SYLLABUS

for

MASTER OF SCIENCE

IN

HUMAN PHYSIOLOGY

under

CHOICE BASED CREDIT SYSTEM

VIDYASAGAR UNIVERSITY
MIDNAPORE – 721102
WEST BENGAL

EFFECTIVE FROM 2016 - 17 ACADEMIC SESSION

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Preamble

The subject of Human Physiology is one of the important interdisciplinary areas in teaching, training and learning that are considered to be important in terms of human resource development as well as community development. Human Physiology is the life phenomenon studied at all level, from molecules to cell with special emphasis to human body. It is that branch of knowledge that applies the 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 different aspects of the functions of biological molecules, organisms and entities. The techniques and methodologies of Human Physiology have wide applications in the biological, medical and related sciences. Students with Masters in Human Physiology have job opportunities in the Universities, Colleges, Schools, R and D Industries, Medical Centers/Colleges, Research Institutes, and other Government and Non-government Organizations.

Eligibility Criteria:

A candidate shall be held eligible for admission to Two-year course for the Master Degree in Human Physiology under Faculty of Science, if candidate has passed the B.Sc. Examination with Honours in Physiology. The graduate course should of three years duration.

General Instructions:

1. The Post Graduate Course of Human Physiology is divided into four semesters each of 300 marks. There are a total of 14 theory papers and 10 practical papers in four semesters. Among 14 theory papers there will be 02 Elective Papers to be chosen optionally by students from other disciplines.

2. Each semester consists of Theory and Practical papers of 50 marks (4 Credits) each consolidating to 300 marks (24 Credits). Each paper is divided into two Units of 25 marks (2 Credits) each and each unit of theory papers is subdivided into 4 Modules (0.5 Credit/Module).

3. The Two Elective Papers will be taught in the Second and Third semesters each.

4. The students are required to complete 20 compulsory papers (12 Theories and 08 Practical) including the chosen Elective Papers and 04 Optional Special Papers (02 Theories and 02 Practical). The Optional Special Papers will be announced at the beginning of each academic session.

5. Each Theory Paper will have workload of 50 Lectures each of 60 minutes duration distributed in Units (45 lectures +5 tutorials). Each Practical Paper will have workload of 75 periods of 60 minutes duration each.

6. Each theory paper will be evaluated by internal assessment (10 marks) and semester examination (40 marks). For each paper there will be two internal assessments, which may be evaluated by written test or oral test or seminar presentation. The average marks of two assessments will be credited to the students.

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7. Each student will have to participate in a field study for Community Health Survey as a part of Practical Training Program in the Second Semester.

8. Students have to carry out an individual project of 50 marks in the final semester. The project will be evaluated by the project report submitted and seminar presented by the students.

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Syllabus of Human Physiology

Items	Semester I: [300 Marks 24 Credits]		Semester II: [300 Marks 24 Credits]		Semester III: [300 Marks 24 Credits]		Semester IV: [300 Marks 24 Credits]		Total Marks: [1200 Marks 96 Credits]	
	Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical
Marks	200	100	150 (including Elective 50)	150	200 (including Elective 50)	100	150	150	700	500
Credits	**16**	**08**	**12**	**12**	**16**	**08**	**12**	**12**	**56**	**40**

Semester I

Theory / Practical	Paper	Unit	Name	Marks	Credits
Theory	PHY-101	01	Physiological Chemistry and Metabolism	25	02
		02	Molecular Biology	25	02
	PHY-102	03	Biophysical Principles in Physiology	25	02
		04	Biomedical Instrumentation	25	02
	PHY-103	05	Biostatistics and Research Methodologies	25	02
		06	Computer Application in Biology and Bioinformatics	25	02
	PHY-104	07	Physiology of Excitable Cells and Higher Functions of Brain	25	02
		08	Integrated Physiology: Homeostasis	25	02
Practical	PHY-105	09	Biochemical Techniques	25	02
		10	Bio-Analytical Techniques and Microbiological Studies	25	02
	PHY-106	11	Statistical Treatment of Biological Data	25	02
		12	Computer Application in Biological Problems	25	02

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Semester II

Theory / Practical	Paper	Unit	Title	Marks	Credits
Theory	PHY-201	13	Community Health: Health, Disease and Nutrition	25	02
		14	Community Health: Environmental Pollution, Toxicology and Management	25	02
	PHY-202	15	Community Health: Exercise Physiology and Mass Fitness	25	02
		16	Community Health: Ergonomics and Occupational Health	25	02
	PHY-204	01	Lifestyle and Health	25	02
		02	Lifestyle Management and Health Promotion	25	02
Practical	PHY-203	17	Anthropometry and Community Health Survey	25	02
		18	Human Experiments	25	02
	PHY-205	19	Growth Monitoring and Nutritional Assessment	25	02
		20	Assessment of Environmental Status	25	02
	PHY-206	21	Studies with Cardiac Muscle	25	02
		22	Studies with Skeletal & Smooth Muscles and Bioassay	25	02

Semester III: 300 Marks

Theory / Practical	Paper	Unit	Name	Marks	Credits
	PHY-301	23	Electrophysiology and Sensory System	25	02
		24	Systems Physiology	25	02
	PHY-302	25	Microbes-Human Interaction	25	02
		26	Human Immune System	25	02

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Theory	PHY-303	27	Special Paper	25	02
		28	Special Paper	25	02
	PHY- 304	01	Environment and Health	25	02
		02	Human Reproductive Health and Related Issues	25	02
Practical	PHY-305	29	Histological and Cytological Techniques	25	02
		30	Histochemical and Histometric Techniques	25	02
	PHY-306	31	Special Paper Practical	25	02
		32	Special Paper Practical	25	02

Semester IV

Theory / Practical	Paper	Unit	Name	Marks	Credits
Theory	PHY-401	33	Endocrinology	25	02
		34	Reproductive Physiology	25	02
	PHY-402	35	Cell and Inheritance Biology	25	02
		36	Biotechnology	25	02
	PHY-403	37	Special Paper	25	02
		38	Special Paper	25	02
Practical	PHY-404	39	Advanced Physiological Studies- I	25	02
		40	Advanced Physiological Studies- II	25	02
	PHY-405	41	Special Paper Practical	25	02
		42	Special Paper Practical	25	02
	PHY-406	43	Project	25	02
		44	Project	25	02

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Human Physiology

Semester I: (Theory: 200 + Practical: 100)

Theory

(Total Marks: 200, 16 Credits)

Paper: PHY-101

Unit 01: Physiological Chemistry and Metabolism F.M. 25, 02 Credits

Module 1

Bioenergetics and biological oxidation: first and second laws of thermodynamics, entropy and enthalpy, concept of free energy, coupling of metabolic energy changes, biological energy transfer, group transfer, Redox potential, aerobic oxidases, mixed function oxidases, anaerobic dehydrogenises including iron- suffer clusters and cytochromes, mitrochondrial electron transport chain, its complex and their roles, extra-mitochondrial electron transport chains; oxydative phosphorylation – chemiosmotic theory, Boyer's binding change model; Q cycle, mechanistic proton translocation, substrate level phosphorylation in aerobic and anaerobic systems, ATP yield – energy conversion and conservation, ionophores in uncoupling oxidation and phosphorylation.

Module II

Enzyme Kinetics: kinetics versus thermodynamics; the Michaelis - Menten approach to enzyme kinetics, Lineweaver - Burk double reciprocal plots, other linear transformations of enzyme kinetic data; Chemical mechanisms in enzyme catalysis; competitive, noncompetitive and uncompetitive inhibition kinetics; allosteric modulation, sigmoid kinetics; regulatory enzymes and their roles; reversible covalent modification; induction and repression; isoenzymes and their roles in vivo; experimental measures of enzyme activity, separation methods in enzyme assays.

Module III

Three dimensional structures of proteins: 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 ligand binding.

Protein targeting and degradation: signal hypothesis; glycosylation of proteins at the level of endoplasmic reticulum and golgi complex; Post-translational modification of proteins, protein transport to lysosomes, mitochondria, peroxisomes and nucleus; eukaryotic protein transport across membranes; protein import by receptor-mediated endocytosis; protein degradation.

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Module IV

Synthesis of biomolecules: synthesis of amino acid from α-ketoglutarate , phosphoglycerate , oxaloacetate and pyruvate; cytoplasmic de novo synthesis of palmitate, microsomal desaturation and elongation of fatty acids; synthesis of arachidonate, prostaglandins, leukokotrienes, sphinglolipids, phosphoglycerides, cholesterol; synthesis of heme, informational molecules (acetyl-choline, catecholamines, GABA, serotonin, histamine).

Integrated metabolism: metabolism of biomolecules; integration of carbohydrate, protein and fat metabolism, TCA cycle: cataplerosis & anaplerois; vitamins as coenzymes in metabolic reactions.

Hormones in metabolic regulation: Tissue specefic metaboliom: division of labor, hypophyseal, pancreatic, thyroidal, adrenal and parathyroidal hormones in carbohydrate, protein, lipid and mineral metabolisms, Leptin system: body mass regulation.

Unit 02: Molecular Biology F.M. 25, 02 Credits

Module I

Chromosome structure and organization: structure and function of chromosome, story of DNA double helix, Geometry of DNA – double helical structure of DNA, B, A, and Z forms of DNA, hyperchromatism and hypochromatism, concept of euchromatin and heterochromatin, chromosomal rearrangement in health and diseases.

Module II

DNA synthesis, processing and repair: DNA polymerases, unwinding proteins, prokaryotic and eukaryotic replications, reverse transcription, dna repair excision, reversal, recombination and sos repairs eukaryotic genomic organization – C value paradox, repetitive sequences, tandem-gene cluster, gene amplification, coding and noncoding sequences, oncogenes.

Classical Genetics: Mendelian principles: dominance, segregation, independent assortment; allele, multiple alleles, pseudo-allele, complementation tests; extension of Mendelian principles- codominance, incomplete dominance, pleiotropy, genomic imprinting, linkage, crossing over, recombination-homologous non-homologous, linkage maps, tetrad analysis, pedigree analysis, genetic disorders, structural and numerical alterations of chromosomes. Karyotyping.

Module III

RNA synthesis and their processing: RNA polymerases, eukaryotic and prokaryotic transcription, organization of transcriptional units, induction, repression and attenuation; exons, introns, post transcriptional

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modification (RNA processing) – cleavage and splicing, RNA editing, capping, polyanenylation, regulation of gene expression in prokaryotic and eukaryotic system.

Module IV:

Genetic code, protein synthesis and their processing: genetic code, codon and anticodon interactions, translation in eukaryotic and prokaryotic organisms, glycosylation of protein, signal hypothesis and membrane trigger hypothesis, post translational modifications, amino acid sequencing in proteins.

Mutations: chromosomal aberrations, gene mutations, inborn errors of metabolism. types, mutant types-lethal, conditional, biochemical, gain of function, loss of function, germinal versus somatic mutants.

Paper: PHY-102

Unit 03: Biophysical Principles in Physiology: F.M. 25, 02 Credits

Module I

Introduction to biophysics: historical overview, connections with physics, biology and medicine.
Viscosity of liquids and gases: use of viscometry, viscoelasticity, laminar and turbulent flow, the Reynolds' number, models for flows of liquids: Bernoulli and Poiseuille's equations and their applications.
Dynamics of the cardiovascular system: fluid mechanics - blood flow, blood pressure, hydraulic system and 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, heart sounds, mechanical power of heart.

Module II

Mechanics in breathing: elastic properties of lung and chest wall, static, dynamic and total lung compliance, Physical basis of lung compliance, physics of alveoli, surface tension, airway resistance, pulmonary vascular resistance, work of breathing, Dalton and Henry's laws of partial pressures in gas mixtures, gas exchange: Fick's law of diffusion, ventilation, perfusion.
Production of speech: phonation (types, mechanism and physiology).
Physics of vision: light and field of view, illumination of retina, eyes as an optical instrument, reduced eye, Critical fusion frequency (CFF)

Module III

Thermodynamics: laws of thermodynamics and living organism, enthalpy, entropy, efficiency and free energy in thermodynamic system, concept of energy in biological system in the light of thermodynamics, living body as a thermodynamics system

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Light and Associated Phenomena: ultraviolet light on living system, photoreactivation, light and application in therapy, biological light (bioluminescence), light interaction with biological materials, light and pigmentary response.

Effects of electromagnetic field, microwaves and gravitational fields on living systems: source and victims to exposures, penetration and propagation within the biological target organ.

Module IV

Fundamental physics of ultrasonic waves: propagation equation, reflection and refraction at surfaces: diffraction, absorption and attenuation mechanisms, beam patterns of a transducer, piezoelectricity, ferroelectricity and magnetostriction, emission and reception of ultrasounds, ultrasound therapy, physiological effects of ultrasound therapy.

Methods in biophysical analysis: single neuron recording, brain activity recording, lesion and stimulation of brain, pharmacological testing, spectrophotometry, circular dichroism, optical rotary dispersion, fluorescence spectroscopy, Raman spectroscopy, X-ray diffraction.

Unit 04: Biomedical Instrumentation F.M. 25, 02 Credits

Module I

Bioelectric electrodes: ECG, EEG, EMG, microelectrodes.

Biomedical recorders: ECG, EEG, EMG, cardiac pacemaker, defibrillators.

Blood flow meters: Electromagnetic, Ultrasonic, NMR, Laser Doppler.

Module II

Pulmonary function analyzers: spirometry, respiratory gas analyzers, blood pH, blood pCO_2, blood pO_2 analyzer.

Microscopy in biology and medicine: visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy phase-Contrast microscopy; fluorescence, ultraviolet microscope.

Module III

Ultrasonic imaging system: Echocardiogram, A, B, M scans and real-time B scanner. PET, MRI, fMRI, CAT.

Biomedical telemetry: Wireless telemetry, single and multi-channel telemetry, transmission of physiological signal over telephone lines.

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Detection of radiation: detection and measurement of different types of radioisotopes normally used in biology; ionization chamber, G.M. counter, proportional counter, liquid scintillation counter, molecular imaging of radioactive material, safety guidelines.

Module IV

Audiometers: basic audiometer, Speech audiometers.
Haemodialysis Machine: dialyzers, artificial kidney.
Physiological transducers: body temperature, pulse sensors, respiration sensors.
Basic idea about physiotherapy and electrotherapy instruments: brief description of generation, circuit diagrams and testing. demonstration of electrotherapy instruments, principles of their functioning, usage, and safety implications for human beings.

Paper: PHY-103

Unit 05: Biostatistics and Research Methodologies F.M. 25, 02 Credits

Module I

Aims and scope of statistics, classification of variables, population and samples.

Frequency distribution and descriptive statistics: computation of a continuous frequency distribution and of the mean, median, percentiles, quartiles, quartile deviation, variance, coefficient of variation, absolute and relative measures of dispersion.

Sampling Statistics: standard errors, sampling distributions, degrees of freedom, probability distribution: normal, binomial, and Poisson distributions.

Module II

Testing of hypothesis: null hypothesis, levels of significance, errors of inference, one- tail and two-tail tests. **Correlation** - product moment correlation, partial correlation, multiple correlations, Regression - simple and multiple linear regressions.

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

Module III

Nonparametric statistics: Chi square tests, application of chi square in testing the normality of a distribution, G test.

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Kendal's rank correlation coefficient, Wilcoxon's signed rank test, Wilcoxons's composite rank test, Median test, Mann-Whitney U test.

Module IV

Analysis of variance: types of anova, models of anova; multiple comparison test - t test, Scheffe's F test, Gabriel's SS-STP; Kruskal-Wallis non-parametric anova and multiple-comparison 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 06: Computer Application in Biology and Bioinformatics F.M. 25, 02 Credits

Module I

History and classification of computer: importance of computer application in biological sciences, brief history of development of computer, computer generations, classification of computer – analogue, digital, hybrid, micro, mini, mainframe and super computers.

C**omputer hardware**: basic components of computer – CPU, peripheral devices, computer memory, and computer buses.

Software – types of software- monitor program and operating system, utility program, application program, language processor, computer languages- machine language, assembly language, high-level languages.

Module II

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.

Principle of programming in BASIC or C: simple programs for solving biological problems and statistical analysis of biological data.

Module III

Simulation and modeling 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

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biological items. Basic concept of email, Internet- components of Internet, www, searching biological information from Internet, library-searching technique, LAN.

Module IV

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, 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: PHY-104

Unit 07: Physiology of Excitable Cells and Higher Functions of Brain

F.M. 25, 02 Credits

Module I

Nerve- muscle physiology: nerve- regeneration of nerves – growth cones, nerve growth factors, axoplasmic flow and molecular mechanism of transport in axon, excitation of nerve fiber.

Skeletal and cardiac muscle: muscle proteins, properties and locations, muscular contraction –interaction of filaments in vitro and in vivo, coupling of mechanical and chemicals events at the cross bridge, muscle energetic, muscle mechanics – mechanical transients, patho-physiology 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.

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

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Neuromuscular transmission: structure, active zone, quantal release – exocytosis, endplate potential, conductance changes, nicotonic Ach receptor, MEPP, molecular basis of Mysthenia gravis and Lambert – Zaton syndrome, Drugs acting in neuromuscular junction

Module II

Spinal cord as a control system: Segmental and intersegmental interactions: myotatic reflex, inverse myotatic reflex, flexor reflex, crossed extensor reflex, propiospinal reflex, feedback regulation of spinal motor functions, role of descending tracts in regulation of muscle tone, posture and spinal reflexes, γ – loop, autogenic inhibition.

Regulatory functions of cerebellum: Cerebellar cortical neural circuitry, feed-back regulation of deep cerebellar nuclei, somatotopical organization of cerebellar cortex, function of vestibular cerebellum. Cerebellar control on muscle tone – α–γ switch, role of cerebellum on voluntary of movements, motor and extra motor predictive functions, cerebellar lesions – deficits in movements.

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

Basal ganglia as a motor control system: Neural circuts and feedback loops of basal ganglia,regulation of muscle tone and movements, control of eye movements,dysfunctions of basal ganglia**.**

Statokinetic control system: Vestibular apparatus, constant angular motion,transduction of vestibular hair cells, gravitational receptors, central processing of vestibular information,vestibuloocular and vestibulospinal reflexes,regulation of posture , nystagmus

Module III

Higher functions of cerebrum: association cortex, habituation and sensitization, conditioning and learning – classical conditioning, conditioning variables, exters – interoceptive conditioning, classical conditioning techniques, instrumental conditioning – operant conditioning, Intracranial self stimulation behavior, discriminations learning, maze learning.

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.

Neural control of sleep – wake cycle, genesis of REM – NREM cycle, sleep – active and passive process, sleep substances. REM sleep – tonic and phasic components, neural and biochemical basis, sleep–awake cycle, sleep disorders

Module IV

Neural basis of circadian rhythm- suprachiasmatic nucleus- cytoarchitecture, electrophysiology, pharmacology, metabolism, Molecular basis of circadian rhythm, alterations in environmental time – Jet lags.

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

Special Environment of central nervous system: CSF as hydraulic shock absorber, mechanism of secretion and absorption of CSF, blood–brain barrier – cellular and muscular basis, neuroglia in the regulation of internal environment of CNS.

Unit 08: Integrated Physiology: Homeostasis F.M. 25, 02 Credits

Module I

The internal environment and homeostasis: Different internal environments, general mechanism of homeostasis.

The control system: physical and physiological control system, components of control system, regulatory mechanism of control system – negative feedback, positive feedback adaptive control system, loop gain and error reduction, stability, sensors – rate and integral. Multiple sensors, set point

The Autonomic control system: Anatomic organization of sympathetic and parasympathetic system, chemical transmission in ganglia and effector organ, metabotropic and ionotropic receptors in autonomic nervous system, the autonomic nervous system in the regulation of internal environment and homeostasis.

Module II

Excretory system: methods of study of tubular functions, tubular transport mechanism and transtubular 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: neural control gastrointestinal functions – bile secretion and cholesterol homeostasis., immune function of GI tract, physiology of gastrointestinal disorders, assessment of gastric, pancreatic and intestinal functions in different patho-physiological conditions.

Module III

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: regulation of blood volume in sudden loss of blood, hemostasis and coagulation of blood, anti-clotting mechanism and anticoagulants, abnormalities of homeostasis, lymph flow, lymphatic pump, interstitial fluid pressure regulation, interstitial fluid dynamics, edema.

Module IV

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Homeostasis in extreme environments: hypobaric and hyperbaric environment, 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, oxygen as toxic molecule, frees 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.

Semester I

Practical

(Total Marks: 100, 08 Credits)

Paper: PHY-105

Unit 09: Biochemical Techniques F.M. 25, 02 Credits

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-Jenson method.
3. Protein estimation by Lowry method UV spectroscopy.
4. Blood calcium and blood lactate estimation.
5. Estimation of total cholesterol content of blood.
6. Estimation of 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 Km.
11. Acid and alkaline phosphatase, bilirubin, free fatty acids, SGOT and SGPT (transaminases) for liver function test

Unit 10: Bio-Analytical Techniques and Microbiological Studies F.M. 25, 02 Credits

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A. Bio-Analytical Techniques

1. Separation and identification of amino acids by paper chromatography
2. Separation and identification of amino acids by thin-layer chromatography
3. Identification of sugars by thin-layer chromatography.
4. Electrophoresis of serum proteins.
5. Separation of protein by polyacrylamide gel electrophoresis (PAGE).
6. 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, determination of microbial dimensions.

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

Paper: PHY-106

Unit 11: Statistical Treatment of Biological Data F.M. 25, 02 Credits

1. Computation and significance of product- moment r between two continuous measurement variables.
2. Computation and significance of Kendall's rank correlation coefficient between two ordinal variables.
3. Computation and significance of partial correlation coefficient between two variables.
4. Computation and significance of multiple correlation coefficient between a continuous measurement variable and two others continuous measurement variables.
5. Computation and significance of point biserial r between a continuous measurement variables and a genuinely dichotomous qualitative variable.
6. Computation and significance of biserial r between a continuous measurement variable and an artificially dichotomized variables.
7. Computation and significance of phi coefficient between two genuinely dichotomous variables
8. Computation and significance of tetrachoric r by cosine pie formula between two artificially dichotomized variables.

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9. Computation and significance of contingency coefficient between two qualitative variables having more two classes.

10. Computation of percentile values from grouped data.

11. Testing the goodness of fit of a continuous frequency distribution with best –fitting normal distribution by Chi square test and G test.

12. Computation and significance of one- way model I analysis of variance and multiple comparison t- test and Scheffe's F test.

13. Computation of Kruskals-Wallis test for one-way anova and multiple comparisons by Mann-Whitney U test.

14. Computation of models I linear regression equation of one variable on another.

Unit 12: Computer Application in Biological Problems F.M. 25, 02 Credits

1. Basic operation of computer – different operations of WINDOWS; data entry, printing of programs and results.

2. Programming with BASIC or C for solving biological problems:

a. Simple programs - computation of sum and mean values of some biological data.

b. Arrangement of biological data – ascending order, descending order, highest value, lowest value.

c. Tabulation of biological data.

d. Evaluation of nutritional status- computation of calorie, BMI, BSA; Study of growth rate.

e. Computation of frequency and percentage distribution of different Physiological parameters in different age groups, in different communities, percentage distribution of blood groups.

f. Statistical analysis of biological data – Mean, SD, SE, t-test, correlation coefficient, percentile values etc.

g. 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.

h. Operation of word processor – text presentation, editing, formatting and printing.

i. Making table with MSWord.

j. Operation of Ms Power point – making slide for any biological topic, editing, slide show.

k. Bioinformatics - study of structure of biomolecules – primary and secondary structure, tools for sequence analysis

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Semester II: (Theory: 150 + Practical: 150)

Theory

(Total Marks: 150, 12 Credits)

Paper: PHY-201

Unit 13: Community Health: Health, Disease and Nutrition F.M. 25, 02 Credits

Module 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, diarrhoeal 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/girl child/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 organisations: national health policy, role of WHO, UNICEF, UNDP, FAO, UNESCO, ILO, WORLD BANK, Red Cross, CARE, national health programmes, alternate health care planning.

Module 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.

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Module III:

Nutrients, gene and health: different food groups and nutrients, dietary fibres, food additives and artificial sweeteners, food processing, food toxicity and safety**,** classes of nutraceuticals, nutraceuticals to age, sex, physiological status (pregnancy), dietary supplements, probiotics and prebiotics, functional foods and its prospects; transgenic foods and its importance; drug-nutrient interaction, nutritional epigenomics, nutrient sensing - role of sensing transcription factors and dietary signaling routes, genomics and transcriptomics.

Nutrition in infancy, childhood and adolescence: nutritional requirement in adults, nutritional requirements of nutrients during infancy, breast feeding – nutritional and others factors, advantages, breast feeding and human immunodeficiency virus transmission, infant milk substitute (IMS) act 1992, formula feeding, vitamin and mineral supplementation – vitamin D, iron, fluoride, supplementary foods of milk, cow's milk, goat's milk, vegetarian beverages, fruit juice, nursing caves; solid supplements wearing, nutritional requirement of pre- term babies; feeding problems – food allergies, cow's milk protein allergy, lactose intolerance, diarrhea, constipations vegetarianism, nutritional requirement of pre-school and school children, monitoring growth and development, nutrition related problems of children- childhood obesity, dental caries, allergies, deficiency of Vitamin A- aetiology, symptoms, prevention; nutritional requirement and problem of adolescents- anorexia nervosa, bubnia nervosa, binge eating disorder, premenstrual syndrome.

Nutrition in pregnancy & lactation: physiological changes during pregnancy, maternal factors effecting pregnancy outcome: maternal age, pre-pregnant weight, weight gain during pregnancy, life style factors. Birth weight standards, nutritional requirements during pregnancy, problems in pregnancy- morning sickness, nausea and vomiting, constipation, oedema and leg cramps, heart burn, excessive weight gain. Physiology of lactation, nutritional requirements, factors affecting the volume and concentration of breast milk.

Module IV

Nutrition related disorders: overweight and obesity- prevalence, factors – environmental and life style factor, food intake, genetic factors- Prader Willi's syndrome, adipocyte factors- leptin, adiponectin, adipose drug targets for obesity treatment, obesity management- drugs, VLCDs, bariatric surgery; underweight – aetiology and management.

Protein energy malnutrition (PEM)- symptoms, nutritional requirement in dietary management.

Nutritional anemia: prevalence, iron metabolism, iron absorption enhancers and inhibitors, clinical features and management of iron deficiency anemia, megaloblastic anemia.

Cardiovascular disorders: coronary heart disease (CHD) - food and nutrients in CHD, cardiovascular risk factors and nutritional management of CHD, hypertension: diet and blood pressure**.**

Diabetes mellitus: dietary management of diabetes mellitus – nutritional requirements, glycaemic index, complication of diabetes – hypoglycaemia and insulin shock, ketoacidosis.

Geriatric nutrition: process of aging, changes in organ function with aging, nutritional requirement, nutrition related problems in old age- osteoporosis, anemia, obesity, constipation, malnutrition; antioxidants in the health of old age.

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Nutrition promotion in community: causes and consequences of malnutrition in India, community based intervention programmes – mid-day meal for school children, special nutrition programme (SNP), integrated child development services (ICDS), national nutritional anaemia control programmes, vitamin A prophylaxis programme, national iodine deficiency disorder control programme, public distribution system, targeted public distribution.

Unit 14: Community Health: Environmental Pollution, Toxicology and Management

F.M. 25, 02 Credits

Module I

Man and environment: concept and types of environment, biotic environment; biotic and abiotic interactions. Ecosystem – structure, function and types, food chains, food webs and energy flow and mineral cycling in ecosystems; primary production and decomposition; biogeochemical cycle.

Pollutants, environmental change and health: major pollutants and their effects, The changing environment-global climate change, global warming and its consequences, the changing disease pattern, different environmental diseases-cancer, birth defects, reproductive damage, respiratory diseases, heavy metal induced diseases etc.

Air Pollution: air pollutants - sulfuroxides, nitrogenoxides, carbonmonoxide, particulatematter, volatile carbon compounds (PAH etc.)- their effects, their control and prevention. Air quality criteria and standards.

Module II

Water pollution: different sources of water pollution. Metallic pollutants- mercury, lead, cadmium, arsenic and fluoride toxicity. Chelating agents and their characteristics, 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 organochlorine, organophosphate, carbamate, nicotinoid, pyrethroid pesticides and other biocides, pesticide residues in food and drinking water and their biological monitoring.

Biotechnology and environment: role of biotechnology in pollution control, biotechnology in forestry and wasteland Development.

Module III

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Environmental toxicology I: toxicokinetics and toxicodynamics – toxic kinetic factors as basic mechanisms of toxicity, toxic dynamic factors as basic mechanism of toxicity, design of toxicity study, biotransformation and bioactivation / bioinactivation of xenobiotics, Factor affecting xenobiotic action.

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

Module 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; Major drivers of biodiversity change; biodiversity management approaches. Principles of conservation; major appraoaches towards conservation; Indian case studies on conservation.

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

Waste disposal: human excreta disposal; solid waste disposal-hazards & protection; hospital and biomedical wastes – hazards & protection, recycling of wastes, radioactive waste, electronic waste & techno trash hazards and protection.

Paper: PHY-202

Unit 15: Community Health: Exercise Physiology and Mass Fitness F.M. 25, 02 Credits

Module 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: energy production and transfer during exercise, energy metabolism during exercise.

Physical training – general principle, strength and endurance training, different methods of physical training.

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Module II

Nutrition and weight control: body weight and health, physiology of weight gain and loss, obesity and exercise, methods of weight control, long-term concept of weight control.

Exercise and aging: aging and muscular strength, aging and joint flexibility, aging and physical work capacity, aging and exercise training, free radical in exercise and training.

Module 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.

Module IV

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.

Age and sex differences in sports performance: age related variation of physical and physiological parameters, exercise in children and adolescents.

Exercise for the disabled- physically and mentally challenged. Yogic exercise and fitness: physiology of yogic exercise, therapeutic use of yoga.

Unit 16: Community Health: Ergonomics and Occupational Health F.M. 25, 02 Credits

Module I

Ergonomics - definition, early history, aim and application in different fields. Social significance of ergonomics. Fitting the job to the person and the person to the job, Human characteristics, capabilities and limitations.

Physiological factors in ergonomics: physiological variation during work, fitness, health, work load 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.

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Module II

Anthropometry: 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.

Body composition: different methods of assessing body composition, body composition and performance.

Manual material handling – health problems, risk factors, guidelines of material handling.

Module III

Occupational Health – definition, factors affecting occupational health, occupational health hazards in work place – mechanical , chemical, biological, fire, toxic substances, and explosive materials, environmental hazards – heat stress, cold stress, noise, vibration, ultra-violet radiation.

Occupational safety and health – concept of health and safety; accidents – theories of accident, effect on industry; method of assessment of accidents, promotion of safety, health and safety training , personal protective devices.

Module IV

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

Repetitive motion injury: causes, and prevention.

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

Occupational stress – causes, evaluation of stress, management of stress.

Paper: PHY- 204 (Elective)

Unit 01: Lifestyle and Health F.M. 25, 02 Credits

Module I

Concept of health and disease: definition of health (WHO), dimension and determinants of health, physical health, mental health, psycho-social health.
Disease - definition, causal factors.
Concept of lifestyle: definition, components of lifestyle, factors influencing, importance of lifestyle on health, lifestyle and environment.

Module II

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Nutrition and health: concept of food, nutrition, nutrients, diet, nutrition as a lifestyle factor; concept of malnutrition and deficiency disorders.

Health concepts of physical education: Concept of physical education, need and importance of physical education, physical activity and health benefits, types of physical activity, recreational physical activity and its importance, physical fitness components, activities for developing physical fitness components, types and components of fitness, cosmetic fitness, physiological effects of exercise; role of physical education programme on community health promotion.

Module III

Lifestyle and diseases: general concept, concept of risk, risk factors, risk groups; lifestyle components related to development of diseases and underlying mechanisms; socio-cultural events - lifestyle and diseases.

Non-communicable diseases: definition, its relation to lifestyle, risk factors, mortality, impact on community health, common non-communicable diseases – Coronary Heart Disease (CHD), cancer, diabetes mellitus, obesity, hypertension, osteoporosis, backpain, hypokinetic diseases.

Drug: abuse and addiction.

Module IV

Communicable diseases: definition, mortality, causative agents, transmission vehicles, transmission modes, its relation with lifestyle; concept of infection and infectious agents; virulence & virulence factors; concept of vectors - common vector borne diseases; sexually transmitted diseases; lifestyle, personal hygiene and communicable diseases; antibiotics and drug resistance.

Food toxicity - general concept, common causes, food handling.

Some common communicable diseases in India: diarrhoea, AIDS, malaria, kala-azar, influenza, hepatitis, tuberculosis, typhoid, skin infections.

Unit 02: Lifestyle Management and Health Promotion F.M. 25, 02 Credits

Module I

Safety education in health promotion: health and safety in daily life, health and safety at work, common injuries and their management, principles of accident prevention, first aid and emergency care. Personal safety.

Module II

Physical fitness and health promotion: activities for developing components of physical fitness, cardio-piratory endurance, muscular strength and endurance, body composition and weight control; assessment of

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physical fitness: body mass index and skin fold measurement, body types and posture, BMR, pulse rate, blood pressure, anthropometry, assessment of fitness.

Sports, lifestyle and recreation: yoga, meditation and relaxation, sports and mechanics, sports and socialization, yoga and stress management. Exercise prescription during pregnancy.

Module III

Nutritional management in health promotion: concept of balanced diet, meal, meal planning, energy intake, therapeutic diet; food fortification, nutritional policies for mass health promotion.

Occupational health hazards and lifestyle management, postural modification and health promotion.

Module IV

Lifestyle modification and management of non-communicable and communicable diseases like coronary heart disease, obesity, hypertension, cancer, diarrhea, malaria, tuberculosis, AIDS.

Occupational health hazards and lifestyle management, postural modification and health promotion.

Semester II

Practical

(Total Marks: 150, 12 Credits)

Paper: PHY-203

Unit 17: Anthropometry and Community Health Survey F.M. 25, 02 Credits

Anthropometric measurements:

1. Body weight.
2. **Measurement of height** – stature, eye height, sub-nasal height, gnathion height, suprasternal height, porion height , acromion height , naval height, iliac crest height, knee height, ankle height, infrascapular height, elbow height.
3. **Measurement of diameter** – biacromion diameter, bicristal diameter, transverse diameter of the chest, antero-poterior diameter of the chest, hip breadth.
4. **Measurement of girth**- neck, upper arm, forearm, chest, waist, hip, thigh, calf, upper body, lower body.

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5. **Measurement of sitting height**- vertex height, eye height, shoulder height, stomion height, elbow rest height, popliteal height, knee height, thigh clearance height.
6. **Measurement of head** – head length, head breadth, head circumference.
7. **Measurement of hand**- hand length, hand breadth, maximum hand breadth, fist girth.
8. **Measurement of foot**- foot length, foot breadth, ankle diameter.

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.

Unit 18: Human Experiments F.M. 25, 02 Credits

1. Determination of diurnal variations of pulse rate, blood pressure, respiratory rate.
2. Study of pulse rate and breathing rate with the change of postures.
3. Study of blood pressure with the change of postures.
4. Study of pulse rate as an effect of breath-holding.
5. Study of pulse rate with the variation of static work load.
6. Study of blood pressure with the variation of static work load.
7. Study of pulse rate as an effect of dynamic exercise.
8. Study of blood pressure as an effect of dynamic exercise.

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9. Determination of Galvanic skin response (GSR)
10. Determination of visual acuity.
11. Determination of visual field by the perimeter.
12. Brightness discrimination test.

Paper: PHY-205

Unit 19: Growth Monitoring and Nutritional Assessment F.M. 25, 02 Credits

1. Assessment of nutritional status of infant (birth to 36 month) from the standard growth curve and determination of 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, and weight for age curves.
3. Assessment of nutritional status from MUAC, head circumference, skin fold (triceps and sub scapular) in infancy, pre–school and school children.
4. Determination of outset of puberty from the velocity growth curve of stature of school children.
5. Assessment of nutritional status of boys and girls from the standard body mass index-for age curves.
6. Determination of grades of malnutrition of children by Gomez classification and waterloos classification.
7. Determination of grades of malnutrition by percentile value and Z – score of height, weight of children using standard data.
8. Assessment of nutritional status from height–vs–weight of adult male and female.
9. Assessment of nutritional status of adult male and female from triceps and sub scapular skin folds.
10. Assessment of nutritional status from measurement of food intake by 24 – hour recall method and food frequency questionnaire method.
11. Assessment of nutritional status from anthropometric measures and anthropometric indices such as BMI, Body surface area, ponderal index, Dugdel nutritional index, Waist- Hip ratio, obesity index.

Unit 20: Assessment of Environmental Status F.M. 25, 02 Credits

A. 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.

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B. Measurement of' chemical environment

a. Estimation of total hardness of water. .

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

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

d. Estimation of silica in water sample.

e. Measurement of BOD and COD in water sample.

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

C. Effect of pollutants /toxicants on biological systems

a. Determination of LD_{50}

b. Determination of parameters of oxidative stress – Malon-di-aldehyde, GSH, GSSG, Catalase, Peroxidase, Superoxide dismutase.

Paper: PHY-206

Unit 21: Studies with Cardiac Muscle F.M. 25, 02 Credits

1. Perfusion of amphibian heart with Ringer solution, Studies on the heart rate and amplitude of contraction a) in normal Ringer solution b) in Ca^{++} free Ringer solution, c) in K^{++} free ringer solution.
2. Effect of gradient pressure on the perfused heart of amphibian.
3. 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.

Unit 22: Studies with Skeletal & Smooth Muscle and Bioassay F.M. 25, 02 Credits

1. Preparation of physiological solutions like Dale, Locke, Normal saline etc.

2. Experiments on isolated skeletal muscle (Isometric contraction):

a) Effect of load, temperature b) summation and tetanus e) Effect of Acetylcholine

3. Experiments on isolated intestine of rat:

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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 through bioassay.

6. Estimation of nature and potency of unknown drug by using reference standard and blocker.

7. Bioassay of catecholamines

8. Estimation of the potency of the unknown sample (Oxytocin) on rat uterus muscle by using reference standard.

Semester III: (Theory: 200 + Practical: 100)

Theory

(Total Marks: 200, 16 Credits)

Paper: PHY-301

Unit 23: Electrophysiology and Sensory System F.M. 25, 02 Credits

Module I

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.

Module II

Brain potentials, electroencephalogram (EEG), source and mechanism of formation of rhythmic pattern of EEG, characteristics of EEG waves. EEG pattern changes in sleep, abnormalities of EEG. Event related potential (evoked potential)- types, characteristics and significance.

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.

Module III

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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 primated spatio-temporal organization of retinal and other visual neurons; chromatic properties of retinal, LGB and striatal cortical neurons; binocular and stereoscopic perception.

Module IV

The auditory system: ultra structure of cochlea, organ of corti, central auditory pathway, descending auditory pathway, the primary and secondary auditory cortical areas, resting and stimulus related potentials – endocochlear potential, cochlear microphone potential, summating potential, auditory nerve potential sound transmission in auditory system; functions of auditory system – frequency analysis of sound by cochlea and central auditory pathway, intensity coding of auditory system, perception of sound in space.
The olfactory system: structure of olfactory receptor; olfactory receptor potential – characteristics and molecular mechanism of transduction, elctro-olfactogram, olfactory pathways – olfactory bulb, central olfactory connections; coding of olfactory informations, anosmia and dysosmia.

Unit 24: Systems Physiology F.M. 25, 02 Credits

Module 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.

The cardiovascular control system – spinal cord, medulla, hypothalamus and cerebral cortical areas in the cardiovascular regulation, cardiovascular reflexes baroreceptor, cardiac stretch receptors – ventricular stretch receptors, chemoreceptors.

Module II

Cardiac physiology: evolution of heart in relation to the development of other systems; regulation of cardiac function; cardiac output – regulation in normal and abnormal conditions, importance of arterial pressure and systemic filling pressure, left ventricular versus right ventricular output, cardiac output curve, venous return curve, ; cardiac failure – causes, unilateral and bilateral, acute and chronic, circulation dynamics in cardiac failure, cardiac reserve, mechanics of cardiac valves.

Module III

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Circulatory system: a) the microcirculation – functional; properties of capillaries, transcapillary exchange, capillary filtration flow- and diffusion-limited transport from capillaries; vasoactive role of the capillary endothelium; c) the peripheral circulation and its control - vascular smooth muscle, basal vessel tone and myogenic regulation. d) extrinsic control of peripheral blood flow – sympathetic vasoconstrictor nerves on resistance and capacitance vessels vasodilator nerves, humoral factors – metabolic, hormonal, vasoactive substance; e) regional circulation: cerebral, coronary circulation in health and disease; regulation of circulation in special situation: hemorrhage, exercise.

Module IV

Respiratory system: a) cells of airways and alveoli – ciliated cells, cells for mucous production, alveolar cells, surfactant; c) control of respiration – respiratory centers, origin of respiratory rhythm, central and peripheral chemoreceptors, chemical control of breathing, breath holding; d) 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; e) respiration in neonates and children- the lung before birth, events at birth, neonatal lung function, development lung function in childhood; f) some respiratory problems-pulmonary oedema-aetiology and mechanism of pulmonary oedema, pulmonary collapse and atelectosis, pulmonary embolism, respiratory distress syndrome, sudden infant death.

Paper: PHY-302

Unit 25: Microbes-Human Interaction F.M. 25, 02 Credits

Module I

Historical developments in microbiology: brief history of infectious diseases, developments preceding the germ theory, the germ theory of disease, chemotherapy, molecular biology and immunization.

Classification of micro organisms: the cell types, classification of micro organisms, major groups of micro organisms, anatomy and physiology of major groups of micro organisms: fungi, algae, bacteria, virus, protozoa.

Module II

Growth and nutritional requirements of bacteria: growth curve, environmental influences on growth, nutritional requirements of bacteria, 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.

Module III

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Scopes of microbiology: microbes in the environment: soil and aquatic microbes, micro organisms in dairy products, micro organisms in food, industrial uses of microbial by-products, micro organisms as biological tools.

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

Module 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.

Unit 26: Human Immune System F.M. 25, 02 Credits

Module I

Cells and organs of immune system: historical background of immunology, elements of immunity – innate, acquired; interrelation between innate and adaptive immunity; organization of lymphoid organs, immunogens and antigens.

Module II

Humoral and cell mediate immunity: immunoglobulin structure, classes of immunoglobulin: iga, igg, igd, igm, ig, biological properties of immunoglobulin; triggering of the immune response, humoral immunity, adaptive immunity; cell cooperation for triggering T and B cells; iImmunosupression, complement system – alternate, classical and lectin pathways.

Module III

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

Module IV

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

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Paper: PHY-303
(Special Papers)

Special Paper A: Microbiology and Immunology

Unit 27: Advanced Studies in Microbiology F.M. 25, 02 Credits

Module 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, biodegradation of petroleum and xenobiotics, microbial interaction in nature: biofilm, bioremediation.

Module 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.

Module III

Microbial metabolism: metabolic diversity - anoxygenic and oxygenic photosynthesis, chemolithotrophy, hydrogen and sulphate reduction, fermentations, fermentative diversity, hexose, pentose, polysaccharide and lipid utilization, hydrocarbon transformation.

Autotrophic-CO_2 fixation: the calvin cycle, reverse citric acid and hydroxy - propionate cycle, the C3 and C4 cycles.

Module IV

Nitrogen fixation: nitrogen fixing bacteria, the nitrogenase system, genetics and regulation of nitrogen fixation.

Unit 28: Cellular and Molecular Immunology F.M. 25, 02 Credits

Module I

B-cell and T-cell structure and function: structure of B cell, B-cell-co receptor complex, B cell development, maturation and activation/ signal transduction, immunoglobin superfamily, T-cell structure, coreceptor-CD3,

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accessory membrane molecules-CD4 & CD8, T-cell development and maturation, immunological synapse, T-cell activation / signal transduction, the co-stimulatory signals.

Module II

Antigen processing – presentation and MHC molecule – cytosolic and endocytic pathway, structure and function of class I and II molecules, polymorphism, HLA typing.

Module III

Immunological tolerance and apoptosis (programmed cell death): immunological basis of graft rejection, immunosuppressive therapy, T cell anergy, apoptosis- overview, death receptors, role of mitochondria, caspase and Bcl-2 protein families, apoptosis and Alzheimer's disease.

Module IV

Antibody diversity and cytokines in immune regulation – genetic rearrangement, generation of antibody diversity, class switching, Cytokine and cytokine receptor families, mechanism of cell activation, monokines, lymphokines, chemokines, interleukins, cytokine-agonists, and cytokine related diseases.

Special Paper B: Ergonomics and Sports Physiology F.M. 25, 02 Credits

Unit 27: General Sports Physiology

Module I

Historical development of sports science- International and Indian context, role of neuromuscular system in exercise, mechanics of muscle contraction, relationship of different types of 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.

Module II

Maximal aerobic capacity - direct and indirect methods of measurements, measurement of VO_2 in children, measurement of VO_2 max during pregnancy; Cardio-respiratory changes during sports performance as well as during static and dynamic work.

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

Fatigue - physical and mental, measurements of fatigue, short term and long term fatigue.

Module 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 3endurence sports, diets for different sports events, pre-game meal, spacing of meals.

Module IV

Endocrine system and exercise: importance of hormones in exercise and sports, endocrine effects on performance, pituitary- adrenocortical 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.

Immunological system and exercise: exercise and innate and humoral immunity, exercise induced change in Ig 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 28: Applied Sports Physiology F.M. 25, 02 Credits

Module 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 and anaerobic training, adaptation to aerobic and anaerobic training, resistance training, strength, stability training, and high-intensity interval training (HIT), strength training, farklet training, periodization of conditioning program, over training.

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

Module II

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Ergogenic aids in sports (doping): methods of study, tolerance limits, types of doping, problems of doping, IOC guidelines.

Sports injury and treatment: general causes, sports specific injuries, methods of treatments, protective equipments.

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

Module III

Exercise for the disabled: sports for disabled persons, importance, selection of event, method of training.

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 different physiological systems, therapeutic application of yoga , limitations of yoga.

Module 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.

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.

Image analysis in sports performance: errors in motion analysis, planar video analysis, 3D motion analysis, data filtering.

Special Paper C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

Unit 27: Advanced Studies in Biochemistry F.M. 25, 02 Credits

Module-I

Biomembrane and Cell Biology: The molecular assembly and organization of biomembranes; Lipid-protein and protein-protein interactions; Role of cholesterol and fatty acid composition in membrane fluidity. Supramolecular membrane structure. Membrane permeability. Metabolite transport in normal and cancer cells. Membrane transport; Structure-function interplay of some typical membrane receptors like ASGP-R, LDL,

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Ferritin etc. Membrane biology of receptor-mediated endocytosis; clathrin-independent and -dependent endocytosis.Membrane asymmetry and its implications in health and disease.

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- Characteristics of each phase; Restriction point of cell cycle and Quiescent cells; CDK complexes in the transition of various check point of cell cycle; Role of ubiquitin-protein ligase –SCF and APC/C in the control of cell cycle. Cell differentiation and transformation. Cell and tissue culture-concepts and techniques; Clone and hybridization of mammalian cells and its application. Apoptosis and its mechanism.

Module-II

Biomolecules and Metabolic Biochemistry: Conformation and significance of glycoprotein and peptidoglycans; polysaccharide chemistry. Different levels of protein conformation; Super-secondary structure-Domains and motifs; Protein folding-assisted protein folding (Chaperones); Misfolding and diseases; Determination of amino acid sequences in proteins; structural and functional study of myoglobin and haemoglobin. 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; Micro-RNA;DNA-RNA hybrids.

Molecular concept of bioenergetics. Energetics of metabolic cycles. Regulation of Glycogen metabolism; Glycoprotein biosynthesis. Regulation of fatty acid and cholesterol biosynthesis; Metabolism of lipoproteins; Formation of prostaglandins, prostacyclins and thromboxanes. Regulation of purine and pyrimidine biosynthesis. Integration of different metabolic pathways. Metabolic regulation under different stressful conditions. Photosynthetic apparatus andpigments, Photosystems I and II; Hill reaction, Photosynthetic electron transport chain, and photophosphorylation; C3 and C4 pathway of carbon reduction and its regulation; Photorespiration. Biochemistry of biological nitrogen fixation-Nitrate assimilation and nitrogen fixation; Thenitrogenase complex; Regulation of nitrogen fixation – influence of ATP/ADP ratio; Identification and repression of *nif* genes.

Module-III

Enzymology, Advanced Nutritional and Clinical biochemistry: Methods for isolation, purification and characterization of enzymes. Acid-base catalysis, covalent catalysis. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, DNA polymerase, aspartic proteases. Reversible covalent modification of 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 B_{12} in enzyme catalyzed reactions.

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Molecular mechanism of vitamins, trace elements and minerals. Sucrose consumption and intolerance; lactose intolerance; Special role of the non-starch polysaccharides. Nutritive value of proteins and the methods for 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 the nutrition- Protein energy malnutrition, Starvation, Obesity .Food borne diseases and their prevention, Porphyrins and Gout, Obesity, Diabetes Mellitus, and Atherosclerosis, 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 alkaline phosphatase, Serum lactate dehydrogenase, Serum alpha hydroxybutyrate dehydrogenase, Serum creatine phosphokinase, serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, serum and erythrocyte cholinesterases, Serum isocitrate dehydrogenase, serum amylase, serum aldolase, serum glucose-6-phosphate dehydrogenase.

Module-IV

Analytical Biochemistry: Buffers and buffering mechanism; Dissociation of amino acids and 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); Morphogenesis- 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.

Cultivation of stem cells; Adult stem cells; Cancer stem cells; Stem cell markers; Applications of stem cells. Carcinogenesis mechanism; Characteristics of cancerous cells; Genetics of cancer - Mutation and cancer; Viral and cellular oncogenes; Activation of oncogenes and dominant negative effect; Molecular nature of oncogenes; Oncogenes as transcriptional activators. Tumor suppressor genes from humans; 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. Immunodiagnostics (methods). Different Therapeutic approaches to cancer.

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Unit 28: Molecular Endocrinology and Reproductive Physiology F.M. 25, 02 Credits

Module-I

Genetic control of hormone formation and Hormone Receptor: Basic steps in the expression of a protein hormone encoding gene signal hypothesis, cellular processing of prohormones, regulation of gene expression 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: Bioassay in general, immunoassay – different types, 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 endocrine function, role of prostatic biomolecules on different physiological systems.

Module-II

Molecular basis of Endocrinopathy: Immune-endocrine system- Recent development of the interaction of immuno 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 including germ cell apoptosis, lymphoid apoptosis. Molecular endocrine tumor biology, multiple endocrine neoplasia, molecular pathogenesis in pancreatic and gut endocrine tumors, endocrine-responsive cancer, 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, arometase 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 paracrinc regulation, first and second meiotic arrest and its withdrawal mechanism for oocyte development, leuteinization and leuteolysis.

Autocrine, paracrine and endocrine regulation of gonadal steroidogenesis, regulation of expression of genes encoding steroidogenic enzymes

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

Module-IV

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

Reproductive Immunology: in male and in 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), intra-cytoplasmic sperm injection (ICSI), in vitro fertilization (IVF), super ovulation technique, subzonal insemination, gamete intra-fallopian transfer (GIFT), Oocyte and embryo culture, oocyte and pre-embryo classification, micro manipulation of human gametes, zygote and embryo.

Special Paper D: Neurophysiology

Unit 27: Physiology of Neuron and Evolution of Brain F.M. 25, 02 Credits

Module 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.

Module 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.

Module 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

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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.

Module IV

Ionotropic and metabotropic receptors: ionotropic receptors- nicotinic acetylcholine receptor, GABAreceptor, 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 28: Development of Brain and Molecular Neurobiology F.M. 25, 02 Credits

Module 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.

Module 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.

Module 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.

Module IV

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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.

Special Paper E: Biophysics and Electrophysiology with Structural Biology

Unit 27: Biophysical Principles and Advanced Methods in Biology F.M. 25, 02 Credits

Module I

Physical laws and its advanced application in biology- Pouseulli's laws, Bernoulli's principle, Laplace laws, Newton's equation.

Structure & Bonding: Quantum mechanics: Pauli's exclusion principle, ionization energy, electron affinity and chemical binding, electronegativity and strong bonds, secondary bonds. The electronics structure of atoms, Molecular orbital and Covalent bonds. Molecular interaction: strong and weak interactions. Stereochemistry and Chirality.

Quantum biology and its uses: Classical mechanics, Newton, Lagrange and Hamilton's equations, Schrodinger's equation and its complete solution for S.H.O, central force and angular momentum.

Module II

Advance Thermodynamics: Basics of Thermodynamics: Laws of thermodynamics and living organisms, Entropy, Enthalpy, Efficiency and free energy of system. Carnot cycle, Chemical potential and chemical kinetics – rate, order and molecularity of reactions and energy of activation. Bomb calorimetry, Energy generation & energy transfer processes in biochemical reactions.

Kinetics of Molecules & Reactions: 0th, 1st, 2nd & 3rd order reactions, Diffusion, Osmosis, Osmotic pressure, osmoregulation, surface tension: definition, angle of contact, interfacial tension, capillary rise, determination of surface tension, temperature effect, dialysis, adsorption, viscosity: determination of viscosity coefficient of liquids, diffusion of gases and solute in solution, Fick's law, viscometric measurement, viscometers- Ostwald capillary, Ubbelonde capillary, relation between intrinsic viscosity and molecular weight, measurement of Viscoelasticity, thermal conduction, colloids, sedimentation.

Bioenergetics: Energy requirements in cell metabolism, role and structure of mitochondria, high energy phosphate bond. Electron transfer phenomenon and biological transfer.

Module III

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Separation techniques: Electrokinetics methods: electrophoresis, 2D electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, SDS- Polyacrylamide Gel Electrophoresis (PAGE), Capillary, Iso-Electric focusing, Instrument design & set-up, methodology and applications in biology and medicine.

Microscopy: Principle, instrumentation and application of microscopy, image formation, magnification, resolving power. Different types of Micrscopy: Dark field, Phase contrast, polarization microscopy, Fluorescence, Electron microscopy: Electron guns, Electron lens. Electron microscopy: High Voltage Electron Microscopy, Scanning Electron Microscopy (SEM), Scanning Transmission Electron Microscopy (STEM),

Spectroscopy: Introduction to spectroscopy, basic principles, instrumentation and applications of UV-VIS absorption, infrared, Raman atomic absorption, fluorescence, Laser spectroscopy, nuclear magnetic resonance, electron spin resonance, acoustic spectroscopy; solvent perturbation; difference spectroscopy; Fourier transform techniques; applications of Laser; mass spectroscopy.

Module IV

Molecular Biophysics: Structure, classification & properties of amino acids, titration of amino acids, Predicting properties from amino acid composition. Unusual amino acids, peptides, polypeptides, structural levels of proteins & stabilizing forces, conformational properties of polypeptides, Ramchandran plot, Helical parameters &conformation, organization & interaction angles. G-proteins and G-protein coupled receptors (GPCRs), proteins as targets for rational structure-based drug design. Binding small molecule by polymer, identical and independent site model, nearest interaction and statistical weight, cooperative binding, anti-cooperative binding and excluded site binding. The random walk, helix-coil transition in protein.

Ionization equilibrium of nucleoside and nucleotides: compositions of nucleic acid, Chargaff's rule in DNA, RNA base compositions, primary structure and covalent chain structure, secondary structure inferences from RNA sequence comparisons, sequence information and analysis of structure function. Structure: DNA & RNA.

Redox potential: Oxidation–Reduction, equivalence of electrical & chemical energy, electrochemical cell, contact potentials, galvanic cell, potential of half-cell, redox potentials & its calculations by Nernst equation, standard electrode potentials & its determination, its relationship with e.m.f. Types of electrodes, pH electrodes, ion selective electrodes, oxygen electrodes

Unit 28: Advanced Cellular and Membrane Biophysics F.M. 25, 02 Credits

Module I

Physics of hydrodynamics : Molecular structure, association of water through H-bonding, nature of hydrophobic interactions, physicochemical properties of water ,State of water in bio-structures & its significance, water as a liquid and solvent: water structure, 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, aqueous environment of the cell.

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Electron Transport & Oxidative phosphorylation: Reduction potentials and free energy changes in redox reaction, organization of electron transport chain, chemiosmotic coupling, proton gradient drive and synthesis of ATP, P/O ratio for oxidative phosphorylation, Cytosolic NADH electron feeding into electron transfer.

Module II

Membrane structure and Models: Lipid structure and their organization, comparison of different membrane models, diffusion and permeability, different types of transport systems across membranes, liposome and its applications. Models of membrane fusion: bilayer fusion, viral fusion, cellular fusion, SNAREs, cell-cell fusion, fusion in mitochondria, lipid bilayer and early models, fluid mosaic model, evidence from model system and bio-membranes.

Membrane transport: Transport system with non-electrolytes and electrolytes. Active transport: nature, selective permeability of bio-membrane, selectivity & ion specificity of bio-membrane, ion channel structure and gating function, ion channel types and characterization, role of carriers in ion transport (ex: -valinomycin& gramicidin), transporting atpase-na-k atpase, calcium ion transporting ATPase of sarcoplasmic reticulum. Transports of molecules by simple and facilitated diffusion, transport by flux coupling, transport by phosphotransferase system, transport by vesicle formation**.** transport and communication between cells and organelles: 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.

Membrane potentials & Lipid Membrane Technology: Nature & magnitude of cell surface charge, 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, Nernst equation, 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, historical perspective of lipid model systems lipid monolayer. Liposomes: small and large unilamellar and multilamellar vesicles, planner lipid bilayer, Application of liposomes in biology and medicine.

Module III

Cellular Biophysics: Cell growth and division: cell cycle, events in cell cycle – G1, S1, G2 phase, control of cell cycle, cell division, cell transportation and malignant tumor growth. Cell aging and death. Cell differentiation: primary and secondary induction, differentiation of cultured cells, cellular apoptosis. Cell recognition: cell adhesion, cell signalling, heat shock proteins, G-protein structure and role in signalling, intracellular cyclicAMP, role of Ca^{+2} in cell signalling, CAM Kinases, (Calmodulin/Ca^{+2} dependent protein kinases), Interaction between cyclic AMP & Ca^{+2}. Concept of receptors, characterization and its function. Receptor – ligand interaction. Signal transduction.

Module IV

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Basic principles of chemical kinetics: Velocity, Order and Molecularity of a chemical reaction, Kinetic equations for zero, first, second & third order reactions. Arrhenious equation, Activation energy & its estimation, Collision & transition state theories of reaction rate, Catalysts, Mode of action of catalysts. Kinetics of single substrate reaction, Michaelies equation, steady state kinetics, transient phases of enzyme reactions, Lineweaver-Burk, Eddie-Hofstee plot, Woolf plot. Control of enzyme activity, feedback inhibition, kinetic behaviour of allosteric enzymes, mechanism of allosteric interactions.

Enzymes as Biocatalysts: Remarkable properties of enzymes as catalysts, active sides, three point attachment, mechanism of enzyme action, flexible enzymes, induced-fit hypothesis, catalytic efficiency of enzymes, molecular dynamics & transient states of enzyme catalysis.

Enzyme Technology: Control of enzyme activity, feedback inhibition, kinetic behaviour of allosteric enzymes, mechanism of allosteric interactions.

Paper: PHY- 304 (Elective)

Unit 01: Environment and Health F.M. 25, 02 Credits

Module I

Environment and health: history and definition of environmental health, perspective on individual health: nutritional, socio-cultural and developmental aspects, Human developmental indices for public health.

Climate change and effects on public health: global warming and its consequences. green house effects, ozone depletion, manifestations of climate change on public health- changing disease pattern and different environmental diseases.

Module II

Environmental pollutants and toxicological hazards: sources, adverse effects of environmental pollutants and contaminants (air, water, soil, radionuclide, pesticides, microbes) on human health (both acute and chronic) and methods of protection and control, food contamination, effects of toxicants on mammalian organisms; xenobiotic-induced oxidative stress, hepatotoxicity, reproductive toxicity, nephrotoxicity, neurotoxicity, genotoxiciy, immunotoxicity, endocrine disruption.

Module III

Perspectives and interventions in public health: epidemiological perspectives of environmental health - disease burden and surveillance, alternative systems of medicine, universal immunization programme (uip), occupational health hazards; occupational diseases - prevention and control; assessment of health risks associated with exposures to environmental hazards.

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Module IV

Environmental management policies and practices: municipal solid waste management, solid waste management system in urban and rural areas, policies and practices with respect to environmental protection act, forest conservation act, wild life protection act, water and air act, industrial, biomedical and e waste disposal rules, wetland management.

Global environmental health issues in developing countries, ethical issues of environmental health-environmental injustice and racial inequality in environmental rule-making and environmental management.

Unit 02: Human Reproductive Health and Related Issues F.M. 25, 02 Credits

Module I

Male and female reproductive physiology: concept of reproductive health, reproductive anatomy and physiology of male and female, sex differentiation, disorder of sex differentiation, physiological basis of male and female puberty, adolescence and adulthood, pregnancy, endocrinology of childbirth, physiology of lactation and physiological importance, contraception, ectopic pregnancy, endometriosis, effects of nutrition, stress and exercise on reproductive functions in vitro fertilization.

Module II

Adolescent health: physical and psychological changes in adolescent, adolescent sexuality, problems of adolescents, adolescent and reproductive health, guidance and counseling for adolescents.

Maternal health and mortality: meaning and concept of maternal health, maternal mortality & morbidity, MCH care, safe motherhood: pre-natal, anti-natal and post-natal care; problems and precautions during pregnancy; abortion, maternal health issues- nutrition, health education, vaccination, PNDT Act, medical termination of pregnancy act, MCH Services in India, MCH & nutrition.

Module III

Infertility -definition, Epidemiology, primary and secondary infertility, psychological and social impact of infertility, causes of infertility, diagnosis and treatment; in vitro fertilization – test tube babies.

STIs/RTIs and HIV/AIDS - diagnosis, treatment, prevention: Concept of RTI, STI, causes and precautions in RTI and STI, Impact of RTI & STI on women; problems of RTI and STI suffering women, HIV/AIDS, transmission of HIV/AIDS, HIV/AIDS counselling, HIV/AIDS suffering adolescent, role of national and international organizations, role of governmental and non-governmental organizations.

Module IV:

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Menopause and beyond - definition, premenopause, perimenopause, postmenopause, signs and symptoms, health complications, psychological and long term effects, management - hormone replacement therapy (HRT), selective estrogen receptor modulators, other medication, other therapies.

Health inequalities - concepts and measurement of equity and inequity in health concepts and principles of health impact assessment, changing paradigms of health and health care, making health and health care universally accessible.

Semester III

Practical

(Total Marks: 100, 08 Credits)

Paper: PHY-305

Unit 29: Histological and Cytological Techniques F.M. 25, 02 Credits

1. **Histological experiments:** fixation, dehydration, embedding and preparation of sections (paraffin, collodion or cold): micrometry, photometry; staining.
2. **Staining of smear for cytological evaluation**: papanicolaou staining, cresyl violet staining.
3. **Study of estrous cycle by different staining techniques**: special and differential staining.
4. **Vital and supravital staining**: platelet count, erythrocyte count, must cell.
5. **Histipathology:** effect of toxicity on the different organ histology.

Unit 30: Histochemical and Histometric Techniques F.M. 25, 02 Credits

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:

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a. Histochemical localization of proteins in the animal tissues using Mercury – Bromophenol Blue method

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

c. Histochemistry of liplds.

3. Histochemical detection of lipids in animal tissues using Blue method:

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 green method.

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. Histipathology:

Effect of toxicity on the different organ histology

8. Immunohistochemistry (demonstration)

Paper: PHY-306
(Special Papers)

Special Paper A: Microbiology and Immunology

Unit 31: Microbiological Techniques F.M. 25, 02 Credits

1. Fermentation of carbohydrates by bacteria: glucose, fructose, lactose, sucrose.

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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 32: Experimental Immunology Practical F.M. 25, 02 Credits

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.

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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.

Special Paper B: Ergonomics and Sports Physiology

Unit 31: Experiments on Work and Sports Physiology - I F.M. 25, 02 Credits

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 32: Experiments on Work and Sports Physiology - II F.M. 25, 02 Credits

1. 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

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

Special Paper C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

Unit 31: F.M. 25, 02 Credits

Biochemical Techniques

A. Methods of Protein Estimation:

1. Folin-Wu Method

2. Bradford Method

3. Ultraviolet Absorbance Method

4. 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, Vmax, 5. Determination of Vmax

C. Studies on Clinical Enzymology

1. Determination of SGOT and SGPT.

2. Determination of serum ALP

3. Determination serum creatine phosphokinase

D. Microscopy

1. Fluorescence and Phase contrast microscopy.

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

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3. DNA damage by Gel electrophoresis.

4. Assay of mitotic index.

Unit 32: Experiments on Endocrinology and Reproductive Physiology of Model Animals

F.M. 25, 02 Credits

A. Experiments on Model Animals

1. Study of drugs (elicit hypo and hyper condition) on functional activities of thyroid, testis and ovary
2. Experiments on thyroidectomy, adrenalectomy on gonadal functions- cholesterol, acid and alkaline phosphatase, ascorbic acid in gonads.
3. 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.
4. Experiment on thymectomy - T lymphocyte and macrophage isolation.

B. Experiment on male reproduction

1. Study of the effect of cryptorchydism on markers of male reproduction.
2. Study of sperm count, sperm motility, sperm morphology, sperm viability, Hypo-osmotic swelling, and effect of someanti-fertility drugs.
3. Study of castration (unilateral) on cholesterol in intact testis- acid and alkaline phosphatase activities in accessory sex glands.
4. Assay of the activities of oxidative stress sensitive enzymes and free radicals quantification in male sex glands.
5. Quantitative study of spermatogenesis measurement of semniferous tubular diameter and Leydig cell nuclear area.

Special Paper D: Neurophysiology

Unit 31: Experiments on Neurophysiology - I

F.M. 25, 02 Credits

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.

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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.

Special Paper D: Neurophysiology

Unit 31: Experiments on Neurophysiology - I F.M. 25, 02 Credits

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 32: Experiments on Neurophysiology - II F.M. 25, 02 Credits

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

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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.
   b. Effect of stimulation of medullary pressure area on heart rate and blood pressure.

Special Paper E: Biophysics and Electrophysiology with Structural Biology

Unit 31: Advanced Methods in Biophysics F.M. 25, 02 Credits

1. Acid – Base titration using pH meter and Determine the pK values: - Strong acid Vs Strong base, Weak acid Vs Strong base, Mixture of Strong and Weak acid Vs Strong base.
2. To prepare the buffers & measurement of pH.
3. To determine the titration curve of protein and amino acids & calculate the pKa values
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. To estimate quantitatively the Amino acids using the ninhydrin reaction.
8. Protein tryptophan fluorescent measurement.

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9. Study of membrane fluidity and phase transition of membrane phospholipids
10. Effect of hypertonic/ hypotonic/isotonic on RBC membrane.
11. Osmolarity: Determination of osmotic pressure of salts
12. To study of conformational changes in biomolecules using Ostwald viscometer. Measurement of viscosity of biological and non-biological samples.
13. Refractometry: study of sugars/proteins/amino acids
14. Study of UV absorption spectra of Proteins and nucleic acids.
15. To verify the Lambert Beer's law and Fick's law.
16. Measurement of viscosity of biological and non-biological samples.
17. To determine the beer's limit and measurement of molar and percent extinction coefficient.
18. To study the protein-ligand interactions by Scatchard plot.

Unit 32: Advanced Cell and Membrane Biophysics F.M. 25, 02 Credits

1. Pressure-flow relationship in rigid system and biological system with different drug activities.
2. To familiarize with bright field, phase contrast, fluorescence & polarizing microscopes.
    a. To study of membrane potential using fluorescence spectroscopy
    b. Microscopic studies of Mitosis & Meiosis stages & determination of mitotic index.
    c. To observe the stained & unstained Prokaryotes & Eukaryotes
    d. To characterize the subcellular fractions and Preparation of Liposome
    e. To determine the energy of activation for a chemical reaction.
    f. To demonstrate the cell fusion using high DC (Direct current) field.
    g. To study the characteristics of different catalytic reactions (Nuecleophilic, Electrophilic & Acid-Base).
    h. To measure the enzymatic activity.
3. To study the effect of temperature, pH, metal ions on enzyme activity & kinetics
4. To isolate and purify the enzymes- isolation of muraminidase from egg white
5. To study the histochemical localization of Alkaline & Acid Phosphatase, Glycogen & Lipids in the tissue.
6. To study the Permeability of model membrane (Liposome) anions.
7. To study the effect of cholesterol on the anion permeability of a Phospholipid membrane.
8. To measure the Membrane potential using Fluorescence techniques.
9. To measure the membrane conductance.
10. To study the phase transition in lipid bilayer membrane.
11. Enzyme Assays (LKH, beta galacotsidase, acid phophotase, arginase, Succinic De –hydrogenase): Time, Temp, Protein concentration, cofactors. LKH: Km & Vmax
12. Microscopic studies of Mitosis & Meiosis stages & determination of mitotic index. To establish the cell growth curve & determination of generation time

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Semester IV: (Theory: 150 + Practical: 150)

Theory

(Total Marks: 150, 12 Credits)

Paper: PHY-401

Unit 33: Endocrinology F.M. 25, 02 Credits

Module I

General concepts of endocrinology and hormonal action: endocrine, paracrine and autocrine secretion; biosynthesis, chemical nature, storage, release and transport of hormones; hormone receptors-types, properties, synthesis and life cycle, protagonists, antagonists and up down regulation of receptors; mechanism of hormones that act on nuclear receptors and the hormones act at the cell surface, laboratory evaluation of the endocrine system.

Neuroendocrinology: neural control of glandular secretion – neurosecretion; hypothalamus-pituitary unit, hypophyseotropic hormones and neuroendocrine axes –TRH, CRH, GHRH, somatostatin, prolactin regulatory factors, GnRH and control of the reproductive axis; effect of leptin on the hypothalamus and neuroendocrine axis, neuroendocrine related diseases.

Module II

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

Neurohypophyseal hormones: synthesis, release and regulation of neurohypophyseal hormones, role in osmoregulation and smooth muscle movements, clinical aspects.

Module III

Pituitary thyroid axis: synthesis and secretion of thyroid hormones – role of Iodine, T3 and T4 - plasma transport, cellular uptake, intracellular binding, activation and inactivation and mechanism of action; regulation of thyroid function; role of thyroid hormones in growth , differentiation and metabolism, thyroid functions in pregnancy, and in the fetus and newborn; thyrotoxicosis endemic and exopthalmic goiter and autoimmune.

In vivo action of corticoids and catecholamines: roles in metabolic, vascular, physical and emotional stress , anti inflammatory role; mineralocorticoids in sodium and potassium metabolism, general idea about cushing syndrome, pheochromocytoma – diagnosis and management.

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Module IV

Hormones involved in calcium metabolism: role of parathyroid hormones, dihydrocholecalciferol, calcitonin and sex hormones – cytokines and growth factors in calcium metabolism; osteoporosis - primary and secondary type; phosphorus metabolism.

Pancreatic and gastro intestinal hormone: role of insulin on ribosomal activity for protein synthesis, role of insulin and glucagons on carbohydrate 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 34: Reproductive Physiology F.M. 25, 02 Credits

Module I

Male and female reproductive systems: sex differentiation– role of SRY antigen, AMII and other hormones, disorders of sex, gonadal differentiation, female and male pseudohermaphroditism, sexual infantilism, folliculogenesis, ovulation, spermatogenesis, 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.

Module 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.

Module III

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

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

Module IV

Fetal and neonatal physiology: cardiovascular and respiratory physiology of fetus and their changes at birth, fetal and neonatal nutrition, factors in embryonic and fetal tissue differentiation.

Pineal gland and reproduction: role of melatonin on reproduction, antigonadal and progonadal role of melatonin, clinical application of melatonin.

Paper: PHY-402

Unit 35: Cell and Inheritance Biology F.M. 25, 02 Credits

Module I

Cells: Evoloution of cells, basic properties and classification.

The plasma membrane: brief history of studies on plasma membrane structure, the membrane proteins and lipids, membrane fluidity and dynamic nature of plasma membrane, membrane transport.

Module II

The cytoskeleton: overview of cytoskeletal functions, roles of microtubules, microfilaments and intermediate filaments, cilia and flagella.

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

Module III

Cell signaling and signal transduction: Basic ideas about cell signaling, 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

Module IV

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Cell cycle and differentiation: in vivo cell cycles and their control, 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.

Unit 36: Biotechnology F.M. 25, 02 Credits

Module 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 of vector.

Module 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, site directed mutagenesis; genomic library, c-DNA cloning. transgenic animal, gene targeting, mobile genetic element, general recombination, restriction mapping; RFLP, RAPD, AFLP techniques.

Module III

Stem cell and tissue culture: stem cell for therapeutics - diseases like diabetes, heart disease etc, reproductive cloning and its applications, cloning model as- DOLLY; animal and 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.

Module IV

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

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Paper: PHY-403
(Special Papers)

Special Paper A: Microbiology and Immunology

Unit 37: Microbial Genetics: Advanced Studies F.M. 25, 02 Credits

Module I

Bacterial genetics: chromosome and plasmids, genes, genetic recombination, conjugation and chromosome mobilization, high frequency transconjugants, transduction: generalized vs specialized, transformation, comparative prokaryotic genomics.

Virology: general properties of viruses, nature of virion, virus host, classification, reproduction and multiplication, bacteriophages, single stranded filamentous DNA bacteriophages, lytic phages, temperate bacteriophages - lambda, transposable phage, RNA bacteriophages, animal viruses, viriod and prions, classical bacteriophage T4 and T7 genetics.

Module II

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

Module 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 genetic switch, the regulation of transcription in prokaryotes and eukaryotes, chromatin structure and the control of gene expression. DNA methylation and gene silencing.

Module IV

Transposable Genetic Elements: discovery of transposable elements, transposable elements in bacteria, IS elements, transposable elements in eukaryotes, genetic significance: mutation and genetic analysis, evolutionary significance of transposable elements.

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

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Unit 38: Clinical Immunology F.M. 25, 02 Credits

Module I

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

Module II

Hypersensitivity and autoimmunity: IgE-mediated (type-I), Ab-mediated cytotoxic (type-II), immune complex mediated (type-III), 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.

Module III

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

Module IV

Vaccination and immunological techniques: vaccine and vaccination, immunological technique: sandwich and competitive ELISA, chemiluminescence, ELISPOT assay, immune electron microscopy- SEM and TEM, flow cytometry (FACS), fluorescence, microscopy, gel-shift analysis, CAT assay.

Special Paper B: Ergonomics and Sports Physiology

Unit 37: General Ergonomics F.M. 25, 02 Credits

Module 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

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term and long term memory, cognitive system, cognitive model of human operator.

Ergonomics standards: ISO standard, OSHA standard.

Module 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.

Module 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, colour etc, principles of lighting in VDT work 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.

Module 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.

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Unit 38: Applied Ergonomics F.M. 25, 02 Credits

Module 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, work space 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 workplace design, human factors in VDT workstation design.

Module 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 dynamic chair.

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, behavioural aspects of posture.

Module III

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

Musculoskeletal disorders (MSD) – causes, relation to the tasks, management of MSD, repetitive motion 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 handling tasks –lifting, carrying, pulling and pushing.

Module 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 of shift work.

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

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

Special Paper C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

Unit 37: Advanced and Applied Biochemistry F.M. 25, 02 Credits

Module-I

Molecular Biology, Genetics and Population Biology: Regulation of DNA Replication in prokaryote and eukaryotic systems. DNA synthesis in vitro. Mechanism of replication in bacteria and viruses, Reverse transcriptase, Mitochondrial DNA replication. DNA Repair. RNA synthesis-The enzymes of transcription in prokaryotes and eukaryotes, mechanism of transcription in bacteria, post transcriptional processing of RNA, role of ribozymes. Translation-Translation 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.

Mendelism. Non Mendelian inheritance. Sex linked inheritance. Gene Mapping. Chromosomal anomalies. Mutation. Human cytogenetics-Karyotyping; chromosomal banding; Genetic diseases. Genomics-functional and structural genomics; Concept of physical, cytological and genetic map; 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.

Module-II

Immuno-, Microbial- and Neuro-Biochemistry: T-cell receptors: molecular structure & gene organization of CD2, CD3, CD4 & CD8;, genetic control of the immune response, 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.

Membrane chemistry of Gram-positive and negative bacteria, 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.

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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 neuropharmacological drugs with brain metabolites and their specificity at target organs.

Module-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.

Concept of 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/si RNA technology and applications in studying gene functions.

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

Biotechnology and Nano-biology: 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, Concept of Nanomotors. Nanohybrids. Nanobiotechnology. Concept of nanofabrication. Application of nanotechnology in cancer therapy and in other diseases.

Module IV

Environmental Biochemistry

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 toxico gens. Metal toxicity–Arsenic and lead. Nonmetal–oxygen and ozone.

Applied and Industrial Biochemistry

Biochemical effects of food, toxins, edible oils and environmental pollutants on human health.

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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 38: Applied Molecular Endocrinology and Reproductive Physiology

Module I

Hormonal basics of hypertension: Hypertension and its classification, hormones involved in hypertension with special reference to role of aldosterone, 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, Immune reaction for diabetes development. Management of diabetis 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.

Module II

Drug abuse: Different types and effects of drug abuse on different physiological system. Management of drug abuse.
Alcohol addiction: Physiological **e**ffect and management of alcohol addiction,
Aging: Effects of aging 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.

Module III

Fertilization: Role of zonapellucida 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 bastocyst 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.

Module IV

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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.

Special Paper D: Neurophysiology

Unit 37: Neurophysiology of Brain F.M. 25, 02 Credits

Module 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

Module 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.

Module 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.

Module IV

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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 38: Applied and Clinical Neurophysiology F.M. 25, 02 Credits

Module 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.

Module 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.

Module 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.

Module 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.

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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.

Special Paper E: Biophysics and Electrophysiology with Structural Biology

Unit 37: Electrophysiology of Cells and Radiation Biophysics F.M. 25, 02 Credits

Module I

Mathematical methods and their applications in biological systems: 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. Vectors: Vector algebra, coordinate systems, Basic vectors and components, Scalar and vector multiplications, Reciprocal vectors, coordinate transformations.

Basic Biomechanics: General concept and biological application of biomechanics, Kinematic concepts of analysing human motion, the biomechanics of human muscle, spine, bone growth and development. Modelling and Remodelling of bones (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 system of human architecture.

Module II

Advanced Electrophysiology: Different electrical signals in human body. Potential of nerve – resting membrane potential–ionic basis. Nernst equation. Hodgkin-Huxley model. Goldman equation. Action potential-ionic basis, gating kinetics and physio-pharmacology of different ion channels. Biphasic and compound action potential. 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. Bioelectric recognition Assay (BERA). Skin contact impedance of Electrodes. Biological Transducers and Measurement of Physiological event, Transducers: properties, principle and biomedical application of Transducers.

Electrophysiology of Heart, Brain & Muscle: Electrocardiogram (ECG), 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; Brain Potentials, Electroencephalogram (EEG), source and mechanism of formation of rhythmic pattern of EEG, characteristics of EEG waves. EEG pattern changes in sleep. Abnormalities of EEG. Event related potential (evoked potential) - types, characteristics and significance; Electromyogram (EMG) – Motor unit potential, physiological significance and analysis of EMG.

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Advanced Electrophysiology of Sensory system: 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. Ultrastructure of cochlea. Resting and stimulus related potentials – endocochlear potential, cochlear microphone potential, summating potential, and auditory nerve potential. Olfactory receptor potential – characteristics and molecular mechanism of transduction. Ultrastructure taste receptors – taste receptor potential – molecular mechanism of transduction.

Module III

Advanced Radiation Physics : Introduction, 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. Cathode Ray Oscilloscope (CRO) and its use in biology. Photon interactions, types of indirectly ionizing radiation, Photon beam attenuation, HVT & TVT, Types of photon interaction, Photoelectric effect, Coherent scattering, Electron interactions-Electron-orbital electron interactions, Electron-nucleus interactions, Stopping power, Mass scattering power.

Radiobiology: Introduction, classification of radiations in radiobiology, cell cycle and cell death, irradiation of cells, type of radiation damage, cell survival curves, measurement of radiation damage in a tissue, normal and tumour cells, therapeutic ratio, oxygen effect, relative biological effectiveness, dose rate and fractionation, radio protectors and radio sensitizers.

Radiation Protection& Radiotherapy: 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. Radiotherapy: principles, dosage data for clinical applications, Gamma Camera, Positron Emission Tomography (PET), Single Photon Emission Tomography (SPECT), Cobalt-60 machine, Therapeutic application of radio isotopes, application of UV radiation for treatments, biological effects of radiation and ultrasound, different telemetry systems, telemedicine applications, concepts, telemedicine technology

Module IV

Fundamentals of biomedical microscopic imaging: Specialised microscopy techniques- differential interference contrast (DIC), phase contrast and dark field microscopy, simple fluorescence microscopy, confocal microscopy, time lapse fluorescence, fluorescence resonance energy transfer (FRET), labelling biomolecules for fluorescence microscopy, atomic force microscopy (AFM).

Modern medical imaging systems and therapeutic Equipment's: Introduction to medical imaging, principles of computed tomography, nuclear medical imaging system- principles of NMR imaging systems, biological effect of NMR imaging, advantages of NMR imaging system, Laser applications in biomedical field and telemedicine. Telemetry system in biology.

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Unit 38: Photophysics and Experimental Methods in Structure Elucidation

F.M 25, 02 Credits

Module I

Physicochemical Fractionation & Electro-analytical Techniques: **Chromatography**-Basic Concepts of Adsorption & Partition Chromatography, 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 Chromatography.

Centrifugation & Ultracentrifugation-Basic principles, Forces involved, RCF Centrifugation, techniques-principles, types and applications. Centrifuges &Ultracentrifuges-types, optical methods used and applications of preparative [Differential, Density Gradient] and analytical [sedimentation velocity, sedimentation equilibrium] ultracentrifugation.

Module II

Photophysics & Photochemistry: Nature and measurement of light, Light sources, Physical properties of excited molecules; Photophysical processes, fluorescence, Photophosphorescence, Action spectra, Optical activity, Basic principles and laws of photochemistry, Quantum photochemical principles, Photochemical primary processes, Types of photochemical reaction, Photochemistry of amino acids and proteins, Photochemistry of DNA & RNA and its constitutes, Recovery from photochemical damage, Chemiluminisence, Bioluminescence- Mechanism and significance.

Photo-medicine: Optical 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, oncology and cell biology, Laser Surgical Systems, Application of ultra-fast pulsed lasers in medicine and biology, Lasers in blood flow measurement, Fibre optics in medicine, microscopy in medicine, birefringence.

Module III

Optical & Diffraction Techniques: Principle, instrument design, methods & applications of polarimetry, light scattering, refractometry, atomic force microscopy, circular dichroism and optical rotator dispersion: plain, circular and elliptical polarization of light, absorption by oriented molecules, dichroic ratio of proteins and nucleic acids. circular dichroism (CD), optical rotatory dispersion (ORD), relation between CD and ORD, application of ORD in conformation and interactions of biomolecules, determination of structural correlations in biomolecules using absorption spectroscopy.

X-ray diffraction methods: General remarks on protein-structure determination from X-ray diffraction, data neutron diffraction, electron diffraction, Synchrotron diffraction. Bragg equation. Scattering factor, structure factor expression, reciprocal lattice, Ewald's sphere, electron density equation, phase problem, Patterson function, molecular replacement method, isomorphous replacement, refinement programs and interpretation of

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results, methods of data collection of crystal containing small molecule and large molecule, factors affecting the measurement of integrated intensities, photographic methods, diffractmeters, area detectors and image plates.

Crystallography: Crystals, molecular crystal symmetry, miller indices, reciprocal lattice, ewalds construction, X ray diffraction by crystals, 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, Crystallization of proteins, structure factors of Centro-symmetric and non-Centro symmetric crystals. Application in Biomolecular structural studies.

Module IV

Nuclear Medicine. : Basic principles of Nuclear Medicine, Diagnostic use of Radioisotopes In-vivo & In-vitro procedures, (Single isotope, double isotope methods), Radio immune assay counting system, general principles & procedures of organ scanning, renal imaging, cardiac imaging, thyroid scanning, blood volume determination by isotope method, rectilinear scanners & gamma scintillation camera, positron emission tomography (PET), single photon emission computer tomography (SPECT), radio-pharmaceuticals & their diagnostic applications**.**

Non-Ionizing Radiation physics: Different sources of non ionizing radiation-their physical; properties, various types of optical radiations-UV, visible & IR sources, Lasers-theory and 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 and microwaves with biological systems, thermal and non-thermal effects on whole body, lens and cardiovascular systems, tissue characterization and hyperthermia and other applications. biomagnetism: effects, applications. Electrical impedance and biological impedance, principle and theory of thermography, applications in biology & medicine.

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Semester IV

Practical

(Total Marks: 150, 12 Credits)

Paper: PHY-404

Unit 39: Advanced Physiological Studies – I F.M. 25, 02 Credits

1. EEG recording of normal human subject in different status by multichannel recorder.
2. Determination of VO_2 max by Queen's college test.
3. Determination of hearing threshold by audiometer.
4. Estimation of physiological active substance by HPLC.
5. ECG recording and interpretation, determination of electrical axis of heart.
6. Determination of percentage of body fat and desired body weight.
7. Electroencephalographic study in humans in different stages of sleep and awakefulness.
8. Measurement of GSR in resting and different stressful condition.
9. Measurement of dark adaptation time.
10. Colour perimetry, measurement of visual acuity.
11. Steriotaxic technique lesioning of a specific brain area.
12. Determination of critical fusion frequency.
13. Effect of Vago-sympathetic Trunk and White Crescentic Line on heart muscle. Effect of Vagal stimulation showing Vagal Escape.
14. Perfusion of mammalian heart by Langendorff's Method and effect of drugs and ions.
15. Study of reflexes in Spinal and Decerebrate frog.
16. To demonstrate the effect of UV and Gamma rays on cell division, Enzymes, Proteins and DNA, cell membrane.

Unit 40: Advanced Physiological Studies – II F.M. 25, 02 Credits

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1. Identification of urease activity for supplied bacteria.
2. Identification of catalase activity for supplied bacteria.
3. Determination of antibiogram of supplied bacteria.
4. Amplification of a target DNA by polymerase chain reaction and identification of amplified DNA by agarose gel electrophoresis.
5. Tissue processing and staining by automatic tissue processor and stainner.
6. Determination of Abs by Ouchtulony double diffusion test. (Demonstration).
7. Delayed type of hypersensitivity response (DTH) (Demonstration).
8. Study of the effect of cryptorchidism on testicular and adrenal cholesterol.
9. Study of estrous cycle after administration of synthetic estrogen or hCG.
10. Measurement of hormone by ELISA techniques.
11. Determination of acid phosphatase activity in the supplied tissue sample.
12. To study bioluminescence of live fire flies by correlating light intensity with time.
13. To study the effect of Inhibitors and Light Intensity on Hill reaction.
14. To isolate cellular fraction by centrifugation methods.
15. To determine the molecular weight of biomolecules using ultracentrifuge

Paper: PHY-405
(Special Papers)

Special Paper A: Microbiology and Immunology

Unit 41: Advanced Techniques in Microbiology F.M. 25, 02 Credits

1. Determination of sensitivity of bacteria to different antibiotics.
2. Determination of minimum inhibitory concentration (MlC) of aintibiotics.
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 *E.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.

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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 42: Clinical Immunology F.M. 25, 02 Credits

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. Haemagglutination 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; IIT, Khragpur, Institute of Microbial Technology, Chandigarh; National Institute of Immunology, Delhi; NICED, Kolkata; NCCS, Pune.

Special Paper B: Ergonomics and Sports Physiology

Unit 41: Experiments on General Ergonomics and Environmental Ergonomics F.M. 25, 02 Credits

1. Evaluation of occupational stress- development of questionnaire, quantitative evaluation technique, pain mapping.

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2. Measurement of different heat stress indices: WBGT, ET, CET, P_4SR; measurement of relative 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 42: Experiments on Ergonomic Design and Group Projects F.M. 25, 02 Credits

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.

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Special Paper C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

Unit 41: Advanced experiments on Biochemistry F.M. 25, 02 Credits

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. Isolation of 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.

E. Differential centrifugation Techniques

Isolation of subcellular fractions.

F. Immunobiochemical Techniques

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

Unit 42: Advanced Experiments on endocrinology and Reproduction F.M. 25, Credits 02

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

1. Bio-assay of oxytocin and epinephrine

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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 ovarectomy (unilateral and bilateral) – effects on ovarian and adrenal cholesterol
3. Study of acid and alkaline phosphatase activities in uterus of ovarectomized animal.
4. Study of immunological methods for pregnancy detection.
5. Basic experiment on superovulation study in mice and rat
6. **Training Programme / Laboratory Visit (Optional)::** Training in higher research institute are to be arranged for the students to learn some advance techniques in Biochemical, endocrinology and 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.

Special Paper D: Neurophysiology

Unit 41: Advanced Neurophysiological Studies – I F.M. 25, 02 Credits

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.

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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 42: Advanced Neurophysiological Studies – II F.M. 25, 02 Credits

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

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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.

Special Paper E: Biophysics and Electrophysiology with Structural Biology

Unit 41: Advance Medical Biophysics F.M. 25, 02 Credits

1. Five Mathematical assignment based on Module-I
2. Recording of simple muscle twitch (SMT). Effect of increasing frequency of stimulus on SMT
3. Determination of strength-duration curve, measurement of contraction kinetics of excitable tissues, measurement of conduction velocity of nerve fibre. Genesis of fatigue
4. Determination of isometric twitch-tetanus of toad with different drugs. Calculation of work done by muscle.
5. Effect of Vago-sympathetic Trunk and White Crescentic Line on heart muscle. Effect of Vagal stimulation showing Vagal Escape.
6. To study the effect of drugs – Nicotine and Atropine.
7. Perfusion of mammalian heart by Langendorff's Method and effect of drugs and ions.
8. Study of reflexes in Spinal and Decerebrate frog.
9. Modern techniques in voltage clamp, current clamp, patch clamp and Single fibre.
10. To study the chromosomal aberrations due to radiation.
11. Conformation of Nucleic acid by Spectral study.
12. Methods of sample preparation for microscopy
13. Electrophysiological recording setup (EEG, ECG, EMG, EOG, Heart rate, respiration, pulse rate, heart sound, etc.),cardiac observation by electrocardiography and blood flow measurement.
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. Measurement of impedance from frog skin by Electrodes
16. To demonstrate the effect of UV and Gamma rays on cell division, Enzymes, Proteins and DNA, cell membrane.
17. To determine the calibration of various personnel monitoring systems; film badges, thermo luminescent Dosimeters, Pocket Dosimeters.

Unit 42: Advance Separation Techniques and Photophysics F.M. 25, 02 Credits

1. Column Chromatography for Proteins, Pigments, amino acids.
2. One and two dimensional Ascending & Descending TLC and Paper chromatography of Amino acids & sugars
3. Fractionation of protein, Sugars from fruit juice using TLC/HPTLC

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4. To perform the separation of Proteins using HPLC
5. To determine the molecular weight of biomolecules using ultracentrifuge
6. To isolate cellular fraction by centrifugation methods.
7. To study the effect of visible light intensity and time of irradiation on photo reactivation process.
8. To study the Action Spectrum for Bacterial killing.
9. To study the Photo Inactivation of Enzymes.
10. To study the survival of E. Coli. as a function of fluence of UV radiation (254 nm) at different temperature.
11. To study bioluminescence of live fire flies by correlating light intensity with time.
12. To study chemiluminescence in a chemical transformation.
13. To isolate and characterize photosynthetic pigments by Chromatography and Spectrophotometry.
14. To demonstrate Hill reaction using Oxygen Electrode.
15. To study the effect of Inhibitors and Light Intensity on Hill reaction.
16. Effect of Lasers on Biomolecules and Cellular Systems.
17. To obtain relation between concentration and Refractive Index (RI) using Refractometry.
18. Training Programme / 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, NBRC, AIIMS, NIH-New Delhi, NIMHAN- Bangalore, and NCBS-Pune etc. as a part of their practical syllabus.

Paper: PHY-406

Unit 43: Project F.M. 25, 02 Credits

Project report: under the guidance of a teacher each student shall have to carry out a project work (laboratory based or field based) for a period of 2 months. Students will have to prepare the project report in a standard format and will submit the same in triplicate well before the date of examination (date will be announced by the department). The report should not be less than 20 A4 size typed pages and the maximum size of the report should not generally exceed 50 pages (A4 size). Each student will be allotted a project reference number. The students will have to take the project report number from the department and the number will be written in the front page of the report.

Unit 44: Project F.M. 25, 02 Credits

Project presentation: the project work will be evaluated on the basis of the internal assessment, seminar delivered by the student as well as viva-voce on the project report.

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Note:

1. **For semester examination four questions each of 5 marks are to be set in each unit of theory papers, taking one question from every module, with one alternative to each question from the same module.**
2. **For the project of Semester IV 10 marks will kept for internal assessment and the remaining 40 marks will be evaluated during semester examination.**

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