in intact testis- acid and alkaline phosphataseactivities in accessory sex glands.

d. Assay of the activities of oxidative stress sensitive enzymes and free radicals quantificationin male sex glands.

e. Quantitative study of spermatogenesis measurement of semniferous tubular diameter

andLeydig cell nuclear area.

C: Biophysics and Electrophysiology with Structural Biology

Unit:1. Advanced Methods in Biophysics F.M. 25

Learning Objectives: Throughout this practical student will learn the processes of different biochemical estimations, will gain knowledge of acidic and basic solution. Will acquire knowledge of different separation techniques that will help the students for the application and development of drugs and medicine.

kill development / Job Opportunity: After complete these practical courses students have the opportunity join as a Laboratory Technician, Biochemist at several research and biochemistry laboratories. They also appointed as Sales Manager of Chromatography.

1. Acid – Base titration using pH meter and Determining the pK values: - Strong acid Vs Strong base, Weak acid Vs Strong base, Mixture of Strong and Weak acid Vs Strong base.
2. To determine the titration curve of protein and amino acids and calculate the pKa values
3. Colorimeter: Verification of Beer's- Lambert law, determination of absorption maxima of colouredcompounds, determination of molar extinction coefficient
4. Estimation of Protein by Lowery/Biuret/ Bradford methods
5. To isolate the Proteins- Casein from milk, Hb from RBC.
6. Separation techniques: Electrokinetics methods- Electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, Polyacryl amide Gel Electrophoresis (PAGE), SDS PAGE, Capillary, Iso-Electric focusing, applications in biology and medicine.
7. TLC: Amino acids/ sugars/ fruit juice/oil
8. To estimate quantitatively the Amino acids using the ninhydrin reaction.
9. Effect of hypertonic/ hypotonic/isotonic on RBC membrane.
10. Osmolarity: Determination of osmotic pressure of salts
11. To study of conformational changes in biomolecules using Ostwald viscometer. Measurement of viscosity of biological and non-biological samples.
12. Refractometry: Study of sugars/proteins/amino acids
13. Study of UV absorption spectra of Proteins and nucleic acids.
14. To study the protein-ligand interactions by Scatchard plot.

Unit:2 Advanced Cell and Membrane Biophysics F.M. 25

Learning Objectives: To understand the cellular nature and its structural morphology with the help of staining methods and fluorescence spectroscopy. Also know the kinetic activity (by measurements of Km and Vmax) of enzymes and ions through assay methods. Measurement of membrane potentials explains the permeability of membrane in different situations.

Skill development / Job Opportunity: After complete these practical courses students have the

opportunity join as a Research Assistant, Laboratory Technician, Enzyme Analyst and Chromatography Analyst at several research and biochemistry laboratories. They also recruit as Quality Control or Quality Assurance officer at different Govt. and privet sectors.

1. To study the effect of temperature, pH, metal ions on enzyme activityand kinetics
2. To study the chromosomal DNA morphology by Feulgen reaction (root tip cells)
3. To study of membrane potential using fluorescence spectroscopy
4. To observe the stained and unstained Prokaryotes and Eukaryotes
5. To characterize the subcellular fractions and preparation of Liposome
6. To study the permeability of model membrane (Liposome) anions.
7. To demonstrate the cell fusion using high DC (Direct current) field.
8. To identify the Cytochemical DNA/RNA with the Methyl green-pyrominmethod.
9. To isolate and purify the enzymes- isolation of muraminidase from egg white
10. To study the effect of cholesterol on the anion permeability of a phospholipid membrane.
11. Enzyme Assays (LKH, beta galacotsidase, acid phophotase, arginase, Succinic De – hydrogenase): Time, Temp, Protein concentration, cofactors. LKH: Km andVmax.

D: Neurophysiology

Unit:1. Experiments on Neurophysiology I **F.M. 25**

1. Gross examination dissection of human brain: Identification of cerebral cortical sulci and gyri, caudate, putamane, globus pallidus, septal area, hypothalamus, thalamus, corpora qudrigemina, corpus callosum, anterior/ posterior commissure, cerebeller peduncle, cerebral ventricles, crus cerebri, pyramid, hippocampus, amygdala fornix.
2. Desection and study of animal brain: Study of serial sections of brain of rat, cat, dog to identify neuclei of basal ganglia, thalamus, hypothalamus, amygdale; study of the structure of mid brain, pons, medulla oblongata, spinal cord.
3. Study of spinal preparation in rats and cats: spinal preparation by surgical method and observation of physiological parameters and behaviour in the stage of spinal shock and stages of recovery, study of decerebrate preparation in rats. Study of cerebellectomy in rats: observation of changes in muscle tone and behaviour after complete of partial removal of different parts of cerebellum.
4. Stereotaxic technique : principle and use of stereotaxic apparatus.
5. Experimental animal preparation by different methods in animals (rat): Aspiration, Electrolytic, Chemical lesioning

Unit 2: Experiments on Neurophysiology II

1. Experimental electrical stimulation in animals (rat/cat): Study of electrical stimulation of different portion of brain, by electrical stimulation and observation of changes in muscle tone, behaviour, heart rate, respiration, blood pressure, evaluation of electrolytic lesion.
2. Experimental chemical stimulation of brain: Microinjection of acetyl choline, epinephrine, nor- epinephrine, serotonin, histamine, kainic acid in different regions of brain and cerebral ventricles and study of changes in physiological parameters.
3. EEG and ECoG in experimental animals: recording of spontaneous electrical activity of surface and deeper parts of brain of experimental animals in acute and chronic condition. effect of .stimulant and depressive drugs on ECoG.
4. Evoked potential study in experimental animals , recording of auditory and visual evoked potential in rats.
5. Study of experimental epilepsy rat.
6. Behavioural study in experimental animals:

a. Exploratory behaviour in open field.

b. Exploratory behaviour in hole board

c. Light dark transition test.

d. Active social interaction test.

e. Pento barbital sleeping time.

f. Maze tests.

7. Locomotor movements in rats: Recording of locomotor movements in rats by Kymograph at rest and after injection of stimulant drug.

8. Study of neuroendocrine functions:

a. Effect of stress on estrous cycle, ovary, adrenal, thyroid, and pineal.

b. Effect of lesion of different neural structure of endocrine function.

9. Studies of blood pressure and heart rate in experimental animals:

a. Effect of bilateral carotid occlusion on blood pressure and heart rate in cats.
Effect of stimulation of medullary pressure area on heart rate and blood pressure

E : Ergonomics and Sports Physiology

Unit 1 : Experiments on Work and Sports Physiology-I **F.M. 25**

Learning Objectives: The course will provide support to develop the practical skill for measuring different physiological parameters related to the physical efficiency of sports persons and the

learners will be able to assess the level of physical fitness of a person for general and specific sports event.

1. Measurements of heart rate at rest and different working conditions.
2. Classification of workload, continuous recording of heart rate by heart rate monitor.
3. Determination of maximal heart rate, cardiac cost and cardiac efficiency by step test method, bicycle ergometer and treadmill.
4. Determination of steady state.
5. Determination of endurance time.
6. Measurement of body temperature, (oral, axial, skin) at rest and different working condition.
7. Recording and interpretation of ECG at rest and working condition, effects of posture on ECG.
8. Recording and interpretation of EMG at rest and working condition.
9. Determination of pulmonary ventilation, static and dynamic lung function tests.
10. Static and dynamic balance test.

Unit 2: Experiments on Work and Sports Physiology – II **F.M. 25**

Learning Objectives: This course will help the students to evaluate the performance of sports persons by means of biochemical, physiological and biomechnical parameters. This training will enhance the employability of the students in the sports field. Determination of VO_2 max by direct method; determination of VO_2 max by indirect method: Queen's college test, 12 min-run test, non-exercise test, Astrand rhyming nomogram method

1. Determination of lactic acid and pyruvic acid in blood before and after exercise.
2. Determination of Haemoglobin level before and after exercise.
3. Anaerobic power test (modified Margaria method).
4. Measurement of flexibility, agility, power and maximal work capacity.
5. Measurement of reaction time (hand, foot) and movement time, determination of simple and choice reaction time.
6. Measurement of blood pressure, sweat rate during exercise.
7. Determination of muscle strength by dynamometer- hand grip strength, pinch strength, leg and back strength.
8. Measurements of body fat in human by (a) skinfold method , (b) anthropometric method densitometric method, determination of body composition.
9. Determination of somatotypes.
10. Gait analysis.

Community health survey

Students shall have to participate in the field studies to evaluate different parameters related to health status of the community and have to submit a field survey report during practical examination properly endorsed by a teacher. The students shall be divided in to some small groups (3 to 4) and a field work of each group will be supervised by a separate teacher. The field survey may be done in the following fields.

1. Cardio-vascular status of the community.
2. Nutritional status of the community.
3. Anthropometrics survey.
4. Prevalence of different disease.
5. Health awareness levels of the community and immunization.
6. Evaluation of awareness and implication of family planning programs.
7. Evaluation of problems and awareness of environmental pollutants.
8. Survey work reproductive health at rural areas.
9. Survey work on mother- child – health care at rural areas.
10. Occupational health.

Semester III

(Theory: 175 + Practical: 100)

(Total Marks: 275, 22 Credits)

DSC-T6 **Credit: 4; Full marks: 50**

Unit:1. Endocrinology **FM-25**

Learning Objectives: The unit will help to develop an understanding of the structure-function relationship as well as mechanism of the endocrine system in maintaining body homeostasis and health. The student will be better able to learn the integrative workings of endocrine signaling system and endocrine pathologies.

Skill development / Job Opportunity: After completing these theory courses students will have the opportunity to join as a Research Assistant, Research Scientist, Endocrinologist Assistant, Clinical Endocrinologist, Endocrine Nursing and Infertility Specialist.

I.General concepts of endocrinology and hormonal action: Chemical nature of hormones, **E**ndocrine, paracrine, autocrine and intracrine secretion; biosynthesis, storage, release and transport of hormones. Hormone receptors-types, properties, synthesis and life cycle, protagonists, antagonists and up down regulation of receptors; Nuclear receptors- detail structure, mechanism of action, ligands, Cell surface receptor- detail structure, mechanism of action, Measurement of Hormones.

Neuro endocrinology: Neural control of glandular secretion –neuro secretion; hypothalamus-pituitary axis, hypophyseotropic hormones and neuro endocrine axes –TRH, CRH, GHRH, somatostatin, prolactin regulatory factors, GnRH and control of the reproductive axis; effect of ghrelin, leptin on the hypothalamus and neuro endocrine axis, neuroendocrine related diseases.

II.Hypothalamo-hypophysial axis and anterior pituitary hormones: functional significance, pituitary transcription factors, pituitary stem cells, anterior pituitary structure, physiology and disorders of different pituitary (anterior) axes: hypothalamo – hypophysial - gonadal axis, hypothalamo-hypophysial-adrenal axis, GH-IGF-1 axis.

Posterior pituitary/Neuro hypophyseal hormones: synthesis, release and regulation of neuro hypophyseal hormones, role in osmoregulation, thirst and smooth muscle movements, clinical aspects. Diabetes insipidus.

III.Thyroid gland: Anatomy and histology of thyroid gland, TSH, T3 and T4synthesis, secretion

andregulation, role of Iodine in hormone synthesis, T3 and T4: plasma transport, cellular uptake, intracellular binding, activation and inactivation, T3 and T4cellular mechanism of action; thyroid function; role of thyroid hormones in growth, differentiation and metabolism, in pregnancy, in the fetus and newborn; Thyroid cell, gene and protein expression; Disorder: thyrotoxicosis, risk factors, sign and symptoms, treatment and prevention; endemic and exopthalmic goiter and autoimmune disease; Calcitonin secretion and its functions.

Adrenal gland: Anatomy and histology of adrenal gland, Synthesis secretion and regulation of adrenal hormone, Functions of adrenal hormone: roles in metabolic, vascular, physical and emotional stress, anti-inflammatory role; Disease: general idea about Addison's disease**,** Cushing syndrome, Adenomas, Adrenocortical carcinoma, Neuroblastoma, Pheochromocytoma, Congenital adrenal hyperplasia-Cause, risk factors, sign and symptoms, diagnosis and treatment and prevention management.

IV. Hormones involved in calcium metabolism: role of parathyroid hormones, dihydrocholecalciferol, calcitonin and sex hormones, cytokines and growth factors in calcium metabolism; Calcium sensing receptor, Parathyroid action on bone cells and kidney, osteoporosis - primary and secondary type; phosphorus metabolism.

Pancreatic and gastrointestinal hormone: role of insulin on ribosomal activity for protein synthesis, role of insulin and glucagon on carbohydrate, protein and lipid metabolism, gastrointestinal hormones.

Immunity and endocrine system: thymic hormones; autoimmunity – tolerance of self-antigens; mechanism of autoimmunity genetics of autoimmunity of the MHC, examples of autoimmunity in endocrine system like Hashimoto's diseases, Grave's disease, juvenile diabetes mellitus.

Unit:2. Reproductive Physiology **Full marks: 25**

Learning Objectives: The major objective of this unit is to provide students with a sound coverage of human reproductive biology including the structure and function of the male and female reproductive tracts, gametogenesis, fertilization, sexual differentiation and development, early embryogenesis, fetal development and preparation for birth, and maternal adaptations to pregnancy, hormonal control of reproduction, contraception, infertility and current reproductive technologies.

Skill development / Job Opportunity: After complete these theory courses students have the

opportunity join as a Research Assistant, Research Scientist, Gynecological Assistant, Clinical Reproductive Consultant, Reproductive Nursing, Infertility Specialist and Public Health Officer.

I.Male and female reproductive systems: sex differentiation– role of SRY gene, different transcription factors. AMII and other hormones, disorders of sex, gonadal differentiation, female and male pseudo hermaphroditism, sexual infantilism, folliculogenesis, ovulation spermatogenesis and its hormonal control, menstrual cycle with special reference to biochemical aspects; steroidogenesis-its different pathways, two cell-two gonadotrophin hypothesis for ovarian steriodogenesis and its hormonal regulation; environmental factors like temperature, hypobaric atmosphere, light-dark cycle on reproduction, effects of nutrition, stress and exercise on reproductive functions.

II. Physiology of pregnancy and lactation: physiology of implantation, pregnancy maintenance, sex biorhythm, role of endocrine, autocrine, paracrine factors in pregnancy regulation, ectopic pregnancy, endometriosis, foeto-placental unit, role of blastocyst in pregnancy maintenance, maternal adaption to pregnancy, endocrinology of parturition, physiology of lactation and physiological importance of lactation, application of molecular biology to reproduction.

III.Contraception: principle of contraception, hormonal contraceptive and their molecular action, IUD and their molecular action, principle of the development of herbal contraceptive.

Oxidative stress and reproductive activities: oxidative stress markers, role of oxidative stress on reproductive system.

IV.Fetal and neonatal physiology: Embryology and epigenetics of fetus; Regulations of embryogenesis, Angiogenesis, Placental development, Regulation of placental circulation, mechanisms of transfer across the human placenta; Basics of cardiovascular and respiratory physiology of fetus and their changes at birth; organogenesis and histologic development of the liver functional development of the kidney in utero, developmental Immunobiology, intra-amniotic infection/inflammation, fetal inflammatory response syndrome, placental function in intrauterine growth restriction, endocrine factors affecting neonatal growth, development of the enteric nervous system and gastrointestinal motility. Fetal and neonatal nutrition; factors in embryonic and fetal tissue differentiation, nutritional and environmental effects on the fetal circulation,

Pineal gland and reproduction: Anatomy, histology, vasculature and nerve supply of pineal

gland; synthesis, secretion regulation of pineal hormone (melatonin); role of melatonin on reproduction and other common functions, anti-gonadal and pro-gonadal role of melatonin, pathophysiology and clinical significance of melatonin

DSE-T2 Credit: 4; Full marks: 50

A : Microbiology and Immunology

Unit 1: Microbial Genetics: Advanced Studies F.M. 25, 02 Credits

Learning Objectives: To develop advanced knowledge regarding basic features of genetic constitutions observed in microbes. In addition to learn the different models of gene expressions, diverse factors in gene expression and their basic mechanisms of action, prospective applications in technology.

Skill development / Job Opportunity: This course will enable students to acquire advance knowledge in microbial genetics that will help them to go for higher research in premiere areas of biology. Also they will develop skills for teaching jobs in higher learning centers.

I.Bacterial genetics: chromosome and plasmids, genes, genetic recombination, Conjugation: mechanism of bacterial conjugation, high frequency transconjugants, Transduction: generalized transduction vs specialized transduction, transformation: bacterial competence, comparative prokaryotic genomics, and transposition.

Virology: General properties of viruses: virus structure, nature of virion, virus attachment to host cells, classification, reproduction and multiplication, bacteriophages, single stranded filamentous DNA bacteriophages, lytic phages, lysogenic bacteriophages – lambda, transposable phage, RNA bacteriophages, animal viruses, viriod and prions, classical bacteriophage T4 and T7 genetics, Virus pathogenesis, prevention and control of viral diseases.

II.Genetics in eukaryotes: genome complexity, composition of eukaryotic chromosomes, structure of chromatin: euchromatin and heterochromatin, one giant DNA molecule per chromosome, packaging of chromosomes, nucleosome, repetitive DNA, satellite DNAs, DNA renaturation kinetics, replication of DNA and replicon in eukaryotes, the mutability and repair of DNA, linkage, molecular mechanism of crossing over, gene conversion , chromosome mapping, the yeast genetics.

Expression of the genome: Mechanism of transcription, RNA splicing, translation, the genetic code.

III.Regulation of gene expression: external signals influencing gene expression, the steps of gene expression to be regulated, protein in gene regulation, the DNA binding motifs, activity of geneticswitch, the regulation of transcription in prokaryotes and eukaryotes, role of chromatin in the control of gene expression, DNA methylation and gene silencing, operon.

IV.Transposable Genetic Elements: discovery of transposable elements, types of transposons, transposable elements in bacteria, IS elements, transposable elements in eukaryotes, genetic significance: mutation and genetic analysis, application of transposable elements.

RNA and Gene Expression: RNA in regulation of gene expression: attenuation, anti- sense RNA, RNAi, micro-RNA, siRNA, snRNA, snoRNA, piRNA.

Unit 2: Clinical Immunology **F.M. 25**

Learning Objectives: To develop advanced knowledge in relation to immunological mechanisms in relation to infection and several immunological techniques having clinical and analytical significances.

Skill development / Job Opportunity: with advanced knowledge in Immunology the students may opt for higher research and teaching professions.

I.Infection immunity and inflammation: Infection immunity in bacteria, viruses, fungi, and parasites; types of cell adhesion molecule (CAM), mechanism of inflammation.

II.Hypersensitivity and autoimmunity: IgE-mediated (type-I), antibody-mediated cytotoxic (type-II), immune complex-mediated (type-III), and delayed type hypersensitivity (type-IV);auto immune disease: (a) organs specific autoimmune disease- Hashimoto's thyroiditis, good pastures syndrome, insulin dependent diabetes mellitus, Grave's disease, and myasthenia gravis. (b) Systemic autoimmune disease- SLE, multiple sclerosis, rheumatoid arthritis.

III.Tumor & transplantation immunology and AIDS: tumor immunology, tumor antigens, oncogene and cancer induction, cancer immunotherapy; types, mechanism of transplantation rejection, prevention of graft rejection, immuno-deficiency diseases including AIDS (primary and secondary immuno-deficiency).

IV.Vaccination and immunological techniques: vaccine and vaccination, immunoassay of antigenby ELISA: sandwich and competitive ELISA, Chip assays, chemoluminescence immune assays, ELISPOT assay, Epitope mapping: T-cell and B-cell epitopes, immune electron microscopy- SEM and TEM, flow cytometry (FACS), immunofluorescence-based imaging techniques, gel-shift analysis, CAT assay.

B : Biochemistry, Molecular Endocrinology and Reproductive Physiology

Unit 1: Advanced and Applied Biochemistry **F.M. 25**

Learning Objectives: The unit aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialized knowledge and understanding with an advanced background in applied biochemistry which will be of particular relevance to the pharmaceutical and biotechnological industries.

Skill development / Job Opportunity: This course may enable students to become a molecular biologist/biochemist /Population Biologist or create interest in higher learning in these areas at several research institute.

I. Molecular Biology: Mechanism and regulation of replication in bacterial and viral and eukaryotic DNA, Reverse transcriptase, Mitochondrial and chloroplast DNA replication, DNA synthesis in vitro. Integration, Excision and Recombination of DNA- The Holliday recombination intermediate, Non-reciprocal and site-specific recombination. DNA Repair. Transcription- Transcription and posttranscriptional processing of RNA in bacteria, Antisense RNA, Viral RNA transcription in prokaryotes, Transcription in eukaryotic cells, Leucine zipper transcription factors, Processing of eukaryotic RNA, Editing of RNA.

Synthesis of proteins –The architecture of ribosomes, transfer RNAs, Protein synthesis in prokaryotes and eukaryotes, Post translational processing of proteins. Regulation of gene expression in prokaryotes, structure and mechanism of different operons. Gene Silencing- Mechanism of action of RNAi and micro-RNA. Recent advances and applications of gene silencing.

Genetics and Population Biology: Mendelian and Non-Mendelian inheritance. Sex linked inheritance. Gene Mapping. Chromosomal aberration. Mutation. Human cytogenetics- Karyotyping; chromosomal banding; Genetic diseases. Genomics-functional and structural genomics; Chromosome walking; Chromosome jumping; Brief outline of human genome project. Epigenomics. Genetic analysis in microbes- mechanisms of DNA transfer; Mapping by recombination; Genetic map of *E. coli*.

Population Genetics: Variation and its modulation, effect of sexual reproduction on variation (Hardy-Weinberg Equilibrium); Sources of variation; Selection balanced polymorphism.

II. Immuno-chemistry: T-cell receptors: molecular structure and gene organization of CD2, CD3, CD4 & CD8; Immune response, genetic control of the Cytokines, characteristics and function; Cytokine Receptor and Network; Chemokines and chemokine receptor; Monoclonal antibodies, T- cell Hybridomas; Hybridoma technology. Immunoassay- Immunoprecipitation, ELISA, RIA,Western Blot, Southern Blot, Northern Blot. Immuno-histochemical techniques.

Microbial biochemistry Membrane chemistry of Gram-positive and negative bacteria, Bacterial peptidoglycan synthesis and cell division, Energy metabolism in bacteria - fermentation, aerobic and anaerobic respiration and bacterial photosynthesis. Entner–Doudoroff Pathways; Tricarboxylic Acid Cycle and the Glyoxylate Bypass. Bacterial toxins. Virions, Viroids; prions, Microbes in gastrointestinal tract. Fermentation technology-Primary and secondary metabolites; Single cell proteins. Viral proteins.

Neuro-chemistry Neuroral metabolism, Metabolism and transport of amino acid, protein, nucleic acids, metabolites in brain. Brain functions modulation by growth factors, hormones, and cytokines. Molecular aspects of neurotransmitters, neuromediater, neuromodulators. Biochemistry of developing and aging brain. Interaction of neuro pharmacological drugs with brain metabolites and their specificity at target organs.

III. Proteomics, genomics and metabolomics: Concept of Proteomics. Purification, separation and identification of proteins. Protein identification by 2D gel electrophoresis, mass spectrometry, MALDI TOF (peptide mass fingerprinting), Protein microarrays, proximity ligation. Peptide sequence analysis by tandem mass spectrometry. Applications of proteomics.

Genomics: Genome annotation- Methods for annotating genomes, characterizing functional genes, Gene Expression, Comparative Genomics, Population Genomics. DNA microarray and its application in disease investigation. Micro/siRNA technology and applications in studying gene functions.

Introduction to metabolomics world. Metabolite identification, pathway identification and pathway integration. Application of metabolomics.

Biotechnology: Concepts of Biotechnology. Recombinant DNA technology. Restriction mapping-Restriction fragment length polymorphism (RFLP).Genomic and cDNA library. Analysis of genomic DNA by Southern hybridization.

Gene knock out; gene therapy. Transgenic animal. Site-directed mutagenesis. Gene targeting. DNA finger printing. Dot-blot; Nucleic acid sequencing; Polymerase chain reaction. RT-PCR, nested PCR, FISH, GISH, microarray technology.

Principles of nanotechnology. Properties and characterization of nanoparticles, Nanomaterials and their different properties. Concept of Nanomotors. Nanohybrids. Nanobiotechnology. Concept of nanofabrication. Application of nanotechnology in cancer therapy and in other diseases.

IV.Biochemistry of xenobiotic toxicity

Biochemical basis of detoxification-phase I and Phase II reactions and their interrelationships. Inducers and inhibitors of microsomal metabolic transformation. Extra microsomal enzymes and their role in detoxification. Effect of toxicants on structure, biosynthesis and catabolism of proteins, lipids, carbohydrates and nucleic acids, Mutation tests. Toxicological evaluation of recombinant DNA-derived proteins. Cytotoxicity, methods to test toxins. Metal toxicity–Arsenic and lead. Nonmetal–oxygen and ozone.

V.Applied and industrial biochemistry

Biochemical effects of food, toxins, edible oils and environmental pollutants on human health. Application of enzymes in industry, diagnostics and medicine, agriculture, research; Immobilized enzymes immobilization of enzymes by chemical and physical methods; its application in industry.Large-scale production of enzymes, enzyme reactors.

Unit 2: Applied Molecular Endocrinology and Reproductive Physiology
F.M. 25, 02 Credits

Learning Objectives: The unit aims to provide an advanced understanding of applied molecular endocrinology and reproductive physiology and their experimental basis to acquire a specialized knowledge and understanding with the course.

Skill development / Job Opportunity: After finishing this course students may get jobs as reproductive biologists at Govt. and privet research institute and companies.

I.Hypertension: Hypertension and its classification, Essential and secondary hypertension hormones involved in hypertension with special reference to role of aldosterone, Renin-angiotensin and aldosterone system and their components and functions, physiological disorders in endocrine system related to hypertension, management of hypertension.

Hormonal basis of Diabetes mellitus: IDDM, NIDDM. Insulin receptor signalling in relation to the development of insulin resistance. Genetics of diabetes, Maturity onset diabetes of the (MODY) and its subtypes. Complications of diabetes mellitus- macrovascular and microvascular. Immune reaction for diabetes development. Management of diabetes mellitus.

Cholesterol metabolism and obesity and its hormonal regulation: Cholesterol, lipoprotein – their synthesis and metabolism. Hormones involved in cholesterol and lipoprotein synthesis. Adipose tissue as an endocrine organ. Pathogenesis and clinical features and complication, treatment and management of lipid disorders and obesity.

II.Drug abuse: Different types and effects of drug abuse on different physiological system. Management of drug abuse.

Alcohol addiction: Physiological **e**ffect on growth and endocrine system and management of alcohol addiction,

Aging: Effects of aging on Leydig and Sertoli cells. endocrine and reproductive system.

Recombinant DNA technology in endocrinology: Gene transfer methods and application of transgenic mice in endocrinology and reproductive physiology. Production of recombinant insulin, recombinant human growth hormone.

III.Fertilization: Role of zona pellucida protein in fertilization. Molecular aspects of fertilization with special reference to integrin, complement, egg peptide receptor. Acrosome reaction and cortical reaction.

Implantation: physiology of implantation, implantation window, role of maternal hormone and blastocyst in implantation, role of uterine agglutinin in implantation.

Maintenance of gestation: molecular aspect of hCG synthesis, molecular aspect of placental steroidogenesis, GnRH- gonadotrophin axis in placenta, detection of gestation from immunological aspect.

IV.Intratesticular regulation of testicular function: sertoli cell-leydig cell axis for steriodogenesis, sertoli cell-leydig cell cross talk in spermatogenesis, tight junction in testis-structure and function.

Contraception: Hormonal contraceptive and their molecular action, IUD and their molecular action, principle of the development of herbal contraceptive.

Pedigree analysis: general aspect of pedigree analysis, different types of pedigrees, problems of autosomal dominant, autosomal recessive, sex chromosomal dominant and sex chromosomal recessive pedigree.

C : Biophysics and Electrophysiology with Structural Biology

Unit 1: Mathematical Expression of Biological Methods, Electrophysiology of Cells and Radiation Biophysics F.M. 25

Learning Objectives: This paper will help the students to acquire knowledge about advanced electrophysiological methods with emphasis on modern techniques like voltage clamp, current clamp, patch clamp and Single fibre.It also provides insights into radiation biology and modern medical imaging systems and therapeutic equipment.

Skill development / Job Opportunity: After finishing this course students may engaged as a Research Associate, Radiologist Assistant, and Electrophysiology specialist at several research institute, Atomic power plant and Water Production Company. They also appointed as a Spectroscopic Analyst, Laboratory technician at Cardiology and Brain wave imaging assessment center.

I.Mathematical methods and their applications in biological systems: Introduction to numerical methods, solutions to non-linear algebraic equations by the method of iteration and Newton aphsonmethod, numerical integration by trapezoidal rule and simpson's rule, numerical solution of ordinary differential equations by picard's method of successive approximation, Euler's method and Runge-Kutta method; Ordinary differential equations of the first degree and first order (variable separable method, linear equation of Bernoullis), linear differential equations of the second order with constant coefficients. The Laplace Transform, Inverse Laplace transform, application of Laplace transform to solutions of differential equations, Fourier series and their applications. Physico-mathematical foundations of the dynamics of non-linear processes;basic rules for differentiation (Without derivation) and maximum and minimum their application in biology, Geometric meaning of integration, and application in biology.

Bioinformatics: Introduction, definition and history of bioinformatics; Internet, resources, repositories, databases of bioinformatics, pairwise sequence-based alignment, relationship between sequence and structures, structural bioinformatics, genomics, proteomics, human genome project, software packages, sequence analysis tools, NCBI, BLAST (Basic Logical Alignment Search Tool) FASTA, Multiple Alignment, Sequence analysis using EMBOSS.SCOP Data Base; Domain Database, Quality assurance of databases; structure comparison and alignment.

Basics of biomechanics: Introduction and overview of biomechanics, Classification: Biofluid mechanics, Bio tribology, Comparative biomechanics, Computational biomechanics, Continuum biomechanics Cardiovascular biomechanics, and Sports biomechanics; biological application of biomechanics, Kinematic concepts of analysing human motion, the biomechanics of human muscle, spine, Soft body dynamics; bone growth and development. Nature of modeling and remodeling of bones during body movement and Wolfe's law of bone remodelling. Analyse the forces at a skeletal joint for various static and dynamic human activities. Calculate the energy expenditure and power required to perform an activity. Lever: Human lever system and its application in body movement. Basic determinants of gaits, Gait cycle and Swing phases, Time sequence, Neural control of gaits, Prostheses & Orthoses, Muscle mechanics, Load velocity relation, Length tension relation.

II.Electrophysiology of cell membrane and its overview: Different electrical signals in human body. Potential of nerve- Hodgkin-Huxely equation, Hodking-Kartz experiment, Goldman equation.Action potential- ionic basis, gating kinetics and physio-pharmacology of different ion channels. Receptor potential- general transduction mechanism, stimulus–receptor relationship, adaptation of receptors. Modern techniques in voltage clamp, current clamp, patch clamp and Single fibre. Computational electrophysiology. Bioelectricrecognition Assay (BERA).Skin contact impedance of electrodes. Biological Transducers and Measurement of Physiological event.

Heart, brain, muscle and their electrophysiology: Electrocardiogram (ECG), Principles of Electrocardiography,10-20 Electrode system, source of ECG voltage: dipole theory, vector analysis of ECG , changes of ECG potential in different cardiac abnormalities myocardial ischemia and infraction, hypertrophy, different types of arrhythmias; Electroencephalogram (EEG): Brain Potentials, EEG Electrodes, source and mechanism of formation of rhythmic pattern of EEG, characteristics of EEG waves. EEG pattern changes in sleep. Diagnostic Application of EEG abnormalities of EEG. EEG Telemetry system, EEG System artifacts, Faults, troubleshooting &maintenances. Electromyogram (EMG) –Principle, Procedure: Skin preparation and risks; Surface and intramuscular EMG recording electrodes, Maximal voluntary contraction motor unit action potential (MUAP).EMG signal decomposition, EMG signal processing: Limitations and Clinical application.

Advancement of electrophysiology in the light of special scenes: Photoreceptor potential – genesis of potential in light and dark phase, recording of potential. Molecular mechanism of photo transduction process. Electroretinogram (ERG) – characteristics, physiological and clinical significance. Chromatic properties of retinal, LGB and striatal cortical neurons. Binocular and stereoscopic perception; Molecular mechanism of cochlear stimulus related potentials and its transduction. Olfactory receptor potential- characteristics and molecular mechanism of transduction. Ultramicroscopic structure taste receptors, taste receptor potential– molecular mechanism of transduction. Abnormalities of taste.

III.Advanced in radiation physics: Introduction, atomic structure models, Constituents of atomic nuclei, Isotope, Radioactivity, laws of Radioactivity, Alfa, Beta, Gamma rays, Properties of Electromagnetic radiation, Particle accelerate absorbed cyclotrons & synchrotrons; Classification of radiation – ionizing and non-ionizing, Nuclearstructure, Nuclear reactions, Radioactivity,Modes of radioactive decay-alpha decay, beta decay, gamma decay, Activation of nuclides, Accelerators, Cyclotron, LINAC, reactors. Heavy charged particles & Neutrons, attenuation coefficient- linear, mass, electronic & atomic, HVL, Mean free path, Absorption edges, LET. Cathode Ray Oscilloscope (CRO): Instruments, principle and its use in biology. Photon interactions, types of indirectly ionizing radiation, Photon beam attenuation, HVT & TVT, Types of photon interaction, Photon fluence and energy fluence, kerma, cema absorbed dose, quantities used in describing a photon beam, Percentage Depth Dose (PDD); Photoelectric effect, Coherent scattering, Electron interactions: Electron-orbital electron interactions, Electron-nucleus interactions.

Radiochemistry and Radiobiology: Radiolysis of water, Production of free radicals & their interactions, Competition kinetics, Kinetic constants studies of transient species, Pulse radiolysis, Diffusion kinetics & Physicochemical effects, Role of scavengers, G-value; Action of radiation on living system – Viruses, Prokaryotic & Eukaryotic cells Cellular radiation action, Radio sensitization and protection, Target theory, Single hit & Multi hit theory, Multi target theory.Radiobiology: Introduction, classification of radiations in radiobiology, irradiation of cells, type of radiation damage, cell survival curves, measurement of radiation damage in a tissue, normal and tumor cells, therapeutic ratio, oxygen effect, relative biological effectiveness, dose rate and

fractionation, radio protectors and radio sensitizers. Radiation syndrome, Early and late effects of radiation, Effect of Chronic exposure to radiation, Dose effect relationship, Genetic burden.

Radiation protection and radiotherapy: Introduction. principles of radiation protection – time, distance, shielding, quantities and units used in radiation protection, physical quantities, radiation protection quantities, organ dose, equivalent dose, effective dose, committed dose, collective dose, justification of medical exposure, optimization of exposure and protection, dose limits, ALARA, ICRP and AERB regulations. Natural & Man-made radiation exposures or principles of dose equivalent limit (DEL) radiation protection, Maximum permissible dose (MPD), Evaluation of external & internal radiation hazards, Radiation protection measures in industrial establishment, Radioisotope labs, diagnostic & therapeutic installation & during transportation of radioactive substances, disposal of radioactive waste, administrative & legislative aspect of radiation protection.

Radiotherapy: Introduction, principles and scope, specification of dose, clinical diagnosis: Gamma Camera, Positron Emission Tomography (PET), Single Photon Emission Tomography (SPECT), Cobalt-60 machine and its therapeutic use in biomedical science, Therapeutic application of radio isotopes, application of UV radiation for treatments, biological effects of radiation and ultrasound and Radioisotope used in biology and Medicine, (Therapy & diagnosis).Autoradiography; Radioimmunoassay (RIA): Overview, principle, Instrumentation, clinical use. Concepts of teletherapy & Brachytherapy.

IV. Basic concept of biomedical microscopic imaging: Principle, instrumentation and application of microscopy- Specialized microscopy techniques- phase contrast and dark field microscopy, differential interference contrast (DIC), Fluorescence microscopy, time lapse fluorescence, and fluorescence resonance energy transfer (FRET), Interference microscopy, labelling biomoleculesfor fluorescence microscopy, atomic force microscopy (AFM).

Advanced medical imaging systems and therapeutic Equipment's: Introduction to medical imaging, Physical aspects of medical-imaging, Principle, Practical System, Medical utility of X-ray imaging, Fluoroscopy, Xeroradiography, Mammography, Angiography, Myelography, Laser applications in biomedical field and telemedicine.

Spectroscopic Techniques: Spectroscopy- Basic principles, nature of electromagnetic radiation, Interaction of light with matter, Absorption and emission of radiation; Atomic & Molecular Energy levels, Electronic, vibrational and Rotational spectroscopy of molecules, transition and selectionrules; Basic principles, Techniques & Design with Instrumentation involved, applications of UV–Visible spectroscopy, IR & Raman spectroscopy, FT-IR(Fourier transformation Infra-Red)spectroscopy, Fluorescence spectroscopy, Atomic Absorption spectroscopy, NMR spectroscopy, ESR Spectroscopy, Mass Spectroscopy (GC-MS).

Unit 2: Non-ionizing Radiation, Photophysics and Experimental Methods in Structure Elucidation F.M 25

Learning Objectives: This paper helps the students to acquire knowledge about physicochemical fractionation and electro-analytical techniques. It also explains the principles of photochemistry, non-ionising radiation, optical & diffraction techniques and crystallography.

Skill development / Job Opportunity: After finishing this course students may engaged as a Research Associate and Molecular Biologists, Chromatography specialist at Govt. and privet research institute and companies. They also appointed as a Crystallographic Analyst, Laboratory technician at different diagnostic center.

I.Non-ionizing radiation physics: Introduction, common sources and sign and symptoms of non ionizing radiation-their physical properties, various types of optical radiations-UV, visible & IR sources, Lasers-theory and its mechanism, optical properties of tissues, theory and experimental techniques, interaction of laser radiation with tissues, photothermal, photochemical, photo ablation electromechanical effect, radiofrequency microwave radiation, production and properties, interaction mechanism of RF with biological systems, thermal and non-thermal effects on whole body, lens and cardiovascular systems, tissue characterization and hyperthermia and other applications. Ozone umbrella & it's significance, Cosmic radiations, Characteristics of microwave and radio frequency radiation sources, interactions with living system, biological effects, safe exposure limits and prevention of health hazards.

Transducer: Fundamental properties and principle of transducers; Types: Resistive Transducers, Thermo resistors, Thermistors, Metallic strain gauges, Potentiometric Transducers magneto resistive transducers, piezoelectric transducers, Inductive Transducers, Signal inducers, Mutual inducers, Capacitive Transducers, Biological transducer and capacitors,Signal Conditioners for Transducers, Transducer Amplifiers**.**

Biomagnetism: effects, applications. Electrical impedance and biological impedance, principle and theory of thermography, applications in biology & medicine.

Photophysics: Nature and measurement of light, Light sources, Physical properties of excited molecules; Photophysical spectra, Action spectra, Optical activity, Photophysical kinetics of bimolecular processes Photophysical processes, fluorescence, Photophosphorescence, Action spectra, Optical activity, Basic principles and laws of photochemistry, Quantum photochemical principles.Photo activation of biological systems, Photodynamic dyes and mechanism of photodynamic action on cells.

Photochemistry: Photochemical primary processes, Thermal versus photochemical reactions, Types of photochemical reaction, Photochemistry of amino acids and proteins, Photochemistry of DNA & RNA and its constitutes, Recovery from photochemical damage.

II.Physicochemical fractionation &electro-analytical techniques: **Chromatography**-Basic concepts of adsorption & partition chromatography. Kinds of adsorption interactions, Importance of adsorption phenomenon. Principle, experimental set-up, methodology & applications of all types of adsorption & partition chromatography methods-chromatography using paper, thin layer, HPTLC column (gel filtration, ion exchange, affinity), gas (GC,GLC) and HPLC: types of HPLC**,** Mobile phase elution , normal phase and reverse-phase HPLC, column packing material, efficiency of column ,types of HPLC-principles of methodologies ; HPLC pumps- efficiency and suitability, Different injectors and Detectors; Ion Exchange Chromatography.

Centrifugation & ultracentrifugation-Basic principles of Centrifugation, Relative Centrifugal Force (RCF), Factors affecting Sedimentation velocity, Sedimentation Coefficient, Measurement of Sedimentation Coefficient. Choice of Rotors:Fixed angle Rotors, Vertical tube rotors, Swinging bucket rotors. Instrumentation and application: Desktop Centrifuges, High Speed Centrifuge Ultracentrifuges. Principle of Differential, Density Gradient, Rate zonal and Isopycnic centrifugation. Preparation of Density Gradient:Gradient materials. Applications of Boundary Sedimentation, Determination of Molecular Weight.

III.Optical and diffraction techniques: Fundamental principle, instrument design, methods and applications of polarimetry, light scattering, refractometry. Circular Dichroism and optical rotatory dispersion: Plain, circular and elliptical polarization of light, Absorption by oriented molecules, Dichroic ratio of proteins and nucleic acids. Circular dichronism (CD), optical rotatory disperson (ORD), Relation between CD and ORD, application of ORD in conformation and interactions of biomolecules, Determination of structural correlations in biomolecules using absorption spectroscopy.CD spectra of di, oligo and polypeptides, structure of supra-molecular structure i.e. membranes and ordered aggregates of chromophores.

X-ray diffraction methods: General remarks on protein-structure determination from X-ray diffraction, data neutron diffraction, electron diffraction, Synchrotron diffraction. Bragg's law & Bragg's diffraction equation, diffraction methods-Laue's method, Weissenberg diffraction camera and powder method, calculating electron density and Patterson maps (Fourier transform and Structure factors, convolutions), phases, model building & evaluation. General remarks on Protein-structure determination from X-ray diffraction data, Neutron diffraction, Electron diffraction, Synchrotron diffraction,

Crystallography: Principles of x-ray crystallography: Unit cell, cell content, crystal symmetry, crystal systems, Bravais lattices, symmetry elements and operations, point groups and space groups. Atomic scattering factors and structure factors, amplitude and phase, Fourier transformation. Crystals, molecular crystal symmetry, miller indices, reciprocal lattice. Types of crystals: Metallic crystal, ionic crystal, covalent crystals, Molecular crystals. Crystallization of proteins, preparation of heavy metal derivatives, Patterson synthesis, isomorphous replacement methods, structure factors of centro-symmetric and non-centrosymmetric crystals. Scattering factor, structure factor expression, reciprocal lattice, Ewald's sphere, Ewalds construction, electron density equation, phase problem, Patterson function, molecular replacement method,

Crystallization of proteins, structure factors of Centro-symmetric and non-Centro symmetric crystals. Important software for visualization and refinement. R- factor, Validation of the structures.

IV.Circadian Rhythms and Extra retinal photoreception: General failures of circadian rhythms, Entrainment to environmental cycles, Mechanisms of circadian rhythms, Circadian organization in multicellular organism including human; Concepts of extra retinal photoreception with reference to invertebrates, Vertebrates, Possible sites of extra retinal photoreception.

Photobiological phenomenon: Photoactivation of biological systems, Photodynamic dyes and mechanism of photodynamic action on cells, Viruses, Proteins and nucleic acids, Concepts, Mechanism and Significance of photomorphogenesis, Photoperiodism, Phototaxis, Phototropism, Photosynthesis, Light acceptor, system, Photosystem as Photosynthetic reaction centre, Photophosphorelation.

Photo-medicine: General concept, overview and **o**ptical properties of skin, acute and chronic effect of sunlight on skin, Photosensitivity, Phototoxicity, Photo allergy and clinical implication, Beneficial effects of sun and artificial light energy, Photoprotection, Photoimmunology. Mediphotonics: Lasers in dermatology and cell biology, Application of ultra-fast pulsed lasers in medicine and biology, modern application of Fiber optics in medicine.

D : Neurophysiology

Unit 1: Neurophysiology of Brain **F.M. 25**

I. **Sensory functions**: sensory coding, conscious perception, sensory cortical column, audition: fourier analysis by cochlea, responses of auditory fibres, spatial localization; vision: retinal interneurons, mechanism of adaptation, visual fonn recognition, akineptosia, achromatopsia; Smell and taste: neural processing in olfactory and taste pathways; pain: higher neural processing of pain, hyperalgesia and allodynia, neuropathic pain; Neurophysiology of human attention.

The control of posture: Vestibular contribution to posture, visual and other contribution to posture

II. **Motor functions**: local motor control, sensory feedback from muscle, descending pathways; global motor contro: Motor cortex - motor cortical column, cerebellum - neural processing in cerebellar cortex, basal ganglia neural circuitry through components of basal ganglia; initiation of motor movements, movements of the eyes

Sleep and cortical arousal: reticular formation, thalamocortical circuitry, EEG, evoked potential, sleep stages, neural mechanism of REM sleep, magnetoencephatography.

III. **Conditioning and learning**: classical conditioning procedure,

measurement of conditioned response, conditioning controls, conditioning-variables, exteroceptive and interoceptive conditioning; classical conditioning techniques - autonomic nervous system and central nervous system techniques, instrumental conditioning, escape and avoidance conditioning, operant conditioning-reinforcement, intracranial self- stimulator, discrimination and maze learning; conditioning and psychopharmacological investigations.

Memory: theories of memory - sensory, short term and long term memory, declarative and non-declarative memory, neuroanatomy of memory, neuronal basis of memory - LTP and hippocampus, molecular biology of memory, amnesia, Korsakoffs syndrome.

IV. Emotion and behaviour: neural systems in emotional processing-limbic systems, orbito-frontal cortex and amygdale, fear and rage; sexual behaviour; aggression, brain chemistry and behavior; neurobiology of motivation.

Cerebral lateralization and specialization: anatomical asymmetries of brain, split brain, functional asymmetries of brain, variation in hemispheric specialization.

Unit 2: Applied and Clinical Neurophysiology **F.M. 25**

I. Cognitive development: classical theory of cognitive development, object recognition, development of attention system, language acquisition during development.

Plasticity of brain: plasticity in normal adult brain- reorganization in human cortex; cortical maps and experience, morphological changes, synaptic plasticity.

Neuroendocrinology: hypophysiotropic hormones and neuroendocrine axis, hypothalamo-hypophyseal axis in stress and depression, neurogenic precocious puberty, anorexia nervosa, circumventricular organs, pineal gland.

II. Neuroimmunology: neural-immune interactions- autonomic nervous system and lymphoid organs, neuroendocrine-immune system interactions; interactions of cytokines with brain, central nervous system lesions and intra cerebroventricular infusions, effect of stress and depression on immunity.

Neural regulation of biorhythm: characteristics of circadian clock- free running clock, entrainment, Zeitgebars, phase relation to zeitgebers; Biorhythm: sleep- wake cycle, feeding, thermoregulation, endocrine and reproductive rhythms, neural basis of circadian rhythmicity - pacemakers, suprachiasmatic nucleus, alteration in environmental times- jet lag, shift work.

Metabolism of brain and effect of malnutrition: brain metabolism, and undernutrition and the developing brain, malnutrition on learning and behaviour.

III. Aging of brain and associated dysfunctions: structural and chemical changes of the aged human brain.

Neurobiology of drug abuse: long term effects of drug of abuse on CNS; tolerance,

dependence and withdrawal.

Neurotoxicology: effect of neurotoxicants - lead, mercury, arsenic, manganese, carbon disulfide, toluene, trichloro ethylene, insecticides.

IV. Disorders of brain: epilepsy, prion, fragile x-syndrome, Parkinson's disease, Huntington's chorea, Alzheimer's disease, depression, autism.

Methods of study of brain: Functions and instruments used in neurophysiology: Stereotaxic technique, aspiration and electrical lesion, electrical and chemical stimulation; EEG, Evoked potential. Neurobehaviour. Neurochemistry. Principle and use of CAT, MRI, PET, CRO, poly-writer.

Consciousness and Brain Mind interaction: Hypothesis relating to brain mind problem, Conscious versus unconscious processing, neuronal groups and conscious experience.

E : Ergonomics and Sports Physiology

Unit 1: General Ergonomics F.M. 25

Learning Objectives: From this special course the learners will be enlightened about the knowledge of ergonomics and its applications. This unit also deals with environmental ergonomics in workplace as well as man-machine interface in workstation.

I. Brief history and components of ergonomics: brief history of the development of Ergonomics. Role of the subject in community development, definition of Ergonomics, role of the subject in industry and agriculture; characteristics of man-machine-environment system, fitting the man to the task and fitting the task to the man, human factor application in system design.

System ergonomics, system classification, man–machine-environment interface, goal of safety, goal of productivity, factors of system design.

Cognitive ergonomics and human information processing- cognitive task analysis, cognitive ergonomics in problem solving and decision making. human information processing model, coding and cognition, role of short term and long-term memory, cognitive system, cognitive modelof human operator.

Ergonomics standards: ISO standard, OSHA standard.

II. Work rest cycle: physiological parameters during work and rest, rest and other allowances.

Kinensiological factors: Kinensiological analysis of human body movement, scientific basis of human body movement, biomechanics of human spine, lower and upper extremity.

Man-machine interaction: interaction of man and machine through control and display; different types of controls and displays- visual, auditory and tactile, control –movement stereotype, Compatibility – types, relationship with control and display design, coding of controls, design of symbols and labels.

III. **Environmental ergonomics:** illumination- effect of illumination on visual performance, factors related to illumination and visual performance, standards of illumination for working and living aspects: other aspects of visual environment, glare, flicker, colouretc, principles of lighting in VDTwork station. Illumination and reading performance

Noise- definition and measurement of noise, sound pressure level: continuous, intermittent and impulsive noise; physiological effects of noise, noise and health hazards, noise induced hearing loss; noise and performance, noise reduction techniques.

Vibration- transmission of vibration, resonant frequencies of human body and organs; effect of vibration on comfort, performance and health; vibration of hand tools, measurement of vibration,preventive measures against vibration.

IV. **Thermal ergonomics**: thermal balance -factors, temperature and climatic factors- thermal indices;scale of comfort and heat stress indices- effective temperature, WBGT, wind-chill index, heat stress index, 4 hour predicted sweat rate; heat stress and performance, control measures against heat stress; Cold stress and performance.

Protective clothing and equipment: physiological aspects of clothing comfort, indicator of comfort or stress, effects of the environment, the clothing microenvironment.

Chemical environments – harmful chemical in industries and their effects on health and performance, preventive measures.

Unit 2: Applied Ergonomics **F.M. 25**

Learning Objectives: This course encompasses different applied aspects of ergonomics. The principle of design of workstation, seat, and hand tools etc. The learners also be able to learn about the occupational diseases and work-related musculoskeletal problems.

I. **Anthropometrics-** structural and functional anthropometry; principle of applied anthropometry in ergonomics – maximum dimension, minimum dimension, cost-benefit analysis, three dimensional digital anthropometry and its application

Work station design –general principles, workspace design for standing and seated workers, requirements on Physical dimensions variability, reach posture, clearances, protection etc, application of anthropometric data to the layout of work space, biomechanical aspect of workplacedesign, human factors in VDT workstation design.

II. **Seat design**: Problem of seating, design for seating for support and comfort in sitting posture- principle of back rest design, role of anthropometric dimensions in seat design, concept of dynamicchair.

Design of equipment and hand tools - general ergonomics principle, design criteria.

Working posture - variation in different tasks, spine and pelvis related to posture; musculoskeletal problems in different postures; different methods of analyzing work posture, biomechanical methods of posture analysis, behavioral aspects of posture.

III. **Human computer interaction** – text characteristics of VDU, illumination, error analysis; design of computer terminal workstations, software- user interface design, virtual environments, problemof VDT workers.

Musculoskeletal disorders (MSD) – causes, relation to the tasks, management of MSD, repetitivemotion injuries- types and management.

Job design- principle of job design, physical and mental capabilities, task analysis- time and motion study.

Design of manual handling tasks -health effects, type of task, biomechanical models of lower back trouble, recommendation of load handling, acceptable work load, design of manual handlingtasks –lifting, carrying, pulling and pushing.

IV. **Occupational diseases**: occupational diseases of workers in agriculture, industry and mines;occupational stress and its management, evaluation of occupational stress.

Musculoskeletal disorders (MSD)–causes, relation to the tasks, management of MSD.

Shift work – circadian rhythm, problems with shift work, night work and health, organization ofshift work.

Selection and training of workers; Methods, models of training and instructions

Human factors application in industries - in manufacturing, process control,

and transportation

MOOC **Credit: 4; Full marks: 50**

Functional Foods and Nutraceuticals

DSE-P2 **Credit: 4; Full marks: 50**

Elective Practical

A : Microbiology and Immunology

Unit 1: Advanced Techniques in Microbiology **F.M. 25, 02 Credits**

Learning Objective: To get in-depth practical training on microbial infection related diagnostic techniques, and several methods related to microbial genetics.

Skill development / Job Opportunity: the skills develop in microbial techniques will help generate interest among students regarding such research areas and thet may prefer to go for higher research and training in these areas of microbial research.

1. Determination of sensitivity of bacteria to different antibiotics.
2. Determination of minimum inhibitory concentration (MlC) of antibiotics.
3. Assay of antibiotic and vitamins.
4. Isolation, purification and identification of enteric bacteria from water and food samples.
5. Isolation of antibiotic resistant mutants of *Escherichia coli* by replica-plating technique.
6. Estimation of toxoid by bioassay.
7. Experiment for demonstrating bacterial conjugation.
8. Virology: Isolation of bacteriophage by dilution plating in soft agar.
9. Determination of host range of *Virbio cholerae* phages.
10. Lysogenic phages and their induction by UV-light/Mitomycin C.
11. Isolation of chromosomal DNA of bacteria and visualization by agarose gel electrophoresis.
12. PCR (Polymerase chain reaction).
13. Observation of DNA (autoradiography) Southern, Northern and Western blotting techniques (demonstration).
14. DNA, RNA and Protein Sequencing (Demonstration).

Unit 2: Clinical Immunology **F.M. 25**

Learning Objectives: Intensive practical trainings to be developed on immunological and related cytological techniques with clinical significance.

Skill development / Job Opportunity: The training in such Immunological techniques may help students to choose career in higher learning centers in Immunology and they may select for teaching and/or research career.

1. Type I hypersensitivity reaction from anaphylactic shock patients, C - reactive protein measurement. Delayed type of hypersensitivity response (DTH) (Mouse model).
2. Phagocytosis experiments, cell isolation from floral effusion and study the functional activity of cell.
3. Cytology and histology of major organs and endocrine glands (permanent slides and fresh preparation).
4. Histological changes of lymphoid organs after the BSA-primed or LPS-primed animals.
5. DNA fragmentation and apoptosis.
6. Blood grouping, ABO blood grouping and Rh typing.
7. Giemsa stain of blood films (Thick and thin) for detection of malaria parasites, filarial parasites, and abnormality in WBC count (Leukemia, different type of anemia disorders in platelet).
8. Commercial kits-based diagnosis of malaria patients, measurement of IgE level.
9. Southern, Northern and Western blot technique.
10. 2D gel electrophoresis of proteins.
11. Hemagglutination test.
12. Training regarding sophisticated instruments (Optional): Students may be taken to visit different advanced laboratories in leading Institutes such as IISc, Bangalore; CCMB, Hyderabad; TIFR, Mumbai; Industrial Toxicological Research Centre, Lucknow; IICB, Kolkata; IITs, Institute of Microbial Technology, Chandigarh; National Institute of Immunology, Delhi; NICED, Kolkata; NCCS, Pune etc..

B : Biochemistry, Molecular Endocrinology and Reproductive Physiology

Unit 1: Advanced Experiments on Biochemistry **F.M. 25**

Learning Objectives: The objective of this unit will provide hands on training for bioanalytical techniques used for the isolation, purification, and characterization of biomolecules, differential centrifugation techniques as well as immune-biochemical techniques for the utilize of the biochemical methods for research purpose.

A. Analytical Techniques in Biochemistry

1. Separation of amino acids and sugars by paper chromatography
2. Separation of amino acids and lipid fractions by thin layer chromatography.
3. Purification of proteins by salt precipitations and column chromatography.
4. Separation of mixtures of proteins by Sephadex Gel Filtration (column).
5. Separation of proteins by Polyacrylamide Gel Electrophoresis (PAGE).
6. Agarose gel electrophoresis of chromosomal & plasmid DNA.

7. Assay of mitotic indices.
8. Isolation of Goat RBC membrane and estimation of Na+/K+ ATPase

B. Determination of Isoelectric pH of proteins

C. Assay of vitamins

1. Estimation of ascorbic acid in biological samples (blood, tissues etc.) by methods using different oxidizing agents
2. Spectrofluorometric methods.

C.Differential centrifugation Techniques

Isolation of subcellular fractions.

D. Immunobiochemical Techniques

1. Immunoelectrophoresis and Immunodiffusion techniques.
2. Separation of Splenic Lymphocytes.
3. Separation of Peritoneal Macrophages.

Unit 2: Advanced Experiments on Endocrinology and Reproduction F.M.25

Learning Objectives: The objective of this unit is to demonstrate the experiments on the assay of hormones and different reproductive biomarkers and genetic experiments as well as on female model animals to assess their normal anatomical and physiological and parameters related to endocrinology and reproduction by hands on training techniques.

A. Assay of hormonal bio-molecules and other techniques in endocrinology

1. Bio-assay of oxytocin and epinephrine
2. Hormone assay-ELISA. RIA
3. Measurement of hormones by spectroflurometer
4. Study of localization steroidogenic enzymes in testis, ovary and uterus by histochemical methods
5. DNA and chromosomal studies in endocrine and reproductive disorder
6. Karyotypic study
7. Pedigree analysis-Autosome and sex chromosome related pedigree

B.Techniques in Reproductive Physiology

- **Experiments on female reproduction**

1. Study on estrous cycle-effect of synthetic estrogen and hCG injection.
2. Study on ovariectomy (unilateral and bilateral) – effects on ovarian and adrenal cholesterol

3. Study of acid and alkaline phosphatase activities in uterus of ovariectomized animal.
4. Study of immunological methods for pregnancy detection.
5. Basic experiment on superovulation study in mice and rat

Optional Training Programme / Laboratory Visit:: Training in higher research institute are to be arranged for the students to learn some advance techniques in reproductive physiology and they are also to be taken for visiting different national laboratories. The student shall submit a report during practical examination for special paper.

C: Biophysics and Electrophysiology with Structural Biology

Unit 1: Advanced Medical Biophysics **F.M. 25**

Learning Objectives: The goal of the unit is to train the next generation of structural biologists and biophysicists to be very familiar with the basic chemical and physical principles important in every living organism and to train the students in the biological and physical sciences including medical and veterinary medicine.

Skill development/Job Opportunity: The students may join as an Electrophysiologist, Laboratory Technicians, Cardiology Assistant and Research Assistant at different Government and non-government laboratory and companies.

1. Five Mathematical assignment based on Module-I
2. Internet search for Bioinformatics resources; DNA and Protein sequence, file format conversion; The PROSITE Database.
3. Radiation Exposure survey using area survey meters and Dosimeters.
4. To record and analyze the Electrocardiogram (ECG) and to draw the mean Electrical axis. To measure the Evoked potentials.
5. Electrophysiological recording (EEG, ECG, EMG, EOG, Heart rate, respiration, pulse rate, heart sound, etc.) of cardiac, brain, muscle.
6. Brachytherapy source: 1) Check for integrity of the source, 2) Calibration using an Isotope calibrator, 3) Plotting of Isodose curves using Ion chamber and/or film.
7. Recording of simple muscle twitch (SMT). Effect of increasing frequency of stimulus on SMT
8. Determination of strength-duration curve, measurement of contraction kinetics of excitable tissues, measurement of conduction velocity of nervefibre. Genesis of fatigue
9. Effect of Vago-sympathetic Trunk and White Crescentic Line on heart muscle. Effect of Vagal stimulation showing Vagal Escape.
10. To study the effect of drugs on skeletal muscle of toads – Nicotine and Atropine.
11. Modern techniques in voltage clamp, current clamp, patch clamp and Single fibre.
12. Conformation of Nucleic acid by Spectral study.
13. Methods of sample preparation for microscopy

14. CRO and its biomedical application. Experiments using electrophysiological techniques: Skin receptors and demonstration of dermatomes in frog. Muscle spindle, Golgi tendon organ activity demonstration in toad/frog.
15. To demonstrate the effect of UV and Gamma rays on cell division, Enzymes, Proteins and DNA, cell membrane.
16. To measure the Output of Gamma ray teletherapy units.
17. To study the renal stone or oil content of oil seeds using Infra-Red (IR) Spectroscopy.
18. To perform the structural analysis of amino acids, small peptides using NMR Spectrometer
19. To perform the Free radical spectral analysis using ESR spectrometer

Unit 2: Advanced Separation Techniques and Photophysics

Learning Objectives: This practical paper will help students to learn chromatographic and spectrophotometric principles and techniques. They will also get hands on training on centrifugation methods and application of ultracentrifuges. Students are also required to submit a laboratory visit report on the basis on their visit to any National laboratory.

Skill development / Job Opportunity: The students may join as a laboratory Technicians, Chromatography analyst, Research Assistant at different Government and non-government laboratory and companies.

1. To perform the fractionation of protein, sugars separation from fruit juice using TLC/HPTLC
2. Cellulose acetate strip Electrophoresis of Amino acids and protein.
3. Column Chromatography for Proteins, Pigments, amino acids.
4. Agar Gel Electrophoresis of Proteins
5. One- and two-dimensional ascending & descending TLC and paper chromatography of amino acids & sugars
6. To isolate and characterize photosynthetic pigments by Chromatography and Spectrophotometry.
7. To perform the separation of Proteins using HPLC
8. To determine the molecular weight of biomolecules using ultracentrifuge
9. To isolate cellular fraction by centrifugation methods.
10. To study the survival of E. Coli. as a function of fluence of UV radiation (254 nm) at different temperature.
11. To study the photo reactivation process in E. Coli
12. To study the effect of visible light intensity and time of irradiation on photo reactivation process.
13. Measurement of Pressure, Movement, Force, Frequency & Time using different transducers.

14. To study bioluminescence of live fire flies by correlating light intensity with time.
15. To study chemiluminescence in a chemical transformation
16. Effect of lasers on biomolecules and cellular Systems.
17. To obtain relation between concentration and Refractive Index (RI) using Refractometry.
18.Training Program/Laboratory visit (Optional):Students will submit a report on the basis of their visit training in some advanced National laboratories such as IICB, Bose Institute, NICED-Kolkata, IIT- Kharagpur, Guwahati; NBRC, AIIMS- Jodhpur, Bhubeneswar; NIH and DRDO-New Delhi, NIMHAN- Bangalore, and NCBS-Pune etc. as a part of their practical syllabus.

D: Neurophysiology (PHY 495D)

Unit 1: Advanced Neurophysiological Studies – I **F.M. 25**

1. Study of the nerve cell: staining of neurons by crestyl violet and Nissl fast violet stain in the paraffin section of the spinal cord and cerebellum.
2. Study of central nervous system architecture by hematoxylin van Giessen method and Mallory's phosphotungstic acid hematoxylin method.
3. Experimental neuroanatomical studies:

a) Nauta – Laidlaw method / Marchi's method

b) Fink – heimer procedure.

c) Cupric silver method.

d) Rapid Golgi cox method / Bulchawosky method.

4. Tracing nerve tract horseradish peroxidase techniques.
5. Vital staining of nerve fibre by Methylene blue method.
6. Measurement of neurotransmitters:

a) Spectroflurometric method for measuring acetylcholine, epinephrine, non-epinephrine, dopamine, serotonin in microdissected brain regions of rats

b) HPLC method for measuring neurotransmitter.

7. Electrocardiographic study in humans in resting and stress condition.
8. Electromyographic study in humans in different stages of sleep and wakefulness
9. Electroencephalographic study in humans: recording of EEG in humans in different stages of sleep and wakefulness.
10. Evoked potent study in humans: Brainstem evoked potential and auditory evoked potential in humans.

Unit 2: Advanced Neurophysiological Studies – II **F.M. 25**

1. Studies of blood pressure in humans:

a) Effect of posture changes on blood pressure and heart rate.

b) Effect of vestibular stimulation on blood pressure and heart rate

c) Valsalva maneuver.

2. Perimetry: visual field determination with different colours in perimeter in resting and stressfull condition.

3. Audiometry: study of frequency threshold curve in humans.

4. Biofeedback: EMG biofeedback studies.

5. Study of galvanic skin response (GSR): measurement of GSR in resting and different stressful condition.

6. Experimental of Chronobiology:

7. Recording of 24 hours body temperature to study circadian rthythm of body temperature

a) Recording of heart rate to study circadian rthythm of resting heart rate

8. Neuroimmnological studies: PMN assay, cytotoxic assay, PLN assay, phagocytotic assay in experimental animals in resting condition and after stress

9. Training programme / Laboratory Visit: Students will submit a report on the basis of their visit training in some advanced national laboratories such as NBRC, New Delhi: NIMHAN, Bangalore; NCBS, Pune; AIIMS, New Delhi etc as a part of their practical syllabus.

E : Ergonomics and Sports Physiology

Unit 1: Experiments on General Ergonomics and Environmental Ergonomics F.M. 25

Learning Objectives: They will be able to get practical training on evaluating work stress and environmental conditions in a work station. They will learn analysis of work posture and time and motion studies.

1. Evaluation of occupational stress- development of questionnaire, quantitative evaluation technique, pain mapping.
2. Measurement of different heat stress indices: WBGT, ET, CET, P4SR; measurement ofrelative humidity.
3. Determination of hearing loss of different groups of workers by audiometric method.
4. Measurement of illumination level by lux meter in different working areas.
5. Measurements of noise level in different working stations.

6. Measurement of vibration level.
7. Determination of environmental conditions surrounding the workers determination of concentration of dust and particulates in air.
8. Product analysis - Pair comparison test.
9. Determination of center of gravity of human body under resting and working conditions.
10. Biochemical study of work posture, joint angle study, determination of spinal curvature, analysis of posture by video graphic method – OWAS, REBA, RULA, OCRA etc.
11. Time and motion study, job analysis.
12. Peg board test.

Unit 2: Experiments on Ergonomic Design and Group Projects F.M. 25

Learning Objectives: The students will be trained on the applied anthropometry. They will get practical training by means of field studies in workplace and industries. They will learn to write report of industrial visits.

1. Anthropometrics measurements- static and dynamic, anthropometric measurements for different design consideration- design of seat, work station, consumer products, personal protective equipments hand-tools, etc.
2. Workshop on biomathematics and biostatistics.
3. Simulation of work and sports model by the computer.
4. Group Projects* -

* Field study in industrial establishments and other work stations to study man –machine interactions

*Students are to be taken for visiting different industrial establishments for ergonomic evaluation of man-machine-environment system and they are also to be taken for visiting different advanced laboratories such as - Central Labour Institute (Bombay), Ergonomic Laboratory, IIT (Bombay), Defense Institute of Physiology and Allied Sciences (Delhi), Netaji Subhas National Institute of Sports(Patiala), Sports Authority of India (Bangalore). Rani Lakshmi Institute of Physical Education (Gwalior). Central Mining Research Institute (Dhanbad), National Institute of Occupational Health (Ahmedabad), Regional Labour Institute (Calcutta) etc. The student shall submit a report during practical examination for special paper.

DSC-P4 **Credit: 4; Full marks: 50**

Unit 1: Histology, Cytological and toxicological Techniques F.M. 25

Learning Objectives: This unit will help to learn essentials of human histology and human cell cytology, techniques of cell and tissue specimen preparation for microscope analysis as well as the clinical application of knowledge of human histology and cytology with specific cell physiology, anatomy and physiology of tissues and organ systems.

Skill development / Job opportunity: Students will be able to serve as Cytologists and Pathologists at different research and pathological laboratories.

Histological experiments: fixation- different fixatives and their utility, dehydration, clearing- different clearing agents, embedding and preparation of sections (paraffin, cold): micrometry, photometry; staining. Characteristic features of transverse section of different histological slides.

1. **Staining of smear for cytological evaluation**: papanicolaou staining, cresyl violet staining.
2. **Study of estrous cycle by different staining techniques**: special and differential staining of vaginal smear.
3. **Vital and supravital staining**: platelet count, erythrocyte count, must cell.

5. Histipathology: effect of toxicity by applying toxicants on the different organ histology.

Unit 2: Histochemical and Histometric Techniques **F.M. 25**

Learning Objectives: This unit will help to learn essentials of histochemical techniques used for the visualization of biological structures for the identification and distribution of various chemical components of tissues through the use of stains, indicators and microscopy as well as through enzymatic, immune-histochemical techniques with special emphasis on histometry and histopathology.

Skill development / Job opportunity: Students are serves as Histopathologists, Consultant Pathologist, Clinical Pathologist and Image Analyst at different research and general pathological laboratories.

1. Histochemistry of Carbohydrates:

a) Detection of glycogen in liver by Best Carmine method

b) Detection of glycogen using PAS method of Hotchkkin.

c) Detection of glycogen using Lugol's iodine test

2. Histochemistry of Proteins:

a) Histochemical localization of proteins in the animal tissues using Mercury – BromophenolBlue method

b) Histochemical detection of proteins in animal tissues using Baker's method

3. Histochemical detection of lipids:

a) Detection of lipids in animal tissues using Oil Red O method.

b) Detection of lipids in the animal tissues using acid haematin method .

4. Histochemistry of nucleic acids:

a) Detection of DNA in animal tissues using Fuelgen reaction.

b) Detection of DNA in animal tissues using Pyronin-Methyl green method.

c) Detection of RNA in animal tissues using HCl method followed by Pyronin-Methyl greenmethod.

5. Histochemistry of enzymes:

a) Detection of alkaline phosphatase.

b) Detection of ATPase.

c) Detection of cholinesterase.

6. Histometry (demonstration):

a) Measurement of testicular Leydig cells.

b) Measurement of liver cells

c) Measurement of thyroid follicular cells etc.

7. Histopathology:

1. Effect of toxicity on the different organ histology

8. Immuno histochemistry (demonstration)

Social service/ Community engagement **Credit: 2; Full marks: 25**

Semester-IV

(Theory: 125 + Practical: 150)
(Total Marks: 275, 22 Credits)

❖ **DSC-T7** **Credit: 4; Full marks: 50**

Unit -1: Human Immune System F.M. 25

Learning Objective: To learn about the basic principles of functioning of human defense system and its major components.

I. Cells and organs of immune system: `Overview of the Immune system: historical perspective of immunology, cells of the immune system, primary and secondary lymphoid organs, elements of immunity – innate, acquired; interrelation between innate and adaptive immunity; immunogens and antigens.

II. Humoral and cell mediate immunity: structure of immunoglobulin, five major classes of immunoglobulin: IgG, IgD, IgE, IgA, and IgM, biological properties of immunoglobulins; triggering of the immune response, humoral immunity, adaptive immunity; cell cooperation for triggering T and B cells; immunosuppression, complement system: major pathways of complimentsystem - alternate, classical and lectin pathways.

III. Immunological regulation and disorders, Structure and function of MHC – I and MHC –II, cytokines, chemokines, hypersensitivity, rejection of grafts, autoimmunity and immunological disorders

IV. Immunological methods/techniques: antigen-antibody reactions, precipitation and agglutination reaction, titre, ouchterlony double diffusion (ODD), single radial immune diffusion (SRID), ELISA, immunofluorescence, monoclonal antibody.

Unit -2: Microbes-Human Interaction F.M. 25

Learning Objective: To develop knowledge regarding microbial world-basic physiology, metabolic patterns of microbes ad cultivation. Moreover, the target is conceptual development about the infectious agents, major infections and other uses of microbes.

I. **Historical developments in microbiology:** Early history of microbiology, Louis Pasteur and germ theory, the germ theory of disease, Spontaneous generation vs. biogenesis, the development of microbiology, scope of microbiology, modern microbiology: development of pharmaceutical products, quality control methods in food and dairy product production, industrial application of microorganisms, biotechnological application, etc., chemotherapy, molecular biology and immunization, nanotechnology.

Classification of micro organisms: the cell types, features and morphology, methods of classification: Adansonian or numerical classification, DNA composition, DNA homology, Ribosomal RNA sequencing, major groups of microorganisms, anatomy and physiology of majorgroups of microorganisms: fungi, algae, slime moulds, archaea, bacteria, virus, protozoa.

II. **Growth and nutritional requirements of bacteria:** Growth requirements for microorganisms: chemical requirements and physical requirements, micro and macro nutrients, nutritional types ofmicroorganisms, growth curve, environmental influences on growth, culture media, sterilization, identification of bacteria, recent laboratory innovations, counting of bacterial cells.

Study of some important genus of bacteria of medical importance: Staphylococci, Streptococci, Clostridia, Neisseria, Mycobacteria, Salmonella, Vibrio, Shigella.

III. **Microbes from different sources:** microbes in the environment: soil and aquatic microbes, microorganisms in dairy products, microorganisms in food, industrial uses of microbial by- products, and microorganisms as biological tools.

Chemotherapeutic agents: characteristics of chemotherapeutic agents, synthetic agents, antibiotics, antifungal agents, antiviral agents, microbial resistance, treatmentand complications.

IV. **Study of some important groups of viruses**: herpes viruses. hepatitis viruses, orthomyxovimses,paramyxoviriises, picornaviruses; retroviruses: HIV and AIDS.

Study of some important groups of protozoa: general characteristics, the traditional groups of 'protozoa: sarwodina, ciliophnra, mastigophora, sporozoa, some common protozoa mediated diseases:amebiosis, giardiasis, trypanosomiasis, leishmaniasis, malaria.

DSC-T8 **Credit: 4; Full marks: 50**

Unit -1: Environmental Physiology and Toxicology **F.M.-25**

Learning Objectives: This unit will help to acquire broad knowledge of the field of Environmental Chemistry including earth and its environment, interactions between different spheres of environment as well as the sources, chemodynamics and fate of air, water, soil and radioactive pollutants in ecosystems. Understanding of natural and man-made hazards, the industrial waste and related safety issues, the meaning of environmental management, as well as broad knowledge of the field of toxicology and related hazards.

Skill development/Job opportunity: In future they serve as a safety officer, Environment Specialist, and Environment Health Safety Officer.

I. **Man and environment:** concept and types of environment, biotic environment; biotic and abiotic interactions. Basic Ecological Concepts and Principles: Ecosystem: structure, types, Homeostasis, energy transfer in ecosystem, Energy flow, trophic structure, food chain, food web, ecological efficiency, biogeochemical cycles in ecosystems. Primary production and decomposition.

Pollutants, environmental change and health: Major pollutants and their effects, Chemistry of organic and inorganic chemicals polluting Environment (air, water and soil). Change of Global climate, global warming and its consequences. Ozone depletion, UV-B and greenhouse gases. The changing disease pattern, different environmental diseases-cancer, birth defects, reproductive damage, respiratory diseases, heavy metal induced diseases etc.

Air Pollution: Effect of Carbon monoxide, Sulfur and Nitrogen oxides, Particulate matter, volatilecarbon compounds (PAH etc.) - their control and prevention. Air quality standards.

II. **Water pollution:** different sources of water pollution. Metallic pollutants- mercury, lead, cadmium, arsenic and fluoride toxicity. Chelating agents and use of chelator to control metal pollution. Sewage treatment. Water quality criteria and standards. Safe drinking water act. Wetland and its importance.

Radionuclide and ultrasonic pollution: types of ionizing radiation, radionuclides; Radiation dosimetry; Biological effects of ionizing radiation. Incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, radiation safety, ultrasonic pollution.

Soil and pesticide pollution: soil pollution by biological agents, mycotoxins; xenobiotic mechanisms of pesticides and fertilizers in soil, heavy metal stress on soil organisms, hazards produced by organo chlorine, organophosphate, carbamate, nicotinoid, pyrethroid pesticides and other biocides, pesticide residues in food and drinking water and their biological

monitoring.

Biotechnology and environment: GMOs and Biosafety, concepts of bioaugmentation, biostimulation, biodegradation, biosorption, biofilms in the bioremediation of xenobiotics, Biosurfactants, biofertilizers, biopesticides, Integrated waste management; production of biomass,biogas and biofuel from waste.

III. **Environmental toxicology I:** Toxicokinetics, toxicokinetic factors as basic mechanisms of toxicity; Toxicodynamics, toxicodynamic factors as basic mechanism of toxicity; Design of toxicity study-Acute and Sub-acute, Chronic and sub-chronic toxicity study; Biotransformation and bio-activation / bio-inactivation of xenobiotics, Factor affecting xenobiotic action.

Environmental toxicology II: Xenobiotic effects of toxicants on mammalian organisms, xenobiotic-induced oxidative stress, hepatotoxicity, reproductive toxicity, nephrotoxicity, neurotoxicity, genotoxicity, immunotoxicity, endocrine disruption, environmental risk assessment and assessment of risk to humans, risk management. Biomonitoring- use of biomarkers, biosensors.

IV. **Environment management concepts and environmental issues:** the concept of sustainable development, Environmental protection programs, Stockholm conference, UNEP, Rio de Janeiro earth summit, UN follow-up etc., Environmental Governance in India. WTO, GATS, environmental concerns and WTO.

Endangered species management and conservation of biodiversity: biodiversity: status, monitoring and documentation; Ecosystem restoration; sustainable forestry; Major drivers of biodiversity change; biodiversity management approaches. Principles of conservation; major approaches towards conservation; Cryopreservation, Hotspots of biodiversity, Indian case studies on conservation; Endangered Species Act, IUCN Red list, Importance of biosphere reserves, wildlife sanctuaries and National parks, Convention on Biological Diversity (CBD).

Conventional and sustainable (non-convention) energy: Energy from fossil fuels**,** nuclear power, conventional energy sources; Sustainable energy sources: solar energy, biomass, and hydropower, wind energy, Geothermal energy, tidal and wave energy, ocean thermal electric conversion (OTEC).

Waste disposal: human excreta disposal; solid waste disposal-hazards & protection; Municipal solid wastes(MSW) management; Methods of source reduction: Concepts of PAYT and EPR, Zero waste initiative; Landfills: Lifecycle of a municipal landfill, Leachate collection practices, Landfill gases, federal standards for landfills. Waste to energy conversion (WTE); Regional recycling options-material recycling facility (MRF), hospital and biomedical wastes – hazardous waste disposal, radioactive waste, electronic waste & techno trash hazards and protection, integrated solid waste management: GPS based garbage tracking system.

Unit 2 . Sports, Exercise Physiology and Ergonomics F.M. 25

Learning Objectives: This course addresses the concept of fitness with emphasis to physical training. It highlights the basic components of ergonomics and anthropometry. It also discusses various aspects of Occupational Health and safety with reference to occupational diseases. The students can acquire knowledge about therapeutic effects of practicing yoga.

Skill development/Job opportunity: Appointed as a Strength and conditioning coach: Like personal trainers, strength and conditioning coaches help people to improve their fitness; Physical education teacher, Exercise physiologist, Sports development officer, Sports and exercise psychologist.

I. **Concept of fitness**: physical fitness, components of fitness , benefits of fitness, role of exercise in fitness and health: prescription of exercise- frequency, duration and intensity, dose – response, general guidelines for improving fitness, maintenance of fitness- sequence of physical activities: walking, jogging, and common games and sports.

Static and dynamic exercise with physical training: Energy production and transfer during exercise, energy metabolism during exercise. Physical training –general principle, strength and endurance training, different methods of physical training. General principle of Physical Training.Strength and endurance of training. Different methods of physical training.

II. **Ergonomics and its Physiological factors:** Definition, early history, aim and application in different fields. Fitting the job to the person and the person to the job, Human characteristics, capabilities and limitations. Physiological variation during work, fitness, health, workload and work capacity; effects of nutrition, sleeplessness and disease on physical work. Cognitive ergonomics: cognitive process, perception and attention at work, memory and learning at work, cognitive requirements at work.

Anthropometry and Body composition: static and dynamic anthropometry, instrument for anthropometry, method of anthropometric data collection, data analysis; uses of anthropometry – assessment of nutritional status, application for ergonomic design. Different methods of assessingbody composition, body composition and performance.

III. **Clinical aspects of exercise physiology:** Exercise physiology in prevention and rehabilitation of cardiovascular diseases: physiological bases for using exercise in CHD prevention, exercise tests for assessment of cardiovascular dysfunctions, exercise induced indicators of coronary heart diseases, principle of exercise testing in cardiac rehabilitation, exercise prescription of cardiac patients, weight training for cardiac rehabilitation, exercise prescription for pulmonary diseases, neuromuscular diseases, and renal disorders; exercise for diabetic patients, exercise prescription for pregnancy, effect of exercise on cancer.

Environment and exercise: exercise in cold - physiological responses to exercise in cold, health risks during exercise in cold, effect of cold on human performance, exercise in hot environment- physiological responses to exercise in heat, health risks during exercise in heat. Exercise in high altitude- physiological adaptation at altitude, aerobic performance at high altitude, training for competition at high altitude. Exercise for the disabled- physically and mentally challenged. Yogic exercise and fitness: physiology of yogic exercise, therapeutic use of yoga.

IV. **Occupational Health and safety** –definition, factors affecting occupational health, occupational health hazards in workplace – mechanical, chemical, biological, fire, toxic substances, and explosive materials, environmental hazards – heat stress, cold stress, noise, vibration, ultra-violet radiation. Accidents – theories of accident, effect on of accidents, promotion of safety, personal protective devices. Repetitive motion injury: causes, and prevention. Occupational stress–causes,evaluation of stress, management of stress

Occupational Diseases: Pneumoconiosis, silicosis, asbestosis, bagasosis, byssinosis, anthrocosis, occupational cancer – skin, lungs, urinary bladder, blood, occupational health problem of agricultural workers.

Prevention and health measures of occupational hazards –nutrition, disease control, environmental sanitation, medical measures, ergonomic measures, legislation.

❖ **Research Project/Dissertation** **Credit: 8; Full marks: 100**

❖ **Internship/Capstone project/ Applied field and Incubation/ Entrepreneurship/Start-up proposal or practice**

Credit: 4; Full marks: 50

❖ **Intellectual Property rights (IPR)/ Skill enhanced course**

Credit: 2; Full marks: 25