UNIVERSITY OF CALCUTTA

Notification No. CSR/ 72 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 13.07.2018 (vide Item No.11) approved the Syllabus of Two-Year (Four-Semester) M.Sc. Course of Study in Human Physiology under CBCS in the Post-Graduate Departments of the University and in the affiliated Colleges offering Post-Graduate Courses under this University, as laid down in the accompanying pamphlet.

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 17th August, 2018

(Debabrata Manna)
Deputy Registrar (Acting)

DEPARTMENT OF PHYSIOLOGY

UNIVERSITY OF CALCUTTA

SYLLABUS

2018

CONTENT

Sl. No.	Topic	Details	Page
1.	**ORIENTATION OF COURSES**	**Semester-wise distribution of courses**	**2-5**
2.	**Detailed Syllabus**		
2.1.	**Core Courses**	**1St Semester – 20 credits (4 credits X 5 papers)** **2nd Semester - 20 credits (4 credits X 5 papers)** **3rd Semester – 12 credits (4 credits X 3 papers)** **4th Semester – 04 credits (4 credits X 1 paper)**	**6-10** **10-16** **16-22** **22-24**
2.2.	**Discipline Specific Elective Courses (DSEC)**	**DSEC will be offered by Parent Department for Physiology students** **included in 4th Semester** **---- 16 credits (4 credits X 4 papers)** (i) Biochemistry (ii) Biophysics & Electrophysiology (iii) Endocrinology & Reproductive Physiology (iv) Environmental Physiology (v) Ergonomics & Work Physiology (vi) Immunology & Microbiology (vii) Neurophysiology (viii) Nutrition & Dietetics (ix) Sports & Exercise Physiology (x) Molecular Cell Biology (xi) Biostatistics and Analytics	**25-29** **30-34** **34-36** **36-41** **41-47** **48-51** **51-57** **58-60** **61-65** **66-70** **70-72**
2.3.	**Generic Elective Course (GEC)**	**GEC will be offered by the Departments for Students of Other Department,** **"Human Physiology and Public Health"** **included in 3rd Semester.** ---- 08 credits (4 credits X 2 papers)	**73**

POST-GRADUATE HUMAN PHYSIOLOGY CBCS SYLLABUS 2018

ORIENTATION OF COURSES

"P" stands for Paper, "TH" stands for Theory, "PR" stands for Practical, "PS" stands for Project & Seminar

Subject code	**Subject**	**MARKS**	**CONTACT HRS**	**CREDIT**
FIRST SEMESTER				
HPY-CC11-TH-P01	**Systems Physiology-I**	**MARKS**	**CONTACT HRS**	**CREDIT**
11011	BLOOD & HEMODYNAMICS	10	12	
11012	CARDIOVASCULAR PHYSIOLOGY	10	12	
11013	RENAL PHYSIOLOGY	10	12	
11014	RESPIRATORY PHYSIOLOGY	10	12	
11015	GASTROINTESTINAL PHYSIOLOGY	10	12	
Total		50	60	04
HPY-CC12-TH-P02	**Biomolecules &Metabolic Pathways**	**MARKS**	**CONTACT HRS**	**CREDIT**
11021	BIOMACROMOLECULES AND THEIR PRINCIPLES OF INTERACTIONS	10	12	
11022	ENZYMOLOGY	10	12	
11023	METABOLISM-I	10	12	
11024	METABOLISM-II	10	12	
11025	BIOENERGETICS	10	12	
Total		50	60	04
HPY-CC13-TH-P03	**Community Health-I &computational Physiology**	**MARKS**	**CONTACT HRS**	**CREDIT**
11031	BIOSTATISTICS	10	12	
11032	ERGONOMICS & HUMAN FACTOR	10	12	
11033	SPORTS & EXERCISE PHYSIOLOGY	10	12	
11034	POPULATION BIOLOGY	10	12	
11035	CONCEPTS OF BIOINFORMATICS FOR HUMAN HEALTH	10	12	
Total		50	60	04
HPY-CC14-PR-P04	**Practical: Experimental physiology**	50	60	04
HPY-CC15-PR-P05	**Practical: Clinical biochemistry**	50	60	04
Grand Total		**250**	**300**	**20**
SECOND SEMESTER				
HPY-CC21-TH-P06	**Systems Physiology-II**	**MARKS**	**CONTACT HRS**	**CREDIT**

12061	CELLULAR ORGANIZATION, CELL TO CELL COMMUNICATION AND SIGNALING	10	12	
12062	NERVOUS SYSTEM	10	12	
12063	NERVE MUSCLE PHYSIOLOGY	10	12	
12064	SPECIAL SENSES	10	12	
12065	BEHAVIORAL PHYSIOLOGY AND COGNITIVE FUNCTIONS	10	12	
Total		50	60	04
HPY-CC22-TH-P07	**Cellular & Molecular Physiology**	**MARKS**	**CONTACT HRS**	**CREDIT**
12071	IMMUNOBIOLOGY	10	12	
12072	MOLECULAR BIOLOGY	10	12	
12073	BIOTECHNOLOGY	10	12	
12074	HUMAN GENETICS	10	12	
12075	MOLECULAR PHARMACOLOGY: CONCEPTS & PRACTICE	10	12	
Total		50	60	04
HPY-CC23-TH-P08	**Community Health-II**	**MARKS**	**CONTACT HRS**	**CREDIT**
12081	PHYSIOLOGICAL CONCEPTS IN INDUSTRIAL MANAGEMENT	10	12	
12082	SPORTS MEDICINE & DRUG ABUSE	10	12	
12083	SPACE & AVIATION PHYSIOLOGY	10	12	
12084	STRESS PHYSIOLOGY & ITS MANAGEMENT	10	12	
12085	MICROBES& MICROBIAL PATHOLOGY	10	12	
Total		50	60	04
HPY-CC24-PR-P09	**Practical: Histology**	50	60	04
HPY-CC25-PR-P10	**Practical: Human physiology/ computer applications and biostatistics**	50	60	04
Grand Total		**250**	**300**	**20**
THIRD SEMESTER				
HPY-CC31-TH-P11	**Systems Physiology-III**	**MARKS**	**CONTACT HRS**	**CREDIT**
23111	ENDOCRINOLOGY	10	12	
23112	NEUROENDOCRINOLGY&CHRONOBIOLOGY	10	12	
23113	REPRODUCTIVE PHYSIOLOGY	10	12	
23114	EVOLUTIONARY BIOLOGY	10	12	
23115	STEM CELL AND DEVELOPMENTAL BIOLOGY	10	12	
Total		50	60	04

HPY-CC32-TH-P12	**Community Health-III: Hazards and Prevention**	**MARKS**	**CONTACT HRS**	**CREDIT**
23121	OCCUPATIONAL HEALTH & PREVENTION OF HEALTH HAZARDS	10	12	
23122	DESIGN ERGONOMICS & DECISION MAKING MODELS	10	12	
23123	PRINCIPLES OF ENVIRONMENTAL PHYSIOLOGY	10	12	
23124	ENVIRONMENTAL POLLUTION, XENOBIOTICS AND ITS MANAGEMENT	10	12	
23125	CHALLENGES IN HUMAN HEALTH: DISASTER, STARVATION, POVERTY, ADDICTION	10	12	
Total		50	60	04
HPY-CC33-TH-P13	**Modern Techniques in Physiology-I**	**MARKS**	**CONTACT HRS**	**CREDIT**
23131	PRINCIPLES OF GENETIC ENGINEERING&RECOMBINANT DNA TECHNOLOGY	10	12	
23132	IMMUNOTECHNOLOGY AND IMMUNODIAGNOSTICS	10	12	
23133	CELL & TISSUE CULTURE TECHNIQUES	10	12	
23134	TECHNIQUES IN BIOPHYSICAL CHEMISTRY	10	12	
23135	ELECTROPHYSIOLOGICAL TECHNIQUES	10	12	
Total		50	60	04
HPY-GEC31-TH-P14	**Generic Elective Course (GEC) - CBCC** **Physiology Students will opt CBCC offered by other Department**	50	60	04
HPY-GEC32-TH-P15	**Generic Elective Course (GEC) - CBCC** **Physiology Students will opt CBCC offered by other Department**	50	60	04
Grand Total		**250**	**300**	**20**
FOURTH SEMESTER				
HPY-CC41-TH-P16	**Modern Techniques in Physiology-II**			
24161	APPLICATION OF INVASIVE AND NON INVASIVE TECHNIQUES IN IDENTIFICATION OF OCCUPATION RELATED DISEASES	10	12	
24162	NANOTECHNOLOGY & ITS APPLICATIONS	10	12	
24163	MODERN IMAGING TECHNIQUES	10	12	
24164	BIOMEDICAL INSTRUMENTATION	10	12	
24165	CONCEPTS OF OMICS: APPLICATIONS AND ANALYSIS	10	12	
Total		50	60	04
HPY-DSEC41-TH-P17	**Discipline specific elective course (Theory)*** **Students will opt DSEC offered by Parent Department**	50	60	04

HPY-DSEC42-TH-P18	**Discipline specific elective course (Theory)* Students will opt DSEC offered by Parent Department**	50	60	04
HPY-DSEC43-PR-P19	**Discipline specific elective course (Practical)* Students will opt DSEC offered by Parent Department**	50	60	04
HPY-DSEC44-PS-P20	**Discipline specific elective course (Project and Seminar)* Students will opt DSEC offered by Parent Department**	50	60	04
Grand Total		**250**	**300**	**20**
Post Graduate Grand Total		**1000**	**1200**	**80**
	* List of **Discipline specific elective course (DSEC)**: (i) Biochemistry (ii) Ergonomics & Work Physiology (iii) Environmental Physiology (iv) Endocrinology & Reproductive Physiology (v) Immunology & Microbiology (vi) Nutrition & Dietetics (vii) Sports & Exercise Physiology (viii) Biophysics & Electrophysiology (ix) Neurophysiology (x) Molecular Cell Biology (xi) Biostatistics and Analytics			

POST-GRADUATE HUMAN PHYSIOLOGY CBCS SYLLABUS 2018

Detailed Syllabus

Subject code	Subject	MARKS	CONTACT HRS	CREDIT
FIRST SEMESTER				
HPY-CC11-TH-P01	**Systems Physiology-I**	**MARKS**	**CONTACT HRS**	**CREDIT**
11011	BLOOD & HEMODYNAMICS 1. Hematopoiesis 2. Formed elements of blood 3. Hemostasis& Thrombosis 4. Blood antigen, Blood transfusion 5. Hemodynamics	10	12	
11012	CARDIOVASCULAR PHYSIOLOGY 1. Anatomy and general function of heart; electron microscopic structure of cardiac tissue. 2. Electrical activity of heart- ionic basis of action potential, conduction of action potential, role of neurohormones; conduction blocks, re-entry phenomenon, fibrillation, defibrillators. 3. Electrocardiogram (ECG)- recording principle, generation of EGC waves, electrical axis, normal and abnormal ECG. 4. Cardiac enlargement and hypertrophy, myocardial necrosis and myocarditis 5. Cardiac metabolism and cardiac efficiency	10	12	
11013	RENAL PHYSIOLOGY 1. Anatomy of Excretory System and Renal blood flow 2. Neural control of renal functions 3. Kidney functions 4. Renal regulation of electrolytes: 5. Functions of different parts of kidney and assessment of renal functions	10	12	
11014	RESPIRATORY PHYSIOLOGY 1. Evolution of the atmosphere and evolution, Anatomy of Respiratory System 2. Principles of Respiratory Mechanisms: Elastic forces, lung volumes, Pressure/volume relationship 3. Respiratory system resistance : Physical principles of gas flow and resistance; Lung function tests	10	12	

	4. Non respiratory functions of the lung: Filtration, Defence against inhaled substances; the endocrine lung, Immune function 5. Physiology of pulmonary disease, Artificial Ventilation, Lung transplantation			
11015	GASTROINTESTINAL PHYSIOLOGY 1. Evolution of GI system and Anatomy, Histomorphological study 2. Role of hepatobilliary systems in gastrointestinal functions. 3. Gastrointestinal hormones and their interplay. 4. Chemistry and mechanism of action of Defensive and Aggressive factors, Immune function of GI Tract. 5. Central control of gastrointestinal functions. Pathological Situations of GI	10	12	
Total		**50**	**60**	**04**
HPY-CC12-TH-P02	**Biomolecules & Biochemical Pathways**	**MARKS**	**CONTACT HRS**	**CREDIT**
11021	BIOMACROMOLECULES AND THEIR PRINCIPLES OF INTERACTIONS 1. Bonds in biochemical reactions: covalent, ionic and hydrogen bonds; Vander Waal's forces, hydrophobic interactions; 2. Principles of Biophysics as applied to Physiology: colloidal chemistry, pH of body fluids; maintenance of pH within the cells; applications 3. Conformation of proteins and polypeptides – Primary, Secondary, tertiary, quarternary and domain structure of proteins; Reverse turns and Ramachandran plot; Helix-coil transition; Protein folding and its problems: Role of chaperons; 4. Structural polymorphism of DNA and RNA; 5. Typical Structures of Biomolecules and their physiological and clinical consequences	10	12	
11022	ENZYMOLOGY 1. Structural basis of enzyme function: Active sites, Coenzymes, Activators, Inhibitors, Kinetics. 2. Allosteric enzymes and their modulators. 3. Mechanism of enzyme induction and repression. 4. Technical approach to the study of enzyme activities.	10	12	

	5. Purification and characterization of enzymes, Clinical enzymology, Diagnostic and therapeutic uses of enzymes.			
11023	METABOLISM-I 1. Carbohydrate metabolism-I : Glycolysis, pentose phosphate pathway and TCA cycle 2. Carbohydrate –II: Mitochondrial function in gluconeogenesis; Biosynthesis of biopolymers 3. Lipid Metabolism-I : Biosynthesis of mono- and polyunsaturated fatty acids and Eicosanoids; 4. Lipid Metabolism –II: Metabolism of acylglycerol, sphingolipids and glycolipids; 5. Amino Acid Metabolism : Biosynthesis of non-essential amino acids; Catabolism of proteins and amino acid pool	10	12	
11024	METABOLISM-II 1. Nucleotide Metabolism: Synthesis of purine and pyrimidine nucleotides;. 2. Membrane Metabolism: Structural organisation and functions; Membrane receptors; Membrane damage and repair. 3. Organ Specific Metabolism: Brain and Nervous System, Cardiac, Muscle, Liver, Kidney 4. Organ Specific Metabolism: Endocrine organs, Reproductive Organs 5. Metabolic alteration in pathophysiological states.	10	12	
11025	BIOENERGETICS 1. Concepts of free energy and strategies of energy metabolism; 2. High-energy biomolecules and coupling phenomenon, energy-rich bonds, weak interactions, group transfer, 3. Biological energy transducers and bioenergetics; Oxidative phosphoryltion and Photosynthesis 4. Extramitochondrial electron transport chains; 5. Oxygen toxicity and superoxide dismutase.	10	12	
Total		50	60	04
HPY-CC13-TH-P03	**Community Health-I & computational Physiology**	**MARKS**	**CONTACT HRS**	**CREDIT**
11031	BIOSTATISTICS 1. Testing of Hypothesis 2. Nonparametric Statistics: Correlations	10	12	

	3. Regressions: Linear regression 4. Analysis of Variances: Models and types of ANOVA. 5. Design of experiment: Data Presentation			
11032	ERGONOMICS & HUMAN FACTOR **1. Introduction to Ergonomics :** Definition and application 2. **Work Study:** Concept of work study, time measurement; application of work and motion study. 3. **System Design**: Concept of system design; Effect of Man, Machine and Environment in System Design; Failure of System – accident. 4. **Ergonomics and Safety:** Application of Ergonomics for the development of safety; Analysis of accident; unsafe conditions; Mechanical (engineering) control/protective devices; Personal Protective Device (PPD). Occupational health. 5. **Anthropometry:** Definition of Anthropometry; Static & Dynamic Anthropometry; Application of Anthropometry in design development.	10	12	
11033	SPORTS & EXERCISE PHYSIOLOGY 1. Classification of physical exercise, sports, workloads etc. Hematological changes during graded muscular exercise.,Oxygen consumption and O2 pulse during graded muscular exercise. 2. Heart rate, blood pressure, pulmonary ventilation, ventilation equivalent, VE Max, VO2Max; 3. Alveolar ventilation at different state of breathing. Cardiorespiratory changes in sedentary and trained persons during exercise 4. Lactic acid concentration and O2 debt, 5. Nutrition in sports and exercise, Concept of Physical fitness., Physiological effects of doping.	10	12	
11034	POPULATION BIOLOGY 1. Population problems : The 'law of diminishing returns', prospective 2. People of India: Overview of the physical (anthropometric) and genetic diversities and affinities of the people of India. Molecular genetic markers in the study of human heritage: 3. Genes and environment as determinants of health and disease: Isolation, migration, immigration, amalgamation and assimilation of populations. 4. Molecular biology to community control of several burdensome diseases in India: A case example like Beta-Thalassemia in India. 5. Community based Health care: Consanguinity	10	12	
11035	CONCEPTS OF BIOINFORMATICS FOR HUMAN HEALTH 1. Principles of Genome Bioinformatics 2. Systems Biology The description of biological networks and protein and metabolic gene network modelling.	10	12	

	3. Emphasis in both topological aspects of networks and their dynamical behavior 4. Different Languages 5. Structural Bioinformatics as applied for Biomedical research			
Total		50	60	04
HPY-CC14-PR-P04	**PRACTICAL: EXPERIMENTAL PHYSIOLOGY**	50	60	04
HPY-CC15-PR-P05	**PRACTICAL: CLINICAL BIOCHEMISTRY**	50	60	04
Grand Total		**250**	**300**	**20**
SECOND SEMESTER				
HPY-CC21-TH-P06	**Systems Physiology-II**	**MARKS**	**CONTACT HRS**	**CREDIT**
12061	CELLULAR ORGANIZATION, CELL TO CELL COMMUNICATION AND SIGNALING 1. **Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting & regulation of intracellular transport, electrical properties of membranes. 2. **Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, ER , peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility. 3. **Cell division & cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction. 4. **Cell signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing. 5. **Cellular communication:** general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.	10	12	

12062	NERVOUS SYSTEM 1. Neuro- & gliogenesis, neuronal migration. 2. Regulation of cerebral blood flow and stroke; B-B-B barrier; astrocyte function, Immune response of nervous system; functions of astrocytes and microglia. 3. Neural Plasticity., Higher order functions of Cerebral Cortex, Dominant Cortex, Laterality, Verbal and non-verbal communication, Cognition, Learning and Memory- cellular and Molecular basis.Structure activity relationship (neural circuitry) of cerebellum, Vestibular apparatus and its functions, Regulatory function of cerebellum with special reference to autonomic function. 4. Neurophysiological basis of decerebrate rigidity and role of higher centres in the regulation of muscle tone. Importance of basal ganglia in the regulation of automatic movements. 5. Modern concept of hypothalamic functions.Neurological disorders of brain- general cellular events; Mechanism of development of degenerative diseases -Alzheimer's, Parkinson's Disease, ALS etc. 6. Thalamo cortical projections and its influence on evoked cortical activity, Brain Waves, Sleep, wakefulness.	10	12	
12063	NERVE MUSCLE PHYSIOLOGY 1. Nerve: Effects of various degree of nerve injury; Regeneration of nerve; Problem of regeneration of neurone within CNS; 2. Neuro-Muscular Junction (NMJ) : Structural architecture including 3-dimensional structure; End plate potential (EPP) recording and miniature EPP; Neuro-muscular transmission – Electrical and 3. Biochemical events; Acetylcholine receptor – Protein and antigenic structure and its relevance to myasthenia gravis, structure-function relationship; 4. Acetylcholine – Structure-function relationship, Metabolism and Regulation; Drugs acting at NMJ; Acetylcholine esterases; Ganglion-Blocking Drugs; Neurotoxins at NMJ. Motor unit, MUAP, motor unit recruitment patterns, control of human movement. 5. Muscle: Protein components and contraction mechanism, Excitation – contraction coupling, Role of fast and slow channels, Ca++ -binding protein including calmodulin, Muscle fibre types	10	12	
12064	SPECIAL SENSES 1.**Sensory system:** From Receptor to Perception – Sensory modalities, Sensory receptors, Sensory circuits, and Sensory perception. 2.**Chemical senses:** Common chemical sense, Internal chemoreceptors. 3.Taste system – Receptor organs – distribution, ultramicroscopic structures, innervation, - membrane mechanisms of	10	12	

	transduction; Sensory processing; Taste pathways; Taste behaviour. 4.Olfactory system – Olfactory epithelium and receptors, turnover and regeneration of olfactory receptor cells; Central olfactory connections; Psychophysics – Anosmia and directional smelling; Olfaction and behaviour. 5.**Visual Sense:** Structures of retina and sensory transduction; Visual pathway, Visual cortex and cortical processing; Colour vision – retinal and neural mechanisms, binocular and stereoscopic perception; 6 **Auditory Senses :** Organ of corti-ultramicroscopic structure, cochlear mechanics, sensory transduction and processing; Functions of auditory system – Frequency analysis and its discrimination; pitch; Intensity processing – factors determining loudness, discrimination of loudness, loudness adaptation, masking, auditory fatigue; Processing of speech; Perception of sounds in space.			
12065	BEHAVIORAL PHYSIOLOGY AND COGNITIVE FUNCTIONS 1. Approaches and methods in study of behavior; proximate and ultimate causation; altruism and evolution-group selection, kin selection, reciprocal altruism; 2. neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behavior; social communication; social dominance; 3. use of space and territoriality; mating systems, parental investment and reproductive success; 4. parental care; aggressive behavior; habitat selection and optimality in foraging; migration, orientation and navigation; 5. domestication and behavioral changes.	10	12	
Total		50	60	04
HPY-CC22-TH-P07	**Cellular & Molecular Physiology**	**MARKS**	**CONTACT HRS**	**CREDIT**
12071	IMMUNOBIOLOGY 1. Antigens, Antigenicity & Immunogenicity. 2. Structure & Function of Antibody Molecules. 3. Primary & Secondary Immune Modulation: Role of cytokines, chemokines&complement 4. Infection & Immunity 5. Vaccine development	10	12	
12072	MOLECULAR BIOLOGY 1. Genetic Element and its evolution: Fundamental aspects : law of DNA constancy and C-value paradox, Eukaryotic Chromosome Organization, 2. Fundamental and applied aspects of Genomics and Proteomics	10	12	

	3. DNA in Molecular Flux: Replication, Repair, Transpositions, Recombination 4. RNA: coding and non coding RNA: RNA in Molecular Flux: 5. The Catalytic RNA, Post Transcriptional Modification			
12073	BIOTECHNOLOGY AS APPLIED FOR HUMAN HEALTH 1. Concepts of Biotechnology: General & historical, aims, achievements and prospects. 2. Microbial technology : Fermentation technology, production of ethanol, penicillin and other antibiotics, microbial-insecticides, enzymes, amino acids etc. and application in industry. Use of microorganisms in pollution control. 3. Enzyme biotechnology: Immobilized enzymes and its application in industry. 4. Principles of protein engineering. 5. Biotechnology as applied to Immunology.	10	12	
12074	HUMAN GENETICS 1. Organisation of human chromosomes: Normal chromosomal constitution, Autosomal & Sex chromosome, cytogenetic mapping, Karyotype, Karyogram, Ideogram, Chromosomal abnormalities, Polyploidy, Anueploidy, Euploidy, dosage compensation and mechanism of sex determination, etc. 2. Inheritance: Laws of inheritance, Autosomal dominant and autosomal recessive inheritance, X-linked inheritance, traits, alleles, linkage and related disorders. Genes in the Kinderds and in the individuals: Genetic variations, genetic factors in diseases, Pedigree analysis. 3. Immunogenetics: Blood Groups, Histocompatibility and Organ Transplantations. 4. Population Genetics: Hardy-Weinberg equilibrium, mutation, selection, drift, gene flow, inbreeding, genetic diversity, races. 5. Genetics disorders: Sickle cell anemia, hemophilia, thalassemia, cystic fibrosis, Huntington disease, Colour blindness, Phenylketonuria. Cancer Genetics	10	12	
12075	MOLECULAR PHARMACOLOGY: CONCEPTS & PRACTICE 1. Factors influencing drug absorption. Drug distribution - protein binding, tissue binding - blood brain barrier, placental barrier, Biotransformation of drugs - microsomal, non-microsomal metabolism, factors influencing, Pharmacogenetics. Cellular and molecular basis of drug action. Molecular models of Drug receptor interaction Stimulus response mechanisms 2. Agonism and Antagonisms, Drug induced signal transduction mechanisms, Receptor structure & biochemistry, Transporter structure and biochemistry 3. Intracellular communication, The cytoskeleton Cell surface biochemistry, Intracellular trafficking 4. State of the art molecular pharmacological assays measurement of intracellular Ca2+ levels by fluorescence probesmeasurement of membrane potential by fluorescence probes	10	12	

	5. scintillation proximity assay (SPA) techniques, Qualitative evaluation of surface expression of receptors by immunofluorescence, Quantitative evaluation of surface expression by ELISA using fluorescent readout,Immunopharmacology			
Total		50	60	04
HPY-CC23-TH-P08	**Community Health-II**	**MARKS**	**CONTACT HRS**	**CREDIT**
12081	PHYSIOLOGICAL CONCEPTS IN INDUSTRIAL MANAGEMENT 1. Work and health 2. Selection of human resources, Design of workstation 3. Occupational Impact on different systems 4. Physiology for safety and productivity 5. Psycho-physiological aspects of work 6. Shift work, Physiological aspects in Regulations and Recommendations	10	12	
12082	SPORTS MEDICINE & DRUG ABUSE 1. **Physician's Interest in the Physiology of Exercise –** Historical contributions made by physicians, special qualifications of the physician – Physiologist, the sports physician, present realization of the dynamic view of the patient. 2. **Physical Examination –** Scope of the examination, timing of the examination, interpreting the examination to the subject. 3. **Principles of safety in Physical Activity and sports –** Role of conditioning, importance of correct coaching and teaching, the use of protective equipment, following the rules, availability of emergency care. 4. **Management of Illness and Injury sustained in Exercise Activities –** Prompt diagnosis, first –aid procedures, definitive medical care, rehabilitation procedures. **DRUG ABUSE IN SPORTS** • Introduction: Brief history – economic and social causes of drug • History of Doping and Dope materials used. • Classification of Drugs and Mechanism of action. • Dope Methods and Mechanism of action. • 10C rules, code of conduct. • 10C Forbidden list of Dope materials and techniques of identifi	10	12	

	• Drug tolerance, sensitivity and vulnerability • Treatment of drug abuse and viable prophylaxes. • Remedial Measure and Rehabilitation.			
12083	SPACE & AVIATION PHYSIOLOGY **1. Atmospheric requirements of Man in space:** Pressure, O_2, CO_2, Temperature and Relative humidity, Micro-contaminant level, energy requirements, water. **2. Waste removal and/or storage.** **3. Human tolerances to stresses in space including space flight:** Acceleration, Deceleration, Weightlessness, Thermal Extreme, High 'g', Ionizing Radiation, Meteorites. **4. The Cabin Atmosphere (Space Craft):** Nutritional problems, Isolation & Sensory Deprivation. **5. General Medical Emergencies.**	10	12	
12084	STRESS PHYSIOLOGY & ITS MANAGEMENT 1. Defining stress, Stress-responses, Heat stress, Acclimatization to heat, Thermal distress: dehydration and heat cramps, heat exhaustion, heat stroke and prevention of thermal distress, Cold stress: Frost bites and Hypothermia. 2. Effect of stress-inducing and anti-stress agents on the activities of catalase, peroxidases, superoxide dismutases, dehydrogenases.Cardio-respiratory Responses during high altitude acclimatization. 3. Oxidative stress, oxidative damage and mechanisms involved. Stress and Heat Shock Proteins, Stress-induced diseases and their possible remedy by anti-stress agents. 4. Antioxidant Defense; Classical and non-classical antioxidants, reaction mechanisms, Antioxidant enzymes and mechanisms of catalysis. Importance of antioxidants in prevention / amelioration of stress-related diseases. How cells respond to stress. Role of hypothalamo-hypophyseal-adrenal axis. 5. Stress responsive elements and molecular pathways.	10	12	

12085	MICROBES & MICROBIOL PHATHOLOGY 1. General Microbiology: Different types of microbes, classifications; morphology, structure, classification, reproduction and physiology of bacteria. Microbial fermentation; antibiotics; organic acids and vitamins; microbes in decomposition and recycling processes; symbiotic and asymbiotic N2-fixation; 2. microbiology of water, air, soil and sewage: microbes as pathological agents in man; general design and applications of biofermenter and biofertilizer. 3. Man-microbe interactions: Commensals, beneficials, parasites and pathogenic microbes. 4. Microbial Pathogenecity: Germ theory of disease, Infectious diseases and its control. 5. Microbial Flora: Normal microbial flora of humans on the skin, in the Gastro-intestinal tract, Respiratory tract, Urino-genital tract etc. and their role in health and disease.	10	12	
Total		50	60	04
HPY-CC24-PR-P09	**PRACTICAL: HISTOLOGY**	50	60	04
HPY-CC25-PR-P10	**PRACTICAL: HUMAN PHYSIOLOGY/ COMPUTER APPLICATIONS AND BIOSTATISTICS**	50	60	04
Grand Total		**250**	**300**	**20**
THIRD SEMESTER				
HPY-CC31-TH-P11	**Systems Physiology-III**	**MARKS**	**CONTACT HRS**	**CREDIT**
23111	ENDOCRINOLOGY 1. **Principles of endocrinology:** Functions of hormones, interaction of hormones, etc. 2. **Chemistry of Hormones:** Chemical nature, synthesis, storage, release, transport and degradation of steroids, amines and peptide hormones. Cytokines and growth factors. 3. **Mechanism of hormone actions:** Membrane bound and intercellular receptors; steroid hormone-receptor interactions; membrane bound hormone-receptor interactions; second	10	12	

	messenger in hormone action/signal transduction; recycling of receptors. 4. **Hormones in immune responses:** Autoimmune endocrine disorders. Non-Conventional Endocrine Molecules in Health & Disease 5. **Hormonal regulation of metabolism:** Carbohydrate, protein, lipid, water, minerals/electrolyte etc. Metabolic and lifestyle disorders.			
23112	NEUROENDOCRINOLGY&CHRONOBIOLOGY 1. **Neuroendocrinology:** Hypothalamus as neuroendocrine organ, process of neurosecretions and neurosecretory materials, synthesis, transport, release, functions and control of neurosecretory materials. 2. Metabolic regulation of hypothalamic function and role of tanycytes; Neuroendocrine regulation of energy metabolism, Neuroendocrine disorders 3. **Chronobiology:Rhythms in Living Organism:** Terminology and Methodology; Photoperiodisms, Influence of visible light radiation upon living organisms; 4. **Clock and cellular mechanisms of clock:**Zeitgebers, synchronizers, Jet Lag, shift-work, Seasonal Affective Disorder (SAD); Sleep mechanisms, Sleep disorders; Human Circadian Rhythm and its mechanism of control- cellular and molecular mechanisms; The SCN, photic and non-photic entrainment pathways, neurotransmitters; Recent advances : Extra retinal illumination experiments, immediate early genes (IEG) and further developments.	10	12	
23113	REPRODUCTIVE PHYSIOLOGY 1. **Embryology of the gonads and the genital ducts:** Origin of primordial germ cells, differentiation of testis and ovary, germ cells and interstitial tissue. **Function of mammalian testis:** Spermatogenesis; Sertoli cells – germ cells – Leydig cells interaction; functions of sertoli cells and Leydig cells. Structure of Sperm: Histology, Biochemistry and capacitation of spermatozoa. 2. **Functions of mammalian ovary:**Folliculogenesis, Ovogenesis, Ovulation, Luteinization and Luteolysis. Biological action of gonadotropins on gonads. Feed-back control of gametogenesis and endocrine functions of gonads. Photoperiods and grade (nerve	10	12	

	pathway of light to pineal gland, synthesis of melatonin and its influence on gonads). 3. **Fertilization:** Molecular mechanism of fertilization; acrosomal reaction; chemical, mechanical and immunological method of controlling fertility; in vitro fertilization, preservation of gamates and embryotransfer. 4. **Onset of Puberty:** Reproductive cycles and its hormonal regulation. **Implantation:**Decidualization, function of placenta and foeto-placental unit, placental hormone (synthesis, control, role in foetal life and bioassay of HCG). 5. **Parturition and Lactation:** Regulation of parturition and lactation. **Reproduction and Senescence**.**Principle and Techniques of fertility regulation in male and female**.			
23114	EVOLUTIONARY BIOLOGY **1. Emergence of evolutionary thoughts:** Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis. **2. Origin of cells and unicellular evolution:** Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism. **3. Paleontology and evolutionary history:** The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants and animals; stages in primate evolution including Homo. **4. Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence. **5. The Mechanisms:** Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of	10	12	

	change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.			
23115	STEM CELL AND DEVELOPMENTAL BIOLOGY 1. Basic concepts of development: potency, commitment, specification, induction, competence, determination and differentiation, morphogenetic gradients, cell fate and cell lineages, genomic equivalence and cytoplasmic determinants, imprinting, mutants and 2. transgenics in the analysis of development 3. Gametogenesis, fertilization & early development, Morphogenesis & organogenesis, Programmed cell death, ageing and senescence Definition AND types of stem cell 4. Genesis and differentiation of stem cells in different organs, Placenta as a source of stem cells and its importance in stem cell research 5. Stem cells: Applications and future in Modern Biology and Health Sciences.	10	12	
Total		50	60	04
HPY-CC32-TH-P12	**Community Health-III: Hazards and Prevention**	**MARKS**	**CONTACT HRS**	**CREDIT**
23121	OCCUPATIONAL HEALTH & PREVENTION OF HEALTH HAZARDS 1. **Introduction to occupational health:** Concept of BernardinoRamazzini. 2. **Prevention of hazards: Personal Protective Devices:**Respiratory protective equipments : Divisions and Uses 3. **Industrial ventilation :** Local Exhaust System as Engineering control 4. **Role of OSHA and NIOSH:** Prevention and management of occupational health hazards	10	12	
23122	DESIGN ERGONOMICS & DECISION MAKING MODELS 1.**Ergonomics in Design :** Concept of Detailed and Total Design 2.**Design Process :** Concept, Scheme Design, Post production	10	12	

	3. **Evaluation of Design:** SWOT,STEP 4. **System Design and Cognitive Ergonomics:** Concept of System Design, basic ideas on cognitive processing and its application in accident prevention. 5. **Decision Making Models:** Simple Decision Model,Pay off Matrices, Decision Tree, Prior and Posterior Probability in identification of Product acceptability.			
23123	PRINCIPLES OF ENVIRONMENTAL PHYSIOLOGY 1. **The Environment:** Physical environment; biotic environment; biotic and abiotic interactions. **Habitat and niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. 2. **Species interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. **Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. 3. **Ecological succession:** Types; mechanisms; changes involved in succession; concept of climax. **Ecosystem:** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). 4. **Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. **Applied ecology:** Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. 5. **Conservation biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).	10	12	
23124	ENVIRONMENTAL POLLUTION, XENOBIOTICS AND ITS MANAGEMENT 1. Environmental Air Pollution, Noise Pollution, Water Pollution and its control .	10	12	

	2. Environmental Radiation and Thermal Pollution and their control. 3. Types and pathways of metabolic reactions; Involvement of cytochrome P.450 – its isoforms and inhibitorsxenobioticmetabolising enzymes Fate of xenobiotic metabolites Factors influencing xenobiotic metabolism; 4. Pharmacologic, toxic, immunologic and carcinogenic effects 5. Clinical correlations and biomedical importance.			
23125	CHALLENGES IN HUMAN HEALTH: DIASTER, STARVATION, POVERTY: 1. Human Health in extreme situations like flood, drought, Landslides, Earthquake, starvation . 2. Malnutrition and nourishment, Compromise of Nutrition 3. Major Public Health Conditions and there prevention 4. Major water and food borne pathologic development s during disaster 5. Management and Preparedness for better living and awareness program.	10	12	
Total		50	60	04
HPY-CC33-TH-P13	**Modern Techniques in Physiology-I**	**MARKS**	**CONTACT HRS**	**CREDIT**
23131	PRINCIPLES OF GENETIC ENGINEERING&RECOMBINANT DNA TECHNOLOGY 1. Molecular Cloning: Vectors, Host, Restriction Enzymes, Transformation, Detection 2. PCR and Real Time PCR, site directed mutagenesis 3. Hybridisation, Immunoblotting DNA micro-array relevant Technique 4. DNA Sequencing, Classical and Modern, and relevant conventional techniques and their principles.. 5.Regenrative Medicine, Gene Therapy	10	12	
23132	IMMUNOTECHNOLOGY AND IMMUNODIAGNOSTICS 1. ANTIBODY GENERATION 2. ELISA, RIA 3. WESTERN & IMMUNOBLOTTING, IMMUNOPRECIPITATION 4. FLOW CYTOMETRY	10	12	

	5. IMMUNOFLUORESCENCE MICROSCOPY IN SITU LOCALIZATION TECHNIQUES (FISH/FLOW FISH)			
23133	CELL & TISSUE CULTURE TECHNIQUES 1. **Cell separation by different techniques.In vitro cell culture, properties of transformed cells.** 2. **Cell line, cell clone, cell fusion. Cell and Tissue culture media.** **3. Gene transfer method in animal cells. Transgenic biology. Tissue culture:** Principle and its practical application. Tissue transplantation technique Hybridoma technology. **4. MICROSCOPY** • LIGHT FLUORESCENCE, SCANNING & TRANSMISSION ELECTRON MICROSCOPY • FIXATION & STAINING TECHNIQUES FOR EM, FREEZE ETCH AND FREEZE FRACTURE METHODS FOR EM, CONFOCAL MICROSCOPY 5.IMAGE PROCESSING METHODS IN MICROSCOPY	10	12	
23134	**TECHNIQUES IN BIOPHYSICAL CHEMISTRY** 1. Electromagnetic spectrum- interaction with non-living and living matters. 2. UV-Vis absorption spectroscopy, fluorescence spectroscopy,infraredspectroscopy, Circular dichroism. 3. Atomic absorption spectroscopy;mass spectroscopy, plasmon resonance spectroscopy. 4. Separating techniques- electrophoresis, chromatography. 5. Radioisotopes, their detection and application.	10	12	
23135	**ELECTROPHYSIOLOGICAL TECHNIQUES** 1. Introduction to different electrophysiological techniques. 2. Recording electrodes- metal, glass. 3. Electrical properties of the cell membrane- membrane potential- driving force, membrane resistance, membrane capacitance; Electronic model of the plasma membrane. 4. Patch clamping- recording modes: voltage clamp and current clamp. 5. Patch clamp configurations and their equivalent electronic circuits.	10	12	
Total		50	60	04
HPY-GEC31-TH-P14	**GENERIC ELECTIVE COURSE (GEC) - CBCC** **Physiology Students will opt CBCC offered by other Department**	50	60	04

HPY-GEC32-TH-P15	**GENERIC ELECTIVE COURSE (GEC) - CBCC** **Physiology Students will opt CBCC offered by other Department**	50	60	04
Grand Total		**250**	**300**	**20**
FOURTH SEMESTER				
HPY-CC41-TH-P16	**Modern Techniques in Physiology-II**			
24161	APPLICATION OF INVASIVE AND NON INVESIVE TECHNIQUES IN IDENTIFICATION OF OCCUPATION RELATED DISEASES 1. Qualitative and Quantitative Assessment of occupational diseases : introduction 2. Analysis of Working Postures : OWAS 3. Identification of noise induced hearing loss 4. Evaluation of Physical and Mental Stress during work and exercise 5. Evaluation of Respiratory conditions in work and sports	10	12	
24162	NANOTECHNOLOGY & ITS APPLICATIONS IN PHYSIOLOGY 1. Definition, Principles of NanotechnologyNanoparticles - Biophysical and Biochemical Characteristics a. An idea of nanotechnological solutions to problems intissue engineering, molecular imaging, Biosensors and diagnostics. 2. Concept of "Nanoproducts" that will aid in early detection, real-time assessment of drug efficacy, symptom management and the knowledge of the discovery of new targets for anticancer therapy. 3. Concept of nanofabrication. An overview of scanned probe microscopy and analysis including scanning tunneling microscopy (STM), atomic force microscopy (AFM), and scanning transmission electron microscopy (STEM). Basic idea about the devices to study the molecular interactions that drive the release of chemical messengers. 4. Concept of red-emitting quantum dots and quantum dot-tagged cancer cells. 5. Concept of surface polymerization to generate patterned arrays for binding of biomolecules	10	12	
24163	MODERN IMMAGING TECHNIQUES Modern techniques and Principles for studying nervous mechanism including neuroimaging, CT, MRI, PET, SPECT, BOLD,	10	12	

24164	BIOMEDICAL INSTRUMENTATION 1. Transducers- classifications, active, passive. 2. Transducers for measurement oftemperature, force, pressure, positioning, flow, heart rate. 3. Optical fiber sensors, electrochemical sensors. 4. Measurement and recording of electrical signals; analog and digital meters. 5. Recordingsystems- cathode ray oscilloscope, chart recorder, galvanometric recorder, potentiometric recorder, ultraviolet recorder, optic fiber recorder, magnetic tape recorder, computer data logging.	10	12	
24165	CONCEPTS OF OMICS: APPLICATIONS AND ANALYSIS 1. Concept of OME and OMics 2. Genomeics, Proteomics, Metabolomics 3. Techniques applied for OMICS study 4. Softwares and Anaysis 5. Application of "Omics" in humanAnalysis	10	12	
Total		50	60	04
HPY-DSEC41-TH-P17	**DISCIPLINE SPECIFIC ELECTIVE COURSE(THEORY)* Students will opt DSEC offered by Parent Department**	50	60	04
HPY-DSEC42-TH-P18	**DISCIPLINE SPECIFIC ELECTIVE COURSE(THEORY)* Students will opt DSEC offered by Parent Department**	50	60	04
HPY-DSEC43-PR-P19	**DISCIPLINE SPECIFIC ELECTIVE COURSE(PRACTICAL)* Students will opt DSEC offered by Parent Department**	50	60	04
HPY-DSEC44-PS-P20	**DISCIPLINE SPECIFIC ELECTIVE COURSE(PROJECT AND SEMINAR)* Students will opt DSEC offered by Parent Department**	50	60	04
Grand Total		**250**	**300**	**20**
Post Graduate Grand Total		**1000**	**1200**	**80**
	* List of **DISCIPLINE SPECIFIC ELECTIVE COURSES (DSEC)**: (i) Biochemistry (ii) Biophysics & Electrophysiology (iii) Endocrinology & Reproductive Physiology (iv) Environmental Physiology (v) Ergonomics & Work Physiology (vi) Immunology & Microbiology (vii) Neurophysiology			

	(viii) Nutrition & Dietetics (ix) Sports & Exercise Physiology (x) Molecular Cell Biology (xi) Biostatistics and Analytics			

DETAILED SYLLABUS OF DISCIPLINE SPECIFIC ELECTIVE COURSES (DSEC)

COURSE OFFERED BY PHYSIOLOGY DEPARTMENT FOR STUDENTS OF PHYSIOLOGY DEPARTMENTS

Paper: **DSEC41-TH-P17, HPY-DSEC42-TH-P18 & HPY-DSEC43-PR-P19, HPY-DSEC44-PS-P20**

"P"– stands for Paper,

FOURTH SEMESTER

BIOCHEMISTRY

PAPER 17	**THEORETICAL**	**Marks**	**Contact Hrs**
		50	**60**
24171BC	**Cell Biology,Molecular Biology and Genetics**	**10**	**12**
	a) Subcellular fractionation, Specialised cells, Molecular basis of motility, cell cycle, Cell differentiation and transformation. Tissue culture-concepts and techniques.		
	b) Replication of DNA *in vivo*, DNA synthesis *in vitro*. Base sequence of DNA, its significance and different methods for its determination. Bacterial and viral genetics, Genetic expression and its control. Repair of DNA. Vectors, cloning of DNA, genomic and c-DNA library, and applications in biomedical fields. Gene Silencing, exon shuffling, frame shifting, gene knock out, gene therapy.		
	c) Genetics:Mendelian (classical) and applied. Epistasis, linkage, genetic drift- clinical prospects.		
24172BC	**Proteins, Proteomics and Functional Genomics**	**10**	**12**
	a) Protein synthesis and its regulation.		

b) Primary concept of Proteomics and New Biology. Overview of analytical Proteomics. Analytical protein and peptide separations, protein digestion techniques, mass spectrometers for protein and peptide analysis, protein identification by peptide mass fingerprinting. Peptide sequence analysis by tandem mass spectrometry. Structural Proteomics. Protein dynamics. Structural evolution-(a) Structures of cytochromes c (b) Gene duplication. Protein microarrays in disease investigations. Applications of Proteomics: Mining proteomes, protein expression profiling, identifying protein-protein interactions and protein complexes, mapping protein modifications. Future developments and challenges.

c) Concept of genome and genomics. A brief idea about the organization and structure of genomes. The organization of nuclear DNA in eukaryotes. DNA microarray technology and its application in disease investigation.Nanobiotechnology

24173BC **Membrane Biology and Enzymes** **10** **12**

a) Structure of membranes, membrane-bound enzymes and cell surface receptors.

b) Mechanism of membrane transport and cell signalling.

c) Serine proteases: Mechanism of action, events at the active site. The digestive serine proteases- chymotrypsin: Kinetics and catalytic mechanism. Transition state stabilization in serine protease. Aspartic proteases: mechanism of action.

d) Comparative biochemistry of myoglobin and hemoglobin: Insights into allostery.

e) Enzymes in clinical diagnosis: 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.

24174BC **Photosynthesis and Nitrogen Fixation** **10** **12**

Photochemical reactions in the membrane; Photooxidation of chlorophyll, Protein-bound chlorophyll; Cyclic electron-transport chain; Chloroplasts-photosystem I and II; Carbon fixation – The reductive pentose cycle, Ribulosebiphosphate carboxylase/oxygenase, photorespiration and C_4 cycle.

Enzymology of nitrate assimilation and nitrogen fixation, The Nitrogenase complex, Regulation of nitrogen fixation – influence of ATP/ADP ratio, identification of nif genes, repression of nif genes.

24175BC **Free Radical Biology in Health and Disease** **10** **12**

Chemistry of biologically important radicals and non-radicals. Antioxidant defenses: endogenous and diet derived. Cellular responses to oxidative stress: adaptation, damage, repair, senescence and death. Measurement of reactive oxygen species. EPR Spectroscopy. Reactive species and diseases. Molecular mechanisms of aging.

PAPER 18 THEORETICAL

24181BC Neurobiochemistry and Biochemical basis of Neuropharmacology **10** **12**

Biochemistry of the nervous tissues: carbohydrate, protein and nucleic acid metabolism in brain. Transport and metabolism of amino acids in brain. Biochemistry of synaptic and neuronal transmission. Biochemistry of developing and ageing brain. Biochemistry of sleep, memory, learning and neuropsychiatric disorders. Neuropharmacological drugs and their interaction with brain metabolites and specificity with target organs. Pharmacogenomics.

24182BC Hormonal Biochemistry **10** **12**

Biochemistry of hormones. Biosynthesis and molecular mechanism of action of hormones – hormone-receptor interactions and signal transduction. Hormones in genetic regulation. Radioimmunoassay of hormones. Hormonal replacement therapy.

24183BC Immunobiochemistry **10** **12**

General principles of immunology, Kinds of immunity, Chemical nature of antigens and antibodies. Cells and organs involved in the antibody production. Clonal selection theory. Immunoglobulin genes and generation of antibody-diversity; antigen-antibody interactions, complement fixation reactions, structure of antibody molecule; MHC, antigen processing and presentation. T-cell receptors. Hypersensitivity, Monoclonal antibodies, Hybridoma technology, Types of cellular interactions – helper and suppressor functions helper/suppressor determinants, mechanism of suppression, macrophage-T cell interaction, idiotype recognition. Cancer and immune system, malignant transformation, oncogenes. Immune mechanism of tumor cell killing. Immunobiologicals, Vaccines. Immunodiagnostics (methods).

24184BC Stem Cells, Molecular Biology of Cancer and Applied Biochemistry **10** **12**

a) Stem Cell Biology:Basic concepts. Stem cell engineering. Apoptosis: Concepts and Mechanisms. Properties of cancer cells, Oncogenes, Carcinogenesis, Cancer treatment: present and future, Tumor markers, Tumour immunology.

b) Biochemical effects of food, toxins, edible oils and environmental pollutants on human health. Biochemistry of Nutrition related disorders.

c) Advanced Biochemical Techniques: Autoanalyser, Spectroscopy, Mass Spectroscopy, (FAB-MS), Liquid crystal Mass Spectroscopy (LC-MS),Fast Atom Bombardment, NMR.

24185BC **Microbiology and Biochemical Toxicology** **10** **12**

a) General introduction – Man, microbes and systematic microbiology – environment, study of microbes including their general microbiology – life history, reproduction, classification and methods of identification. Microbial ecology – microbial interaction in the rumen, synergism and commensualism , Microbes in gastrointestinal tract and their role in health and disease; germ-free life study, Methods of sterilization with special reference to thermolabile substance and tests for sterelity.

b) Biochemical toxicology: Acute and chronic toxicity testing, LD_{50} determination, Therapeutic index, routes of administration; Drug kinetics, tolerance and excretion. Biochemical basis of detoxification.

PAPER 19 **PRACTICAL** **50**

Methods of Protein Estimation:

a) Folin-Lowry's Method

b)Bradford Method

c) Ultraviolet Absorbance Method

d)Microkjeldahl Method.

Biochemical Separation Techniques

1. Separation of amino acids by paper chromatography (Ascending, descending and two dimensional).
2. Separation of sugars by paper chromatography.
3. Separation of amino acids and lipid fractions by thin layer chromatography.
4. Purification of proteins by salt precipitations and column chromatography.
5. Separation of mixtures of proteins by Sephadex Gel Filtration (column).
6. Separation of proteins by Polyacrylamide Gel Electrophoresis (PAGE).
7. Separation of proteins by Agarose gel electrophoresis

Determination of Isoelectric pH of proteins

Tissue Culture and microscopy: Preparation of media, Cell counting and plating, Transfection with a GFP vector and monitoring by immunofluorescence

microscope (demonstration). Study of cellular stress using COMET assay – Apoptosis, Necrosis and DNA damage.

Assay of vitamins

1. Titrimetric and colorimetric methods – Estimation of ascorbic acid (total and free) in biological samples (blood, tissues etc.) by methods using different oxidising agents (Bromine, 2,6-dichlorophenolindophenol and activated charcoal).
2. Spectrofluorometric methods.

Studies on Enzymes

1. Effects of pH and temperature and determination of Q_{10}; Kinetics – Effects of substrate concentration, determination of Km, Vmax and effect of competitive and non-competitive inhibitors.
2. Tissue respiration – to study the activity of succinic dehydrogenase in presence or absence of inhibitors.

Food macro and micro nutrient content analysis (ascorbic acid. Ca, PO4, Fe etc.)

Clinical Enzymology

1. Determination of SGOT and SGPT.
2. Determination of serum lipase.
3. Determination serum creatine phosphokinase (may be used for estimation of CPK M Brand).

Differential centrifugation Techniques: Isolation of subcellular fractions.

Immunology

1. Immunisation and production of antibody.
2. To study the agglutination, hemagglutination and bacterial reactions.
3. Immunoeleectrophoresis and Immunodiffusion techniques.
4. Separation of Splenic Lymphocytes.
5. Separation of Peritoneal Macrophages.
6. Cell function studies.

Microbiology

1. Preparation of media and cultivation of bacteria, molds and yeasts and their isolation from natural sources.
2. Microbial morphology: a) gram staining and acid fast staining, b) spore staining, c) staining of molds, d) staining of yeast, e) determination of microbial dimensions.

3. Isolation of a pure culture from mixed bacterial culture by (i) streaking, (ii) pour plate, (iii) spread-plate techniques.
4. Study of the growth-kinetics of bacteria and determination of generation time

PAPER 20 **PROJECT AND SEMINAR** **50**

BIOPHYSICS AND ELECTROPHYSIOLOGY

PAPER 17	**THEORETICAL**	**Marks**	**Contact Hrs**
		50	**60**

24171BE **Biophysical properties of biological macromolecules** **10** **12**

1. Historical overview, relation between physics, biology and medicine.
2. Water: Molecular structure, association of water molecules through H-bonding, nature of hydrophobic interactions, physico-chemical properties of water, state of water in bio-structures & its significance.
3. Acids and Bases: Mole & normality, weak acids, amphoteric electrolytes, pH, measurements of pH, Henderson Haselbatch equation, pK values, buffer systems.
4. Structural level of proteins & stabilizing forces, conformational properties of polypeptides, proteins in solution.
5. Double helical structure of DNA, conformational parameters of nucleic acids & their constituents, DNA supercoiling, circular DNA.
6. Mechanical properties of cell materials, mechanical properties of cell membrane.

24172BE **Dynamics of physiological fluids** **10** **12**

1. Hydrodynamics and Hemodynamics: Principle and application in biological system, pressure flow relationship in rigid and in vascular systems.
2. General concept of viscosity, coefficient of viscosity, and different factors affecting viscosity; viscometry, viscoelasticity. Principle of measurement of viscosity. Viscosity of elemental protoplasm.
3. Development of turbulence in flowing blood and its significance. Laminar and turbulent flow, Reynold's number, concept of critical closing pressure,
4. Newtonian and non-Newtonian fluids.
5. Poiseuille's law, Bernoulli's equation.

6. Effects of gravity and external acceleration on circulation.
7. Haemodynamics in different phases of the cardiac cycle. Heart sounds.
8. Mechanical power of heart.

24173BE **Mechanics in Pulmonary system and phonation** **10** **12**

1. Mechanics in breathing: Elasticity of lung and thorax, their role in breathing, compliance.
2. Airway resistance, pulmonary vascular resistance.
3. Ventilation and perfusion: Ideal gas equation, Dalton and Henry' laws for partial pressures; Fick's law for diffusion of gas.
4. Work of breathing.
5. Vocal cord: structural overview, production of speech – vocal mechanism.

24174BE **Biophysical and electrophysiological properties of excitable tissues** **10** **12**

1. Biophysics of muscle: Electron and light microscopic structure of both skeletal and smooth muscle.
2. Various modes for study of muscle contraction. Muscle contraction at the molecular level.
3. Electrophysiology of excitable tissues: electrophysiological techniques – single fibre and microelectrode techniques – patch clamp and voltage clamp.
4. Sensory transduction, generation potential, action potential, conduction velocity of nerve, cold block, anodal block.
5. Physiology of receptors: pulmonary receptors, muscle receptors, chemo-receptors and baro-receptors; static and dynamic behavior of muscle receptors.
6. Physiology of synapse, synaptic potential, pre-synaptic and post-synaptic inhibition, excitatory post-synaptic potential.
7. Dynamics of oxygen deprivation and electrophysiological changes during myocardial ischemia.
8. Electrical potential of cardiac muscle, skeletal muscle and brain.

24175BE **Thermodynamics, thermoregulation and G-force** **10** **12**

1. Laws of Thermodynamics, living body as a thermodynamic system, concept of free energy, unavailable energy & entropy, negative entropy change in living system, heat content of food, Bomb colorimetry, energy generation & energy transfer processes in biochemical reactions, metabolism of glucose & formation of ATP.

2. Gravitational fields: concept, and their effects on living system; effect of positive and negative 'G' forces on living materials.
3. Physical mechanism of heat loss and temperature regulation: Thermal regulation, relationship between skin temperature and blood flowing through it, thermal-circulation index.
4. Thermo-electricity: thermo-couple principle.

THEORETICAL

PAPER 18		**50**	**60**
24181BE	**Aviation, high altitude, space & deep-sea physiology**	**10**	**12**

1. Effect of low oxygen pressure on body, mountain sickness, clinical lessons at high altitude.
2. Effect of acceleratory forces on the body in aviation & space physiology.
3. Radiation & temperature, Problems at high altitude & space, weightlessness in space, Physiological adaptation to space flight.
4. Physiology in deep sea diving & other high-pressure operations.

24182BE	**Mechanical engineering of the body and bioelectronics**	**10**	**12**

1. Mechanical properties of soft elastic tissues.
2. Stress-strain relationship of physical systems and comparison with bones and soft tissues (special and hollow organs).
3. Physical lever systems and their application in human body.
4. Fundamentals of electronics: vacuum diodes and triode, pentode; diodes as rectifier, triode and pentodes as amplifiers; D.C. amplification, operational amplifiers, use of FET and MOSFET devices.
5. Basic principles of modulation and demodulation, AM and FM modulation.
6. Basic idea of integrated circuits, logical operations: AND, OR, NOR, MAND.
7. Boolean-algebra, binary units, basic ideas of analog and digital computers.

24183BE	**Hydrodynamics and electro-analytical techniques**	**10**	**12**

1. Chromatography: principle of thin layer, paper, column and gas chromatography, HPLC.
2. Centrifugation & ultracentrifugation, viscometry, osmosis, diffusion and surface tension.
3. Isoelectric focusing, potentiometry, pH meter, ion selective electrodes, conductometry.
4. Electrophoresis: agarose gel and polyacrylamide gel electrophoresis (PAGE): principle of separation of protein and nucleic acids.

24184BE	**Ultrasound and ionizing radiations: interaction with living organism**	**10**	**12**

1. Sound: general physics.
2. Physical properties of ultrasound, interaction with human body.
3. Application of ultrasound: Diagnostic, therapeutic and in research. Physiological effects of ultrasound therapy.
4. Ionizing radiations: general concepts, different forms of ionizing radiation, Source of ionizing radiation. Application of ionizing radiation: Diagnostic, therapeutic and research.
5. Electromagnetic field and microwaves: concept, effect on biological system.

24185BE	**Biomedical instrumentation**	**10**	**12**

1. Ballistocardiograph, electrocardiograph
2. Electric thermometer
3. Ultrasonic imaging system: A, B, M scans and real time imaging.
4. Echocardiogram
5. Blood gas analyzers: blood pH,
6. Blood pCO2, blood pO2.
7. Detection of radiation by ionization chamber: GM counter, proportional counter, liquid scintillation counter.
8. Pulmonary function analyzers: spirometry, respiratory gas analyzers.
9. Blood flow meters: Electromagnetic, ultrasonic and NMR, laser Doppler.
10. Different spectroscopic techniques and Differential Scanning Calorimeter.

PAPER 19	**PRACTICAL**	**50**

1. Determination of strength-duration curve, measurement of contraction kinetics of excitable tissues, measurement of conduction velocity of nerve fibre.
2. Determination of isometric twitch-tetanus of toad with different drugs. Calculation of work done by muscle.
3. Experiments using electrophysiological techniques: Skin receptors and demonstration of dermatomes in frog. Muscle spindle, Golgi tendon organ activity demonstration in toad/frog.
4. Recording of ECG, EEG and EMG: ECG recording in normal conditions and under different postures. EEG – spontaneous and evoked by sensory stimuli; EMG measurement in normal and pathological condition.
5. Experiments on Hemodynamics: Pressure-flow relationship in rigid system and biological system with different drug activities.

6. Measurement of viscosity of biological and non-biological samples.
7. Separation of plasma protein by gel electrophoresis.
8. Purification of protein using column chromatography, Analysis of purified protein by spectrophotometric and spectrofluoremetric method.
9. Experiment on thermo-electricity: Measurement of skin temperature in normal condition, various environmental conditions.
10. Kymographic experiments: Recording of normal blood pressure and respiration, effect of drugs, viscero-vascular reflex, somato-vascular reflex.

PAPER 20	**PROJECT AND SEMINAR**	**50**

ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY

PAPER 17	**THEORETICAL: Molecular Endocrinology**	**Marks**	**Contact Hrs**
		50	**60**
24171ER	Discovery of hormones as chemical signals for control and regulation of physiology processes. Techniques for quantitation of hormones; RIA, immunoradiomertic assays (IRNA), immonochemilumetric assays (ICMAS), radioreceptor assays, functional hormone bioassays; statistical procedure for immunoassay data-deduction, design and development of hormone assays.	**10**	**12**
24172ER	Structure of peptide and protein hormones; purification and characterization of hormones. Structural-functional relationship in different hormones. Phylogenic analysis of hormone structure and function , pharmokinetics of hormones.	**10**	**12**
24173ER	Genetic control of hormone formation : subcellular structure of cells that secrete protein hormones , storage and secretion of hormones – molecular mechanism of regulation. Structure of a gene encoding a polypeptide hormone ; regulation of gene expression: transcriptional and post transcriptional mechanisms of hormone biosynthesis and secretion. Hormonal genes and hormone regulated genes in the context of biosynthesis. Inhibitors of biosynthesis and their use. Metabolism of hormones by target and non-target tissues.	**10**	**12**
24174ER	Discovery of receptors in target tissues; biochemistry and molecular biology of steroid receptors, hormonal control of gene expression, RNA synthesis, RNA stability and steroid hormone action. Hormones that act at the cell surface: mechanism of hormonal action and signal attenuation. Signal discrimination, signal transduction and signal amplification in hormone regulated physiological processes. Receptor antagonists and their applications.	**10**	**12**

24175ER	Autoimmunity and endocrine disorders – generation of specificity, recognition of antigens, tolerance of self antigens, mechanism of autoimmunity, genetics of autoimmunity, non-endocrine function of endocrine molecules, non-conventional endocrine molecules in health and disease. Endocrine disruption.	**10**	**12**
PAPER 18	**THEORETICAL: Neuroendocrinology/ Reproductive Physiology**	**50**	**60**
24181ER	Neuroendocrinology – neuronal control of glandular secretion; hypothalamic-pituitary unit; regulation of secretion of tuberohypophysial hormones; feedback concept in neuroendocrinology: neuroendocrine control of pituitary hormones; pineal gland; circumventricular organs, neuroendocrine disorders, neuro-endocrine-immune interaction. Neurone as target cells for hormone action, neuronal modification of hormone metabolism and regulation of neuronal function – effect of ion channels, electrical events.	**10**	**12**
24182ER	Sex determination and differentiation – mechanism of determination and sexual differentiation – differentiation of gonads and differentiation of genital tract. Male reproductive system: an overview of male reproductive physiology. Male sterility, Azoospermia, Oligozoospermia, Asthenzoospermia, varicocele, genetic basis of male infertility.	**10**	**12**
24183ER	Female reproductive system : an overview of female reproductive physiology; puberty, folliculogenesis, ovulation, lutenization, lutelysis, follicular atresia.	**10**	**12**
24184ER	Fertilization, capacitation, acrosomic reaction, sperm-egg fusion, activation of eggs, prevention of polyspermy, implantation, parturition and lactation. Contraception leading to prevention of fertilization – surgical, hormonal and immuno contraception.	**10**	**12**
24185ER	Reproductive senescence : male and female designing experiments for the study of breeding and fertility – breeding of laboratory animals. Principle and techniques of animal cloning.	**10**	**12**
PAPER 19	**PRACTICAL**	**50**	
2419ER	I. Surgical Techniques 1. Thyroidectomy 2. Adrenalectomy 3. Ovariectomy 4. Castration 5. Pancreatectomy		

6. Cryptorchidism

II. Histological and histochemical techniques

1. Study of estrous cycle after unilateral and bilateral ovariectomy with and without estrogen treatment
2. Compensatory hypertrophy of adrenal and thyroid gland after unilateral adrenal and thyroidectomy
3. Compensatory hypertrophy of testis after unilateral castration
4. Studies on thyroid gland in hypo and hyperthyroid condition
5. DNA and chromosomal studies in endocrine disorders
6. Basic studies on Immunocytochemistry in hypo and hyper active conditions of endocrine glands
7. Studies of certain enzymes of TCA cycle and steroidogenic pathway in adrenal glands
8. Sperm count and motility and effect of some antifertility agents

III. Biochemical Techniques

1. Estimation of Ascorbic acid, Cholesterol, Blood Glucose, and Glycogen levels under experimental conditions
2. Determination of serum sodium in experimental condition.
3. Chromatographic separation of amino acids/ peptides.

IV. Biochemical Techniques

1. Bioassay of oxytocin on rat's uterine contraction
2. Bioassay of adrenaline on rat's intestinal contraction
3. Bioassay of adrenaline on blood pressure of cat
4. Assay of any one hormone by RIA/ELISA for which facility exists

PAPER 20 PROJECT AND SEMINAR 50

ENVIRONMENTAL PHYSIOLOGY

PAPER 17	**THEORETICAL**	**Marks**	**Contact Hrs**
		50	**60**

24171EP **INTERACTION BETWEEN MAN AND ENVIRONMENT** **10** **12**

a) ORIGIN OF LIFE, EVOLUTION.

b) ECO SYSTEM (Concept and dynamics of ecosystem, types of ecosystem, components, food chain and energy flow, productivity and biochemical cycles. Population ecology and biological control.).

c) BIODIVERSITY (Biodiversity: major habitat types of subcontinent, seasonality of subcontinent, geographic origin and migration of species).

d) SUSTAINABLE DEVELOPMENT and ITS IMPORTANCE.

24172EP **ENVIRONMENTAL TEMPERATURE AND PHYSIOLOGICAL SYSTEMS: HEAT AND COLD** **10** **12**

- Heat balance; Cellular and metabolic changes; **Heat** disorders and stroke and remedial measures; Adaptation or acclimatization to heat at Cellular, Organ and System levels; Heat stress and cellular oxidative stress and its protective mechanism; Effect of heat on body immune system; Arid zone physiology – effect of extreme dry and wet heat on performance of work by normal inhabitants and soldiers and others – limitations involved and remedial measures.
- Acute and chronic exposure of **cold**; Mechanisms of heat conservation – insulation, behavioral, haemodynamical and neurophysiological; Non-shivering thermogenesis; Chemical thermogenesis, mobilization of fat and caloric shunt; Mechanism of adaptation in youngs, adults and aged; Dietary modifications involved in combating cold; Cold stress and body defence system – impact on immuno-modulating systems; Cold and cellular oxidative stress – impact on antioxidativedefence system; Work performance at low temperature and its limitations; Polar and Antarctic Physiology – Physiological and metabolic adaptation at – Cellular, Organ and System levels; Neurological disturbances due to altered environment.

BAROMETRIC PRESSURE AND PHYSIOLOGICAL SYSTEMS :
Hypobaric and Hyperbaric Physiology

24173EP

- Effects of high altitude on human endurance, acclimatization and performance of work in mountaineering and when guarding the borders, Permanent human habitation and limitations of survivability for longer periods in the Himalayan conditions; Cellular basis of physiological changes and adaptation; Low pressure oxygen effects; High pressure oxygen effects; Changes in immune responses – its cellular basis. **10** **12**

Limitations of physiological functions in under-sea environment, deep-sea diving, underground mines – their limitations; Their cellular and metabolic basis; Use of technology to overcome such restrictions; “Decompression Sickness” or ‘Dysbarism’ and its remedial measures to increase work efficiency.

24174EP	**ADVANCED ISSUES IN SPACE PHYSIOLOGY**	**10**	**12**

- Changes and maintenance of various physiological functions in space; performance of work in weightlessness; Science and Technology involved in the maintenance of normal physiological functions. Effects of +G and – G forces.
- Significance of Biological Rhythms**:** Biospheric vs. extrabiospheric.

24175EP	**ADVANCED TECHNICAL APPROACHES and ITS APPLICATION in ENVIRONMENTAL PHYSIOLOGY**	**10**	**12**

- Application ofGenomics, Proteomic and Metabolomics; Stem cell research; imaging technologies.
- Bioremediation and Phytoremediation; Economical importance of plant products and microbes for benefit of health.

PAPER 18	**THEORETICAL**	**50**	**60**

24181EP	**ENVIRONMENTAL FACTORS AND THEIR IMPACT ON PHYSIOLOGICAL SYSTEMS**	**10**	**12**

PHYSICAL FACTORS- RADIATION NOISE, ILLUMINATION

Impacts of ultraviolet rays specially on skin, eye, etc.; Impacts of infrared radiowaves and other non-ionizing radiations specially on skin, circulation, etc.; Impacts of visible day-light and artificial light at different levels.; Impacts of sound waves or sonic vibrations – noise pollution; Concept of geomagnetism and its impact on human body.; Impacts of cosmic radiations, X-Rays and γ-Rays

CHEMICAL FACTORS

- Effects of inert gases; Effects of CO_2, SO_2, NO_2 ; Formation of photochemical oxidants or secondary products and their potential health hazards; Dusts and other suspended particulate matters (SPM) and their impact on physiology of health; Heavy metals.

- ***Metals and other chemicals*** and their impact on Human Systems specially the Liver, Kidney and Lungs and other Health Parameters, and remedial measures.
- ***Pesticides*** and their health hazards and remedial measures.
- ***Food Preservatives, Additives and Toxins*** and their impact on health and remedial measures against health hazards.
- Metabolism and safe use of drugs in different environmental conditions such as at sea level, high altitude and at dry heat zones.

INDOOR POLLUTANTS and health hazards.

24182EP **TOXINS : Genotoxicity and mutagenesis** **10** **12**

- Metabolism of carcinogens; Principles of toxicology; Epidemiological and experimental methods in cancer research, Mutagenicity, Carcinogenesis and human reproductive disorders and other risks; passive smoking and lung function.
- Life styles and factors of the environment which increase risks of cancer and teratogenecity; Environmental factors affecting reproductive physiology; Toxic animals and plants – effects on health.

24183EP **PHYSIOLOGICAL ASPECTS OF MICROBIAL INVASION** **10** **12**

- Microbes of soil, air and water.; Man-microbe interactions – beneficials, commensals, parasites and pathogens and infections with a reference to normal microflora of healthy human host; Germ-free life. Influence of microbial environment on gastro-intestinal physiology; Microbial therapy; Drug resistance of bacteria.
- Community health hazards- swine flu, bird flu.

24184EP **ENVIRONMENTAL ISSUES : Current concerns** **10** **12**

a) GLOBAL ENVIRONMENTAL ISSUES AND THEIR IMPACT ON PHYSIOLOGICAL SYSTEM

- Greenhouse gases and global warming, Ozone depletion and its impact on global climate, Temperature inversion.
- Impact on community of global warming, Outbreak of new diseases due to climate change phenomenon.

(b) SAFETY and ENVIRONMENTAL DISASTERS : NATURAL AND ANTHROPOGENIC

- Environmental safety-Oil Spills.
- Natural disasters.
- Bhopal, Chernobyl.

24185EP **WORK ENVIRONMENT AND LEGISLATION** **10** **12**

(a) **PHYSIOLOGY OF WORKING ENVIRONMENT**

- Working environment in different factories, mines, agricultural field, office, informal sector.
- Use of personal protective devices.

(b) PHYSIOLOGICAL BASIS OF NATIONAL AND INTERNATIONAL REGULATIONS ON ENVIRONMENT

Environment (Protection) Act and Rules made hereunder.

PAPER 19 **PRACTICAL** **50**

2419EP **I. Determination of the Physical Aspects of the Environment and their Physiological Effects on Different Systems :**

1. ***Thermal:*** Measurement of thermal environmental parameters: Heat and Cold.
   i) DB, WB, Relative Humidity, Measurement of Raidant Temperature (GT).
   ii) Different Heat and Cold Stress Indices; Wind Chill Index; Wind speed – Hot Wire Anemometer.
2. ***Illumination:*** Measurement of light intensity and illumination levels, Discomfort Glare Index, Disabled Glare Index.
3. ***Noise and Vibration:*** Measurement of noise and vibration levels and their effects: Audiometry, Low and high frequency and Intensity Vibrations.
4. ***Atmospheric Pressure:***Haemopoetic studies in rats exposed to simulated low atmospheric pressures.

II. Chemical Aspects of Environment and their Physiological Effects :

1. Determination of particulate matters, respirable and non-respirable dusts and fumes, vapours and gases.
2. Determination of B.O.D. of water.
3. Determination f microbial status of water and soil.
4. Lung Function Tests.
5. Effects on cardiovascular system – Pulse rates with extremeties immersed in hot and cold water and measurement of oral and skin temperatures.

III. Total Human Performance :

Physical Measurement of physical fitness and $VO_{2\ max}$ of human subjects with respect to seasonal changes.

Mental (Psychophysical Tests) – Skill, Choice Reaction Time, Hand – Eye Coordination.

IV. Measurement of some Blood Parameters in Different Environmental Conditions :

1. Plethysmography for regional blood flow tests.
2. Determination of blood lactic acid.
3. Determination of blood ascorbic acid.
4. Determination of blood corticosteroid.
5. Estimation of some serum enzymes – Acid phosphatase, Alkaline phosphatase, SGPT, SGOT.
6. Estimation of blood levels of certain metallic pollutants.

V. Biochemical Toxicology and Immuno-Pharmacology :

1. Acute and chronic toxicity testing.
2. Anaphylaxis and allergen testing.
3. Genotoxicity testing.
4. CNS modulation.
5. Mast cell degranulation.
6. Macrophage/Lymphocyte isolation.
7. Estimation of mediators: Histamine, Acetylcholine. Serotonin, etc.
8. Determination of LD_{50} / ED_{50}.

VI. Histological and histochemical changes in male and female tissue systems in different thermal conditions.

VII. Visit to different National Laboratories.

PAPER 20 **PROJECT AND SEMINAR** **50**

ERGONOMICS AND WORK PHYSIOLOGY

PAPER 17	**THEORETICAL**	**Marks**	**Contact Hrs**
		50	**60**

INTRODUCTION TO **ERGONOMICS: DEFINITION, ORIGIN, DEVELOPMENT, BENEFITS**

Historical background, development of ergonomics;

Definition and scope of ergonomics;

Aims, objectives and benefits of ergonomics;

The role of the ergonomist ;

Fitting the job to the person vs. fitting the person to the job.

24171EW	**PRINCIPLES OF TECHNIQUES USED IN ERGONOMICS**	**10**	**12**

Principles of instrumentation in Ergonomics and Work Physiology.

Principles of measurement of temperature, dB, etc.;

Force Measurement: push-pull force gauges & dynamometers, torque gauges, hand dynamometers, muscle strength measurement systems;

Radio and Infra-red telemetry,

Heart rate monitors; Cardio-respiratory test systems;

EMG & Physiological Data Acquisition Systems; Nerve conduction velocity – measurement and interpretation.

Motion Analysis and Improvement, Motion Capture Systems and Movement Analysis, Pressure Mapping;

Eye movement recording; 3-D imaging; Calibration.

Questionnaires, interviews in assessment

Measurement of human performance, Methods in Industrial Ergonomics

Computer application for management and statistical treatment of ergonomics and work physiology related data;

Computer programming (BASIC / FORTRAN); Image editing,

Spreadsheet analysis, Graphs & charts, Presentations.

Computerized systems,

Mathematical and digital human modelling

24172EW	**ANTHROPOMETRY and PRINCIPLES OF DESIGN FOR HUMAN BENEFIT**	**10**	**12**

Physical dimensions of the human body as a working machine, static and dynamic body measurements, size and motion relationship;

- Application of anthropometry in the design of seats, furniture, clothing, consumer products, etc., Percentiles;
- Body segment data – length, weight, mass centre, etc.;

- Somatotyping, measurement of body composition, body fat, lean body mass, and their relation to human performance in sports and industry.

DESIGN

- Design characteristics of controls (shape, size, color, layout) and effect on performance;
  - Design characteristics of visual, auditory and other displays, quantitative and qualitative information, multiple displays and layout;
  - Compatibility and population stereotypes;
  - Warnings, signs and labels;
  - Continuous control/tracking, simulators, control room ergonomics;
  - Designing for special populations;
  - Work-station evaluation, designing an efficient and ergonomic workstation.
- **Cognitive Ergonomics**
  - Cognitive Ergonomics - information processing, memory, situation awareness, attention

24173EW BIOENERGETICS and BIOMECHNICS in ERGONOMICS 10 12

- Biochemistry and bioenergetics of muscular contraction and relaxation, fuel for muscular work;
  - Aerobic work, classification of work loads, maximum aerobic power; Anaerobic work, oxygen debt, lactic acid production, maximum anaerobic power;
  - Measurement of Maximal Physical Work Capacity using graded sub-maximal and maximal dynamic exercise;
  - Effect of different factors (age, sex, body build, nutrition, smoking, etc.) on performance;
  - Absolute and Relative Cardiac Cost, Energy cost of different activities;
  - Work demand and individual capacity, Relative Aerobic Strain, Occupational Work Capacity (OWC) / Acceptable Work Load (AWL);
  - Fitness for health and work;
  - Fatigue – mechanism of development, measurement, and prevention.

- Anatomical and biomechanical considerations of the human musculo-skeletal system;
    - Angular motion of limbs, goniometry, range of motion;
    - Muscle strength evaluation;
    - Power and precision grips, power assisted controls;
    - Forces and moments at L_5/S_1 level, physiology of back pain;
    - Static and dynamic multi-link biomechanical models in 2D and 3D.
    - Analysis of motion and gait using force platforms and digital motion capture and analysis systems.

24174EW **OCCUPATIONAL ERGONOMICS** **10** **12**

System Analysis

Man as a system component, allocation of functions;

Job / Task analysis, methods of job/task analysis;

Human error, methods of estimating human error, Human Reliability analysis.

Musculo- Skeletal Disorders

Work Related Upper Limb Disorders (WRULD), Work Related Upper Extremity Musculo Skeletal Disorders (WRUEMSD), Cumulative Trauma Disorder (CTD); Repetitive Stress Injuries (RSI);

Body components at risk, Anatomical and biomechanical aspects of causation, Occupational and Non-Occupational factors, specific disorders;

Standardised Questionnaires, Prevention.

Manual Material Handling

Manual material handling, lifting and carrying loads;

Personal and job risk factors, Intra Abdominal Pressure (IAP);

NIOSH guidelines and equation;

Back braces / belts;

Design of material handling tasks, Assist devices, "Zero lift" programmes.

Posture

Maintenance of posture, mechanics of different postures including traditional postures;

Biomechanics of the sitting posture;

Pressure distribution, postural sway;

Observational and descriptive methods, measurement of postural discomfort.

24175EW	**PSYCHO-PHYSIOLOGY OF WORK**	**10**	**12**

Occupational Stress - causes, effects and preventive measures;

Learning time, learning curve, problems of Ageing and compensatory measures;

Inspection / sustained alertness (vigilance) tasks – industrial inspection, radar operators, locomotive drivers;

Mental fatigue and loading, Simple and Choice Reaction Time, Critical Flicker Fusion Frequency, Sinus Arrhythmia, Secondary Task;

Rating of Perceived Exertion (RPE), BORG Scale;

Virtual environments; Human visual, auditory, tactile, and vestibular sense organs and sensory perception;

Auditory System: Sound detection, transmission;

Visual ergonomics, visual acuity and color vision, lighting levels, contrast and glare, reflections and flicker, effect of color and monochromatic light on industrial performance, lighting standards

PAPER 18	**THEORETICAL**	**50**	**60**

24181EW	**OCCUPATIONAL PHYSIOLOGY AND DISEASES**	**10**	**12**

Physical and chemical aspects of work environment

Thermal work environment - heat balance, measurement, indices, body temperature regulation and acclimatization, clothing, subjective assessments - thermal comfort and discomfort, heat disorders, thermal protective suiting.

Work environmental Noise – Continuous noise, impulse noise, Continuous equivalent levels (Leq), weighting networks (dBA), standards, exchange rate, audiometry, Noise Induced Hearing Loss (NIHL), Hearing Conservation Programmes (HCP), distraction, annoyance and emergency signals, effect of noise on performance, Non-auditory effects of noise exposure.

Vibration - Whole Body vibration, Hand Arm vibration, vibration criteria (Reduced Comfort, Fatigue & Decreased Proficiency, Exposure Limit), effects of vibration on the human body, vibration units, weighting networks, vibration standards, measurement and control.

Ionising and Non-Ionising Radiations in the work environment. long-term and short-term effects, genetic and somatic effects; maximum exposure standards and methods of control.

Chemical aspects of the work environment - dust, fumes, vapours, gases, etc., , Maximum Allowable Concentration (MAC), Threshold Limit Value (TLV) and Short Term Exposure Limit (STEL), synergism, effect of work rate.

OCCUPATIONAL DISEASES**:** Occupational lung and other diseases (asbestosis, byssinosis, silicosis, etc.)

24182EW	**PERFORMANCE IN ADVERSE CONDITIONS**	**10**	**12**

Physiology in High Altitude, Space, Aquatic, Desert and Arctic conditions.

Effects of high and low barometric pressures, physiological adaptation of high altitude dwellers, physiology of mountaineering, High Altitude Pulmonary Oedema (HAPO);

Effects of acceleration and deceleration, positive and negative G forces, weightlessness and performance, gravitational cues;

Physiology of deep-sea diving, problems of pressurization and decompression, Caisson disease and its prevention; phenomena of sensory deprivation; Heat and water regulation, nutrition and performance in desert and arctic climates;

Protection against climatic extremes.

24183EW	**ERGONOMICS FOR SAFETY, LOSS PREVENTION**	**10**	**12**

Safety and Ergonomics

Accident: definition, types, impact, theories ;

Ergonomics in Use of PPE

Ergonomics in prevention and management of accidents, Case Studies

Ergonomics in Risk Mitigation and Hazard control

24184EW	**PRINCIPLES OF MANGEMENT AND TECHNOLOGY IN ERGONOMICS**	**10**	**12**

- **Ergonomics in management of human resources**

Selection, placement, training of HR; Motivation of HR

Job evaluation, analysis, design, enrichment, rotation;

Work-rest schedules, rationalization; Cost Benefit analysis

Shift work – zeitgebers, circadian rhythms, effects, alternate shift systems, off-shore and on-shore patterns.

- **Work study: Principles of Industrial, Production and Reliability Engineering in Ergonomics**

Method Study, Work Measurement

Process chart, Double handed Process chart

24185EW	**NATIONAL , INTERNATIONAL REGULATIONS AND STANDARDS related to ERGONOMICS and OCCUPATIONAL HEALTH**	**10**	**12**

- ILO WHO conventions

- Factories Act and Rules made thereunder
- Environment (Protection) Act and Rules
- Workmen Compensation Act
- Ergonomics related ISO standards;
- Occupational Health & Safety Management System Standards (OHSAS), ergonomics requirements in OHSAS

PAPER 19 PRACTICAL 50

2419EW

1. Experiments on the principles of instrumentation for measurements of different parameters.
2. Determination of body dimensions by anthropometric equipment. "Workshop" on the design of seat, work space, etc. Determination of body composition.
3. Experiments with the actions of muscles, use of goniometer, dynamometer, etc.; location of motor points; velocity off nerve impulse.
4. Ergonomic evaluation of the design of different control knobs, hand tools (screw drivers, pliers, scissors),etc.
5. Experiments on taking different physiological responses (heart rate, blood pressure, respiratory rate, pulmonary ventilation, oxygen consumption, sweat rate, oral, aural, rectal and skin temperatures) during graded work on step test, bicycle ergometer, treadmill tests, etc. – Use of gas analysis apparatus, aerobic and anaerobic power – oxygen debt; evaluation of maximal physical capacity; experiments on energy expenditure.
6. Evaluation of lung function – estimation of FVC, VT, IRV, ERV, IC as well as FEV_1, MSC (MVV).
7. Biochemical estimations in blood and urine (lactic acid, glucose, creatinine, chloride, pO_2, pCO_2, etc) during test, work and recovery; histochemical methods for estimation of glycogen, red and white muscle fibres, etc.
8. Experiments with the measurements of muscular activity – myography and eleectromyography, chrono-cyclographic techniques.
9. Motor skill and performance analysis – cine film analysis.
10. Experiments with vision and hearing, olfaction and taste. Methods of measurements of illumination and noise levels, audiometry, olfactometer, taste acuity. Experiments on semicircular canals.
11. Determination of thermal, lighting and acoustic conditions of the environment.

12. Determination of chemical conditions of the environment. Determination of concentrations of dusts, fumes, vapours, etc.; bacterial content of air.

13. Use of digital computers for problem solving. Programming, data input methods, diagnosis of errors in syntex and logic.

14. Analysis of Posture through OWAS, REBA,RULA methods

15. Uses of Checklist and Questionnaire

16. "Workshop" on information retrieval, experimental design analysis and presentation of results and delivery of scientific lectures.

17. "Workshop" on biomathematics and biostatistics.

PAPER 20 **PROJECT AND SEMINAR** **50**

IMMUNOLOGY AND MICROBIOLOGY

PAPER 17	**THEORETICAL**	**Marks**	**Contact Hrs**
		50	**60**
24171IM	**Molecular Immunology**	**10**	**12**

T-cell heterogeneity in man:-in response to antigen receptor on T lymphocytes, Antigen dependent and independent T cell repertoire, Regulatory and cytotoxic T-cells.

B-cell lymphopoiesis: -B cell antigen receptor, B cell repertoire, Heterogeneity of Immunoglobulin, Affinity maturation, Molecular basis of receptor editing, Class switching, and regulation of gene expression.

Genetic control mechanism of the immune response: Role of MHC polymorphism, Immune response mechanism to tissue damage, Inflammation, Role of interleukins, adhesion molecules, leukocyte recruitment, mast cells and allergy, Regulation of immune response.

24172IM **Cellular and Molecular interaction (in vivo) during immune responses** **10** **12**

Hemopoietic cell differentiation, Lineage commitment in haematopoietic cells, Cell signaling pathways, Receptors and signal transduction Role of lymphoid organs, Pattern recognition Receptors, TLRs, Signals for cell cycle

regulation, Cell death, survival and apoptosis in the immune system, General principles of cell-cell interaction and its regulation.

24173IM	**The biotechnological approach to vaccine development**	**10**	**12**

Genetic attenuation of pathogens, Attenuated pathogens as vectors for heterogeneous antigens, Genetic attenuation of bacterial toxins, DNA vaccination, trans-cutaneous immunization, Expression of microbial pathogens in plants (edible vaccines), Reverse vaccinology, Genetically modified animals and their relevance in drug discovery, congenic, transgenic and knock out mice, application of transgenic animals

24174IM	**Molecular basis of autoimmune, immunodeficiency and other disorders of immune response**	**10**	**12**

Clonal selection hypothesis and problem of immunological tolerance, Clonal and peripheral tolerance mechanisms, Experimental approaches to study of T-cell tolerance, Breakdown of tolerance and autoimmune disease, Animal and clinical model of autoimmune diseases, Transplantation Immunology, Molecular diagnosis of cancer diseases, NK cells and virus killing, Cell - cell fusion in both normal and abnormal cells, Interaction of cancer cells with normal cells, Therapeutic intervention of uncontrolled cell growth.

24175IM	**Systemic- immune interaction**	**10**	**12**

Neuro-endocrine-immune regulation, Stress, ageing and immune response. Antioxidants and immune functions, Free-radical mechanisms in immune-modulations, Oxidative bursts and mechanisms involved.

PAPER 18	**THEORETICAL**	**50**	**60**

24181IM	**Microbial infection and immunity to infectious diseases: (Bacteria, virus and parasites)**	**10**	**12**

Pathogen recognition, Immune responses to intracellular and extracellular infection, infection mechanisms, Host-parasite interaction: Recognition and entry processes of parasites into host cells, parasite burden, life cycle of parasite inside host cells, parasite survival mechanism inside the host environment, Structure of viruses, viral replication, replication of animal (DNA/RNA) viruses, retroviruses, regulatory events in the synthesis of viral constituents, recognition and entry processes of viruses into animal cells, alteration of host cell behaviors by pathogens, virus induced cell transformation, Germ free life study: Methods of preparing germ free animals, gnotobiotic animals, Effects of microorganisms on the metabolism of germ free animals.

24182IM	**Medical Microbiology and therapeutic use of Antibiotics:**	**10**	**12**

Microbial diversity, disease transmission, diagnosis, prevention, Epidemiology and public health, microorganism and human diseases, Pathogenesis and pathophysiology of infectious diseases, Acquisition and transmission of antibiotic resistance, Bacterial diversity, Antibacterial, Antifungal, Antiviral, Antiprotozoanantimicrobics, Molecular and genetic basis of antibiotic action and resistance, Plasmids and transposons and their role in the dissemination of antibiotic resistance.

24183IM **Microbial metabolism** **10** **12**

Metabolism of protein, fat carbohydrate and nucleic acids in microbes, Production of energy rich intermediates by bacteria, Synthesis and release of toxins from the bacteria, Cholera toxin, TSST, LPS etc and their mechanism of action (in vivo and in vitro.)

24184IM **Microbial genetics** **10** **12**

Microbes and recombinant DNA technology, practical application in various life processes, selected approaches to study of virulence, selected virulence determinants and selected bacterial pathogens, methods of genetic transfer, mapping genes by interrupted mating, fine structure analysis of genes.

24185IM **Applied and Environmental Microbiology** **10** **12**

Microbial fermentation, Food poisoning by microbes, Production of enzymes, penicillin, Microbial ecology, Normal microbial ecology of the human body, skin, GI tract, genital urinary tract, Factors influencing the persistence of these microorganisms within the host and their role in health and disease, Nosocomial infection, synergism and commensalisms

PAPER 19 **PRACTICAL** **50**

Experiments on Immunology

1. Preparation of antiserum against bacterial cell suspension, SRBC as particulate antigen and BSA as soluble antigen and determination of antibody titer.
2. Demonstration of antigen-antibody reaction by agglutination, hemagglutination and precipitation reaction.
3. Demonstration of ELISA.
4. Study of cell mediated immune response by delayed type hypersensitivity reaction.
5. Study on the enumeration of antibody secreting plasma cells by hemolytic plaque assay.
6. Separation of human lymphocytes, monocytes and neutrophils from whole blood
7. Isolation of murine splenic and peritoneal macrophages.

8. Assessment of murine macrophage functions: Phagocytosis, bacterial killing, bactericidal enzyme (Lysozyme) release, tests for intracellular killing, respiratory burst response.

9. RIA (demonstration only).

10. Cell separation by FACS (demonstration only).

Experiments on Microbiology

1. Isolation of a pure culture from mixed bacterial culture by i) Streaking, ii) pour plate, iii) Spread plate techniques.

2. Isolation of yeasts and bacteria from natural sources.

3. Determination of minimum inhibitory concentration (MIC) of an antibiotic for pathogenic bacteria.

4. Determination of antibiotic resistance profile by disc agar diffusion (DAD) technique.

5. Animal experiment for testing patogenicity or virulence using hospital strains of bacteria, Animal experiment for testing endotoxic shock using purified bacterial Lipopolysaccharide (LPS): animal model for inducing inflammation.

6. Isolation of genomic DNA from animal tissue or bacterial cell, Isolation and agarose gel electrophoresis of a plasmid DNA from antibiotic resistant bacteria (Demonstration only).

7. Characterization of organism by Urease production activity.

8. Characterization of organism by Nitrate Reductase activity.

9. Studies on enzyme kinetics and determination of Michelis –Menten constant (Km.)

10. Separation of serum proteins by polyacrylamide and agarose gel electrophoresis.

PAPER 20	**PROJECT AND SEMINAR**	**50**

NEUROPHYSIOLOGY

PAPER 17	**THEORETICAL**	**Marks**	**Contact Hrs**
		50	**60**
24171NP	**Fundamentals of Neurophysiology**	**10**	**12**

1. History of Neuroscience, Scope of Neuroscience.

2. Evolution of Human Brain: Phylogenetic development of nervous system from invertebrate to mammals.

3. Neurons: Molecular biology of neurons – membrane proteins, lipids cytoskeleton, regulation of axonal transport.

4. Neuroglial cells: Different types and functions. Gliotransmitter release from Astrocytes and its regulation.

24172NP **Cellular Neurophysiology and Neurochemistry** **10** **12**

1. Synapses: Characteristic features of type- I and type-II synapses. Cell adhesion molecules in synapse. Molecular components of active zone, PSD. Synaptic vesicles – Biogenesis, molecular composition of synaptic vesicle, synaptic vesicle cycling pathway, proteins for membrane trafficking. Regulation of synaptic vesicle cycling. Postsynaptic scaffolding proteins. Glial influence on synaptic transmission. Gap junction and electrical synapse. Gap junction and neuronal oscillation. Neuromuscular junctions: Post synaptic basal lamina. Lambert-Eaton myasthenic syndrome (LEMS). Familial infantile myasthenia.

2. Neurochemistry of neurotramasmitter and neuromodulators: Biosynthesis, storage and inactivation of classical neurotransmitters- Acetylcholine, Catecholamines, GABA, Glycine, Serotonin, Peptide neurotransmitters - Substance P, Enkephalins, NPY, Neurotesin. Unconventional neurotransmitters - NO, CO, and growth factors, Purinergictransmitter.

3. Action potential generation in postsynaptic neurons: Theories of neuronal information processing. Post synaptic potentials and synaptic integration. Dendrites: Dendritic spines, Complex information processing in dendrites, Electrotonic spread in dendrites.

24173NP **Molecular Neurophysiology** **10** **12**

1. Voltage-gated ion channels: Structures of Sodium, Potassium, Calcium and Chloride channels. Different types of potassium channels: Fast potassium, Delayed potassium, Serotonin dependent, Calcium dependent ATP sensitive, G-protein linked Muscarinie potassium channels. Different types of chloride channels: Chloride-nucleotide modulated channels phospholemman. Molecular mechanism of voltage sensitivity and ion selectivity.

2. Ligand gated ion channels: Stuctures of nicotinic acetylcholine, $GABA_A$, Glycine, ionotropic Glutamate receptors (NMDA, AMPA, Kinate, Quisqualate), Purinoceptors. Molecular mechanism of nAchR opening and ion selectivity.

3. G-protein coupled receptors (GPCR or Metabotropic receptors). General structure of GPCR. Receptor desensitization. Direct interaction of GPCR and ionotropic receptors. Muscarinic acetylcholine receptors, Adrenergic, Dopaminergic, Purinergic receptors, $GABA_B$ receptors, Serotonin receptors,

Opiate receptors. Intracellular signaling-Protein Kinase, Phosphatases. Nuclear Gene expression. AP- 1, C- fos genes, C- jun genes and gene expression. Cytokines and Steroid hormone receptors in gene expression of neurons.

4. Myelin proteins: Myelin basic protein, proteolipid protein, protein zero, Pelizaeus-Merzbacher disease, Charcot-Marie-Tooth disease.

5. Molecular basis of neurogenic and myopathic diseases: Amyotropic lateral sclerosis, Guillain-Barre Syndrome, Limb-Girdle muscular dystrophy, Duchenne muscular dystrophy.

6. Molecular basis of channelopatheies: Familial hemiplegic migraine, generalized epilepsy with febrile seizures, episodic ataxic type 2.

7. Transmissible neurodegenerative diseases - Prion diseases.

24174NP **Plasticity of Brain** **10** **12**

Plasticity of Brain: Plasticity in sensory and motor systems. Cortical maps and experience. Visual deprivation and amblyopia. Whiskers barrels in mouse. Training in enriched environment on brain anatomy, neurochemistry and behavior. Plasticity of brain and spinal cord after injury. Rehabilitation and retraining influence plasticity. Plasticity in learning, memory and behaviour. Endocrine regulation of plasticity. Critical periods of plasticity. Cellular and molecular basis of plasticity. Anatomical and physiological plasticity of synapses and dendritic spines.

24175NP **Developmental Neurobiology** **10** **12**

1. Embryological development of human brain.

2. Molecular basis of neural induction: Sonic Hedgehog, Retinoic acid, FGF, BMP, Wnt. Rostrocaudal axis of neural tube. Homeobox genes. Rhobomeres,. Neurogenesis and gliogenesis. Molecular basis of neuronal generation. Generation of neuronal diversity- Timing of differentiation, signal from targets. Survival of neurons. Neurotropic factors- NGF, BDNF, NT3, TGFβ. Neurotropic signalling; neuronal migration and radial glia. Axonal guidance and its molecular cues. Growth cones. Axonal pathfinding and target selection. Integrins, CAM, Cadherin, Netrin, Semaphorines, Ephrins. Formation of topographic maps. Synapse formation and elimination. Critical periods in development- Filial imprinting.

3. Neurogenesis in adult brain. Anterior subventricular zone (SVZ).

4. Sex differentiation of the nervous system: Hormonally dependent sexual difference in brain. Sex difference in brain and behavior. Homosexuality and brain.

PAPER 18 **THEORETICAL** **50** **60**

24181NP **Regulatory systems and brain metabolism** **10** **12**

1. Emotion and behavior: Theories of emotion, Neural representation of feeling- Limbic system, orbito-frontal cortex, hypothalamus, amygdala. Fear and rage. Sexual behavior. Aggression.
2. Major regulatory systems in brain: Neural pathway carrying glutamate, glycine, GABA, Ach, dopamine, norepinephrine, serotonin, endorphin. Distribution of the receptors of these neurotransmitters.
3. Thalamocortical regulatory system: Thalamic neurons as pacemaker. Neural basis of partial and generalized epilepsy.
4. Central neural control of autonomic functions: Hypothalamus, Medulla, Limbic cortex and Cerebellum.
5. Chronobiology: Characteristics of circadian clocks – Free running clock, Entrainment by environmental time cues. Zeitgeber, Phase relation to zeitgeber. Circadian timing system: Single clock, Multiple clock, Structural elements of timing system. Models of oscillators, Coupled oscillators. Suprachiasmatic nucleus – Comparative anatomy, metabolism, electrophysiology, pharmacology, and functions. Neural basis of circadian rhythm in sleep-wake cycle and ultrdian rhythm in sleep stages. Circadian rhythm in thermoregulation. Molecular mechanism in circadian timing in mammals. Rodent estrous cycle. Medical implication: Jet-lag and shift workers, Drug effectiveness and toxicity, Susceptibility to trauma and toxins, implication for diagnosis.
6. Brain energy metabolism of the brain: Energy substrate- Glucose, Ketone bodies, Lactate, Pyruvate, Neuronal activities, blood flow and energy metabolism. Reactive Qxygen Species and the protective role of glutathione. Neuronal function and consumptions of energy. Glia and vascular endothelial cells in brain energy metabolism.

24182NP **Motor and Sensory systems** **10** **12**

1. Motor System: Motor Cortical Column. Control of gaze. Motor learning in vestibulo-occular control. Disorders of movements- Huntington Chorea, Athetosis, Ballism, Parkinson's Disease,
2. Sensory System: Coding of Sensory information, Columnar organization of primary somatosensory cortex and primary visual cortex. Visual deprivation and ocular dominance column. Perception of motion and form. Neural coding of colour. Auditory information processing in cerebral cortex. Localization of sound source. Vomeronasal organ. Pain-Opoid and non opoid mechanism. Hyperalgesia, Analgesia
3. Integration of motor and sensory functions: Association areas of brain, Multimodal Association areas, Prefrontal Association Area. Interaction among association cortices.

24183NP **Cognitive Neuroscience** **10** **12**

1. Cognitive development in the first year of life. Disorders in cognitive development- Autism, Schizophrenia.
2. Memory: Neurobiology of age-related memory decline. Dementia, Alzheimer's disease. Wernicke-Korsakoff syndrome.
3. Attention: Neural basis of spatial attention. Defect of special attention-neglect syndrome.
4. Language and communication: Universal design of language, language development in children, Neural organization of language, Alexia, Dyslexia, Aphasia, Neural structures of animal communication system.

24184NP **Neuropsycopharmacology and Neurotoxicology** **10** **12**

1. Motivation and reward, Dopamine and lateral hypothalamic syndrome, Reinforcement system, Brain aversion syndrome.
2. Drug abuse: dependence and addiction, neurobiology of drug dependence and addiction. Hallucinogens, PCP, Ketamine, Alcohol, Opiate, Marijuana, Hashish
3. Disorder of moods and anxiety, unipolar and bipolar depression. Different types of anxiety disorders.
4. Toxicology: Toxicity, Routes and duration of exposure. Degradability, Bio-accumulation and bio-magnification. Toxin poisoning ion channels: Tetrodotoxin, Saxitoxin, α-Bungarotoxin, Conotoxin, Arecoline. Neurotoxins: α-agatoxin, NSTX-3, Jorotoxin, β-philanthotoxin, Stychnines, Organophosphorus compounds. Environment and occupational neurotoxin – Lead, Mercury, Arsenic.

24185NP **Advanced Neurophysiology** **10** **12**

1. Neuroimmunomodulation: Neuro-immune interactions. Central neural areas regulating immune responses.
2. Sleep and wakefulness: Onset of NREM sleep- Somnogens, Orexin. Basal forebrain cholinergic system. Septum and Hippocampal theta wave generation. REM sleep- neural activity in different regions of brain. Disorders of sleep and wakefulness: Insomnia, Narcolepsy, Parasomnia.
3. A brief idea of nanoneuroscience and neurogenetics. System approach in neurophysiology
4. Consciousness: Brain-mind interaction, Hypothesis relating to brain mind problem. Neural basis of consciousness, Perceptual illusion, Consciousness in other species, Theories of consciousness.

PAPER 19 PRACTICAL 50

1. Dissection and study of brain

Study of the brain of rat, goat to identify the different regions of brain. Demonstration of gross anatomy of human brain, Animal preparation: Spinal preparation, decerebration, cerebelectomy.

2. Histology of Neuron

(a) Study of the nerve cell: Staining of neurons by cresyl violet and Nissl fast violet stain in the paraffin section of the spinal cord and cerebellum.

(b) Study of central nervous system architecture by hematoxylin and eosin.

(c) Experimental neuroanatomical studies:

(i) Rapid Golgi-Cox method

(ii) Bulchawosky method.

(iii) Fink- Heimer procedure.

(d) Vital staining of nerve fiber by Methylene blue method.

3. Stereotaxic Technique

Animal preparation by aspiration, electrolytic and chemical lesion. Stimulation of different brain areas by electrical and chemical methods. EEG recording from chronic and acute rats. Evoked potential in experimental animals. Experimental epilepsy: Penicillin induced and PTZ induced epilepsy in animal.

4. Neurobehavior

Locomotor movement in open field, Lordosisbehavior, Pentobarbital induced sleeping time, Exploratory behavior in hole board apparatus.

5. Autonomic tone

(a) Studies on autonomic tone:

i) EI ratio.

ii) Orthostatic test.

iii) Valsalvamaneuver.

iv) Cold pressor test.

(b) Study of Galvanic skin response (GSR): Measurement of GSR in resting and different stressful conditions.

6. Neurochemistry

Measurement of neurotransmitters:

Spectroflurometric method for measuring acetylcholine, epinephrine, nor-epinephrine, dopamine, serotonin in microdissected brain regions of rats.

HPLC method for measuring neurotransmitters.

7. Electrophysiology

(a) Electrocardiographic study in human in resting and stress condition.

(b) Electromyographic study in human in different stages f sleep and wakefulness.

(c) Electroencephalographic study in human: Recording of EEG in human in different stages of sleep and wakefulness.

(d) Evoked potential study in human: brain stem evoked potential and auditory evoked potential in human.

8. Neuroendocrine functions and Experimental Chronobiology

(a) Experimental stimulation / lesion in amygdala, septum, cerebellum, hypothalamic nuclei on estrous cycle, ovary, adrenal, blood cortisol.

(b) Recording of 24 hours body temperature to study the circadian rhythm of body temperature.

(c) Recording of heart rate to study circadian rhythm of resting heart rate.

9. Neuroimmunological studies

Neuroimmunological studies: PMN assay, Cytotoxic assay, PLN assay, Phagocytic activity assay in experimental animals in resting condition and after stress.

10. Molecular Neurophysiology

(a) SDS-PAGE gel electrophoresis of brain tissue homogenate (Post mitochondrial fraction) and serum.

(b) DNA (mitochondrial and nuclear) and RNA (total) isolation from brain tissue, estimation and determination of purity of DNA and RNA by spectrophotometer.

(c) Agarose gel-electrophoresis of DNA after digestion with restriction endonuclease.

(d) Reverse transcription (RT) of total RNA isolated from brain tissue to cDNA, Primer designing for PCR, PCR of a transcript (mRNA) with suitable primer, agarose gel-electrophoresis of PCR product.

11. Simulation study in software

(a) Changes of gNa, gK on Resting membrane potential.

(b) Voltage clamping in membrane to observe the changes of membrane current and conductance.

(c) Measuring the features of the current following patching of single voltage gated Na and K channels.

(d) Experiments with IPSP

(e) Changes in the activation and inactivation kinetics of Na and K channels and its effect on membrane excitability.

12. Training program / Laboratory visit

A report on the basis of a visit in Research institutes or laboratories of national importance.

PAPER 20	**PROJECT AND SEMINAR**	**50**

NUTRITION AND DIETETICS

PAPER 17	**THEORETICAL**	**Marks 50**
24171ND	**Public health and nutrition**	**10**

1. Nutrition monitoring and surveillance,
2. Assessment of Nutritional Status (Diet survey, Anthropometry, Clinical Examination, KAP), Nutritional counseling, epidemiology,
3. Meal planning, mode of feeding, midday meal, ICDS, National immunization programme,
4. National & international bodies & research organization, Nutritional and health economics
5. Major nutrition problems in India, National Nutritional Programmes and goals, National Nutritional policies & laws, Nutrition & global interaction. (Preferably with case studies.)

24172ND	**Diets and dietetics**	**10**

1. Principles, classification and applications of Therapeutic diets
2. Diet in Cardiovascular, hepatic, renal, bone and bowel diseases, genetic disorders and diabetes
3. Food intolerance and food allergy

	4. Bromatology, Classification of foods according to different criteria, food composition databases	
	5. Malnutrition, sustainable diet, Diet trends and fad diets	
	Nutritional pharmacology	**10**
24173ND	1. Basic principles of pharmacology	
	2. Nutridynamics, nutrikinetics	
	3. Nutritional toxicology	
	4. Food/Drug And Drug/Nutrient interaction	
	5. Pharmacology of malnutrition	
	Case study of supplements vs balanced diet	**10**
24174ND	1. Carbohydrates in sports medicine	
	2. Lipids in Cognition and Immune Function	
	3. Bioactive proteins and protein supplements	
	4. Vitamin and mineral supplements	
	5. Supplements for Anemia prevention	
24175ND	**Microbes in nutrition**	**10**
	1. Probiotics and Prebiotics, microbial therapy	
	2. microbes as food	
	3. microbes in food industry,	
	4. microbial spoilage and Food borne diseases, food preservation	
	5. Nutritional role of gutmicrobiota	
PAPER 18	**THEORETICAL**	**50**
24181ND	**Molecular nutrition**	**10**
	1. Nutrigenomics, Nutrigenetics	
	2. Nutriepigenomics	
	3. Measurement of the nutritional phenotype	
	4. Nutrient Sensing mechanism	
	5. Genetic approach for studying nutritional disorders	
	Neutraceuticals and functional food	**10**
24182ND	1. Bioactive substances in food: Types, Biological Activities and Health Effects,	
	2. safety issues	
	3. delivery systems,	
	4. Identifying bioactive compounds and establishing their health effects	
	5. Nutritional thearapy in chronic diseases	
	Emerging trends in nutrition	**10**

24183ND	1. Transgenic food 2. Nanotechnology in Food 3. Convenience foods, junk foods, Adulteration, Additives 4. Food security 5. Chrononutrition	
	Case studies in Community nutrition	**10**
24184ND	1. Maternal and infant mortality rate and its relation to nutrition 2. Breast milk vs infant supplements 3. Nutritional aspect of growth stunting in adolescents 4. Obesity, diabetes and metabolic disorders 5. Disease burden, poverty and role of nutrition	
	Tools of nutritional research	**10**
24185ND	1. Epidemiology- Measures of Disease, Risk Rates, Descriptive Epidemiology, Measuring infectivity, clinical trials 2. Survey methodology including census procedures, Surveillance, outbreak investigation 3. Statistical support to epidemiology- Study design, Sample size, Sample selection, Bias, Outcome measures, Analysis and reporting, 4. Questionnaire designing and validation 5. Nutritional informatics	
PAPER 19	**PRACTICAL**	**50**
2419ND	**Techniques for Purification and characterization of biomolecule** 1. Chromatography – paper, thin layer, gel filtration, ion exchange 2. Ammonium sulphate ppt and dialysis 3. Electrophoresis– acrylamide gel (native & SDS), 4. MW determination by SDS gel **Techniques of molecular biology** 1. DNA and RNA isolation 2. Western blot 3. PCR, RT PCR. **Histological and flow cytometry Techniques** 1. Cell preparation from bone marrow, spleen, thymus and flow cytometry detection 2. Macrophage culture, viability and bioassay (ROS, NO, arginase) 3. Platelet and reticulocyte count 4. Collagen staining, PAS	

5. Immunohistochemistry

Nanotechnology: Preparation of nano particle, nanoconjugation and size estimation

Animal model and toxicological assays:

1. Development of Hepatotoxicity,hematoxicity, nephrotoxicityand diabetes models in experimental animal
2. Studying the Urinary, Serum parameters.
3. Preparation of tissue homogenate and measurement of relevant parameters
4. Zymography

Biostatistics and anthropometry in relation to nutritional assessment

Nutritional assessment/diet survey/ Visit to an Institute of National Importance: Diet survey or visit to an Institute of National interest; Participation in Nutrition related Programmes.

PAPER 20	**PROJECT AND SEMINAR**	**50**

SPORTS AND EXERCISE PHYSIOLOGY

PAPER 17	**THEORETICAL**	**Marks**	**Contact Hrs**
		50	**60**
	SPORTS AND EXERCISE PHYSIOLOGY: ORIGIN AND DEVELOPMENT Historical development of sports sciences		
24171SE	**MUSCULAR SYSTEMS IN SPORTS AND EXERCISE PHYSIOLOGY** The Neuromuscular system and exercise: Striated muscle, Contraction mechanics, Muscular strength, Muscular fatigue, Neuromuscular Integration, motor unit, motor unit recruitment, motor learning, skill learning, and muscle involvement in different actions.	**10**	**12**
24172SE	**NUTRITIONAL ASPECTS IN SPORTS AND EXERCISE** Bioenergetics and exercise metabolism Nutrition and Sporting Performance Existing and current research for optimal nutrition for sporting performance. Current nutritional guidelines for sprint athletes, endurance athletes, and games players. Nutritional Supplementation	**10**	**12**

Current literature regarding the biochemistry action, proposed benefits, and potential health risks associated with various nutritional supplements and ergogenic aids.

Dietary Assessment

Accuracy, prescription, reliability and validity of the available nutritional measurement tools

24173SE **SPORTS AND EXERCISE IN DIFFERENT :** **10** **12**

1) PHYSIOLOGICAL ASPECTS

Applied physiological aspects of some specific sports.

Physiological demand of sprints, middle and long distance running, amateur boxing, Rowing, cycling , badminton, field hockey, football (soccer)

2) ENVIRONMENTAL CONDITION

- Effect of biological rhythm, Jet lag on sports performance.
- Sports and Exercise at Altitude, thermal extremes-

  Hot and Cold environment and sports performance

Factors influencing physical activity : Season, Altitude, Temperature, Humidity, Food habits, Drugs

Altitude training and sports performance, Diving physiology

3) IN CHILDREN, WOMEN,OTHERWISE-ABLED PEOPLE

children- Pediatric exercise physiology.-Function vs. body size during growth, anaerobic performance , Aerobic performance

women –exercise in different phases of menstrual cycle, pregnancy

adapted physical activity- Sports and Exercise for otherwise-abled people,

PRINCIPLES OF TRAINING WITH MODERN TECHNIQUES IN SPORTS AND EXERCISE PHYSIOLOGY

Assessment of Body profiles

The Physiological principles of training, training methods, training cycles – effect of training on body systems, Training equipment. Warm up, cooling down, stretching exercise

Methods in sports training and assessment of sports performance

Physiology of training: effect on VO2 max, aerobic and anaerobic threshold level and performance

24174SE **SPORTS AND EXERCISE PHYSIOLOGY AT** **10** **12**

- **MOLECULAR / CELLULAR LEVEL**

Sports and Exercise at the molecular level

- **SYSTEM LEVEL**

Endocrinology in Sports and Exercise

Immune function in Sports and Exercise

24175SE	**SPORTS AND EXERCISE PSYCHOLOGY**	**10**	**12**

Psychology of expert performance - Optimal performance states, visual cues, decision making and situation awareness anxiety, arousal and performance - Conceptual, models, new dimensions to the anxiety response, measurement issues and practical implications.

Sequential and deterministic approaches to establishing a performance model; Motivation

Applied Sport Psychology - Ethical issues and professional training, models of assessment and professional practice, specific interventions (goal setting, imagery, and relaxation, self-talk)

PAPER 18	**THEORETICAL**	**50**	**60**

24181SE	**BIOMECHANICS, KINESIOLOGY in SPORTS AND EXERCISE**	**10**	**12**

- Concept of Biomechanics and kinesiology
    - Movements at Specific Joints
    - Force. Kinematics , Kinetics, Work, Power, Energy
    - Motion
    - Body mechanics and kinesiological problems : Understanding the scientific basis of human movement. Kinematics, Mechanics of human movement, modern techniques of biomechanical analysis, qualitative analysis.
    - Human movements and lever system
- Stability and Equilibrium
    - Center of Gravity , Static Balance and Dynamic Equilibrium
    - Pattern Recognition and Usage , Skill Analysis
    - Skill Error Analysis and Correction

24182SE	**ERGONOMICS IN SPORTS AND EXERCISE**	**10**	**12**

DESIGN IN SPORTS AND EXERCISE-design of sports equipment, sports wear

Definitions in Ergonomics, principles of Ergonomics**,** Importance

An Overview of Athletic Ergonomics, Athletes postures

Ergonomics and injury, etiology and pathomechanics of injury, equipment design and injury - sports engineering

Mechanical support to the body - taping, splinting, braces, orthotics.

Protective equipment - body padding, mouthguards, helmets, headgear.

Shoe-surface interaction - footwear design, surface characteristics, traction

Sport-specific problems - skiing, cycling, tennis, mountain sports

24183SE	**INJURIES: CAUSES, PREVENTION, REHABILITITION IN RELATION TO SPORTS AND EXERCISE**	**10**	**12**

Injury rates, Injury types, Practice versus competition injuries,

Body parts/regions injured,

Injury mechanisms,

Age, Gender differences in injuries

Injuries in selected sports and physical activities,Diagnosis & Management of Musculoskeletal Injuries

Physiotherapy in injury management

Prevention of sports injuries

Rehabilitation issues

First Aid Emergency Care

24184SE	**EXERCISE FOR HELTH AND WELL BEING**	**10**	**12**

- **Exercise Therapeutics:** Exercise for special populations-senior citizens, diabetics, COPD patients, people suffering from hypertension and CAD,
- Exercise prescription for health and wellbeing- Physiotherapy

PHYSIOLOGICAL BASIS OF TRADITIONAL SPORTS AND EXERCISE- YOGA

24185SE	**MANAGEMENT OF SPORTS AND EXERCISE PERFORMANCE**	**10**	**12**

Planning, Organizing, Sports Exercise and Recreational Activities and Facilities. Selection of talented sportspersons,

Principles of training for performance improvement,

Train the trainer Programme,

Management of Sports team, Motivation for performance

Management of stress; Risk Management, Legal Issues in Sports

National International Standards

Management of Sports Events

PAPER 19 **PRACTICAL** **50**

1. Introduction to practical experiments on human subjects and Standardisation of different techniques for recording different parameters on human subjects
2. Study of structural anthropometry on human subjects.
3. Study of body composition, i.e. Lean Body Mass (LBM), FM, target weight, somatotype etc.
4. Study of cardiorespiratory systems following exposure to different work load by ergometers (bicycle, treadmill, step test, etc.).
5. Study of recovery cardiac cost following exposure to treadmill running at different speed and inclination.
6. Determination of Physical Fitness Index with step test.
7. Determination of Physical Fitness Index with Astride Jump Test.
8. Determination of VO_2 max with Queen College Step Test.
9. Determination of VO_2 max with Astrand-AstrandNomogram by Bicycle ergometry
10. Determination of VO_2 max with MargariaNomogram by Step Test.
11. Determination of Cardio-respiratory fitness with Pointslope Method by Step Test.
12. Determination of distance of 12 min run (Cooper test).
13. Determination of distance of 6 min run with maximum speed.
14. Determination of Hb concentration before and during graded exercise.
15. Electrocardiographic changes before and during graded exercise by electrocardiograph.
16. Exercise-Tolerance test to determine cardiac efficiency.
17. a) Hand-muscle strength by Hand-grip-Dynamometer.
    b) Hand-muscle-strength during different postures.
    c) Blood pressure changes during hand-muscle-endurance study.
18. Determination of blood lactic acid concentration by photoelectric colorimeter.
19. Determination of lung volumes by expirograph.
20. Determination of static and dynamic lung functions.
21. Determination of steady state heart rate at different work load on a bicycle ergometer.

22. Determination of ventilation volume of lungs at steady state heart rate.

23. Study report of visiting institute of repute for exposure to modern techniques, etc.

PAPER 20 **PROJECT AND SEMINAR** **50**

MOLECULAR CELL BIOLOGY

		MARKS	CONTACT HOURS
PAPER 17			
24171	**Introduction to cell biology** a) **Cell Theory Origin of life, chemical evolution and theories of origin of life** b) **General structure of cells** c) **Visualization of cells, ultrastructure and molecules** d) **Organization of the biological membrane; Transport across membranes; Ion Channels** e) **Cellular Organelles: structure and function, Endoplasmic reticulum, Golgi complex, Types of vesicles - transport and their functions, Lysosomes. Nucleus - Internal organization, Nuclear pore complex, Nucleosomes, Chromatin.** f) **Mitochondrial Structure and Function – Oxidative Metabolism in the Mitochondrion – The Role of Mitochondria in the formation of ATP – Translocation of Protons and the Establishment of a proton-motive force – The Machinery for ATP formation – Peroxisomes. Mitochondrial diseases: a preliminary idea**	**10**	**12**
24172	**Integration of cellular macromolecules, vesicular trafficking and protein sorting** a) **Cytoskeleton – components of Cytoskeleton, Microtubules, Intermediate filaments – Microfilaments,** b) **DNA, RNA and proteins; basic structure, assembly and organization**	**10**	**12**

c) **Cellular compartments and functions, protein sorting**
d) **Vesicular traffic inside the cells**
e) **Transport of macromolecules between the nucleus and cytosol; Transport of macromolecules between the cytosol and mitochondria; Transport from ER to golgicomplex; identifying features**
f) **Molecular mechanisms of membrane transport and the maintenance of compartmental diversity**

24173	**Cell-to-cell communication and cell signaling** **a) Concepts of signal molecules** **b) Gap and tight junctions and cell signaling** **c) Receptors: G protein linked receptors and G protein mediated signaling** **d) Second messengers** **e) Role of Calcium, lipid signaling, Phospholipase and Phosphoinositides signaling** **f) Signaling through enzyme linked cell surface receptors** **g) Cytokine receptors and JAK-STAT pathway,** **h) Receptor tyrosine kinases, Map kinase pathways,** **i) Wnt, Notch and Hedgehog signaling cascades** **a) Steroid receptor and TLR pathways** **j) Integration of Signals and experimental approaches for building a comprehensive view of signal induced responses**	**10**	**12**
24174	**The Cell Cycle and Programed Cell Death** a) **Overview of cell cycle** b) **Components of the cell cycle control system - the checkpoints** c) **CyclinsandCdks** d) **Intracellular control of cell cycle** e) **Regulation and deregulation of the cell cycle machinery** f) **The mechanics of cell division Mitosis and cytokinesis** g) **Cell death : apoptosis versus necrosis** h) **Programmed cell death– intrinsic and extrinsic signals and cascades** i) **Detection of apoptosis**	**10**	**12**
24175	**Stem Cell Biology** **a) Stem cells: Concept, types, self-renewal, pluripotency, differentiation; Commitment and Specification** **b) Adult, embryonic, induced pluripotent and cancer stem cells** **c) Isolation and characterization of stem cells** **d) Stem cell culture; principles for identification, purifications, assessment of proliferation long-term maintenance and characterization.** **e) Niche and stem cell engineering** **f) Cell - cell interaction and signaling during morphogenesis in early embryo; Pattern formation and Morphogenic gradients in development; Oogenesis, spermatogenesis** **g) Molecular mechanisms of animal development: homeotic genes, DNA methylation and epigenetic gene regulation** **h) Gene therapy and therapeutic application of stem cells Neurodegenrative disorders, spinal cord injury, diabetes, burns and orthpedic applications of stem cells** **i) Genetic Manipulation of stem cells, overview of different methods of introduction:.micronuclear injection method, transduction with**	**10**	**12**

recombinant retroviruses, targeted gene insertion, cre-LoxP recombination and production of transgenic animals

PAPER 18

24181	**Genome organization; Transcription; Translation and Post-Translational Modifications** **a) Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; DNase I hypersensitive regions; DNA methylation & Imprinting** **b) Replication initiation, elongation and termination; Enzymes and accessory proteins; Fidelity; Gene targeting; Cre/Lox recombination.** **c) Transcription unit; Promoters; Operators; Regulatory elements; Initiation; Attenuation; TerminationAnti-termination; Transcriptional regulation; Operons; Processing of tRNA and rRNA; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; Activators and repressors; Transcriptional and post-transcriptional gene silencing** **d) Post Transcriptional Modifications; Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.** **e) Translation & Transport; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Iso-accepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation**	**10**	**12**
24182	**Mutations, Oncogenes and Tumor Suppressor Genes** **a) Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations** **b) Physical, chemical and biological mutagens** **c) Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation** **d) Viral and cellular oncogenes** **e) Tumor suppressor genes; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins** **f) Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes** **g) Oncogenes as transcriptional activators**	**10**	**12**
24183	**Cancer and oncogenesis** **a) Chemical carcinogenesis**	**10**	**12**

b) **Biochemistry and molecular biology of cancer Classification through gene expression profiling**
c) **Initiation, promotion, progression, cell behavior**
d) **Benign versus malignant tumors**
e) **EMT**
f) **Angiogenesis and Metastasis**
g) **Cancer immunology**
h) **Cancer-critical genes and epigenetic mechanisms**
i) **Treatment strategies**

24184	**Components of Cellular Defense Systems** a) **Inflammation and immunity** b) **Cells of immune system: Hematopoeisis, surface molecules, NK cells, dendritic cells, macrophages, T and B lymphocytes; Cell-cell cooperation** c) **Immune responses generated by B and T lymphocytes** d) **Immunoglobulins: classes and subclasses, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily** e) **Immunological basis of self/non-self-discrimination** f) **Kinetics of immune response, memory; B cell maturation, activation and differentiation; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses.** g) **Cytokines: properties, receptors and therapeutic uses** h) **Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.** i) **Immunosuppression and immunodeficiency**	**10**	**12**
24185	**Techniques in Molecular Cell Biology** a) **Cell culture techniques, transfection and infection of cells** b) **Protein purification and characterization** c) **Nucleic acids, RNA interference miRNAs and siRNAs** d) **Immunohistochemistry** e) **Microscopy and imaging (light, fluorescence, confocal, EM)** f) **Fluorescence activated cell sorting** g) **Transgenics and Knock-outs** h) **Western Blot,** i) **PCR** j) **ChIP; FISH; FRAP; RAPD;RFLP,** k) **Cloning, restriction enzymes, plasmids: selection and isolation, transfection in vivo knock-out and knock-in** l) **Cell based reporter assays**	**10**	**12**
PAPER 19	**PRACTICAL**		
	Basic Cell Culture Techniques **Media preparation, isolation and culture of primary cells, isolation and culture of peritoneal macrophage: evaluation of nitric oxide from culture supernatant, trypan blue and MTT assay** **Introduction to flow cytometry and fluorescence microscopy**	**50**	

Cell cycle phase distribution of nuclear DNA by Flow cytometry

CD4/CD8 profiling

Nuclear staining by DAPI

Development of tumor model

Intra-peritoneal tumor passage, intra-muscular tumor cell injection, evaluation of tumor volume

Evaluation of cell cytotoxicity and redox status

LDH, ALP, SGOT, SGPT, DHE standard curve, ROS by fluorimetry, NO standard curve, Nitric Oxide scavenging Assay, Glutathione cycle; DPPH Assay of known antioxidants (Vitamin C/NAAC/tBHQ

Cell based assays

Post mitochondrial supernatant preparation,

Whole cell lysate preparation,

Nuclear/ cytosolic lysate preparation,

Protein estimation (Lowry's method),

DNA/RNA extraction and purity evaluation, Electrophoresis: SDS PAGE, Agarose DNA gel electrophoresis,

Western blot, PCR

PAPER 20 **PROJECT AND SEMINAR** **50**

BIOSTATISTICS and ANALYTICS

PAPER 17		**MARKS**	**CONTACT HOURS**
24171	**Quantitative Approach in Understanding Human Physiology** • Quantitative Approach in understanding Physical and Biochemical foundations of Human Physiology: • Cardio respiratory, Renal, Sensory Physiology in Quantitative Terms	**10**	**12**
24172	**Statistics and Analytics: Application in Human Physiology** Foundations and applicability in Human Physiology of • Probability and Probability Distributions, • Simulation Techniques, • Non-linear dynamics • Operations Research	**10**	**12**
24173	**Quality Issues in Physiological Data Management** o Concept of Quality	**10**	**12**

- Quality Issues in Design of Experiments
- Quality Considerations in Data Management
- Concept of six sigma

24174 Public Health Analytics **10** **12**

- Epidemiology,
- Incidence and Prevalence of different disease Assessing diseases Risk
- Clinical Data analyses – statistics of clinical tests
- Analyses of Time and Event data
- Human Development Indicators

24175 Human Body Segment Measurement : Anatomical and Physiological Basis of Product Design and Development **10** **12**

- Principles of Human Body Segment Measurements
- Error minimization
- Concept of Constant Body ratio
- Concept of product Designing
- Anthropomorphic products and their design

PAPER 18

24181 Mathematical Modeling **10** **12**

- Foundations of Mathematical Modeling
- Development of Mathematical models for Application in Disease Indicationand in establishing physiological relationship
- Validation of Models, Confidence Intervals
- Sensitivity Analyses

24182 Analytics of Human Performance and Pattern Recognition in Physiological Data **10** **12**

- Quantitative Aid for Facilitating Human Performance including Biomechanics
- Recognition of Pattern in Physiological Data – Inheritance pattern
- Neural Network
- Application of Artificial Intelligence

24183 Accidents Analytics **10** **12**

- Quantitative Approach to Human Factor Issues in Accident Management
- Risk Management Matrices
- Concept of Odds Ratio
- Computation of Accident Indices, Standard Guidelines

24184	**Analytics of Public Health Policies**	**10**	**12**
	• Analyses of different Public Health Policies, having Implications in Human health, of National and International Bodies, like UN, WHO and ILO		
24185	**Multivariate and Non Parametric Data Analyses Techniques**	**10**	**12**
	• Principles and Application of Multivariate and Non parametric data analytical techniques in Human Physiological Studies		
PAPER 19	**PRACTICAL**		
	• Application of Fundamental Mathematical and Statistical Tools in Human Physiology - Measures of central tendency and dispersion, relationship; testing of hypothesis; categorical data analyses • Advanced Statistical Techniques - Bivariate and Multivariate Data Management Techniques - ANCOVA, MANOVA • Usage of computer packages for data analyses • Mathematical Modeling • Virtual Product Design • Preparation of Reports, Term Papers and Case Studies • Visit to National Research Institutes	**50**	
PAPER 20	**PROJECT AND SEMINAR**	**50**	

DETAILED SYLLABUS OF GENERIC ELECTIVE COURSE (GEC)

COURSE OFFERED BY PHYSIOLOGY DEPARTMENT FOR STUDENTS OF OTHER DEPARTMENTS

Paper – GEC-Physiol

Title: Human Physiology and Public Health

[one paper for 50 marks in 3rd Semester as draft syllabus for CBCC course offered by the Dept. of Physiology; each module carry 10 marks; 5x10 = 50 marks; Credit - 04]

1. **Elementary concepts:** Cellular & Systems Physiology -Cell structure,different tissues, organs &systems, homeostasis, Physiomes; Biomolecules, cellular signaling, Cell division and genetics, cell death,Cellulardefense mechanism, cellular stress;immunological cells & body defense,Communicable and non-communicable diseases, Pharmacology &application of drugs.

2. **Gastrointestinal Physiology & Nutrition**: GI structure, Food Digestion and Absorption, Metabolism and Biochemical pathways; Diet, nutritional assessment, Malnutrition, Over-nutrition, under-nutrition.

3. **Cardio-Pulmonary & Renal Physiology**: Blood and hemodynamic, Blood Pressure, Heart Rate, Cardiac cycle, Cardiac Output, ECG & Echocardiography for disease diagnosis; Respiratory Rate, Lung Volumes, Oxygen Uptake, lung function tests for disease diagnosis; Nephron, glomerular filtration rate, urine formation, renal clearance test for disease diagnosis, dialysis.

4. **Neuro-Musculo-Skeletal systems and Endocrine Physiology**: Brain and peripheral nervous systems, neurotransmitters, synapse, Neuro-muscular junction, neurodegenerative diseases, EEG, Brain imaging; Musculo-skeletal systems, Bones and cartilages, osteoporosis and arthritis; Endocrine glands, Hormones, Endocrine disorder, Reproduction, Hormonal dysfunction and Reproductive failure, contraceptive, IVF.

5. **Environmental Physiology and Human Performances**: Hypobaric/hyperbaric condition, heat & cold stress, Radiation, Pollution & toxicity; Body composition ,Anthropometry and its applications, Occupational Ergonomics, Occupational health hazards, Shift work & biological rhythms, Sports science and its management.