UNIVERSITY OF CALCUTTA

NotificationNo.CSR/02/2022

It is notified for information of all concerned that the Syndicate in its meeting held on 08.12.2021 (vide Item No.50) approved & confirmed the new "Updated Syllabus" (with UGC regulation of CBCS format) of two years (four semester) M.Sc. Course of Study in Human Physiology offered by the Post-Graduate Department of Physiology, 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 session 2022 -2023.

11/02/22

Prof.(Dr.) Debasis Das

Registrar

SENATE HOUSE

KOLKATA-700 073

The 11th February, 2022

UNIVERSITY OF CALCUTTA REGISTRAR

DEPARTMENT OF PHYSIOLOGY

UNIVERSITY OF CALCUTTA

SYLLABUS

Under

Choice Based Credit System (CBCS)

2021

CONTENT

ORIENTATION OF COURSES

Codes: ***"HPY" stands for subject (Human Physiology), CC stands for Core Course, GEC stands for Generic Elective Course, DSEC stands for Discipline Specific Elective Course, "TH" stands for Theory, "PR" stands for Practical, "PS" stands for Project & Seminar, "P" stands for Paper***

Codes of unit: Year-Semester-Paper-Unit (e.g. 11011 refers 1st Year-1st semester-Paper01-Unit-1)

**** 20% marks are included as Internal Assessments. The marks distribution and the process of the Internal Assessments are appended below the table.***

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	RESPIRATORY PHYSIOLOGY	10	12	
11014	RENAL 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 FACTORS	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	IMMUNE SYSTEM	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	CELLULAR ORGANIZATION, CELL TO CELL COMMUNICATION AND SIGNALING	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	**Practical: Advance techniques in Physiology**	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**	**MARKS**	**CONTACT HRS**	**CREDIT**
24161	APPLICATIONS OF GENETIC ENGINEERING & CONCEPTS OF OMICS	10	12	
24162	CELL/ TISSUE CULTURE & IMMUNOLOGICAL TECHNIQUES	10	12	
24163	INVASIVE AND NON INVESIVE TECHNIQUES IN IDENTIFICATION OF OCCUPATION RELATED DISEASES	10	12	
24164	BIOPHYSICAL CHEMISTRY, ELECTROPHYSIOLOGY & BIOMEDICAL INSTRUMENTATION	10	12	
24165	NANOTECHNOLOGY & NERO-IMAGING TECHNIQUES	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) Biophysics & Electrophysiology (III) Biostatistics and Analytics (IV) Endocrinology & Reproductive Physiology (V) Environmental Physiology (VI) Ergonomics & Work Physiology (VII) Immunology & Microbiology (VIII) Molecular Cell Biology (IX) Neurophysiology (X) Nutrition & Dietetics (XI) Sports & Exercise Physiology			

Components of examination & marks distribution

(I) Internal Assessment (20%): Daily/weekly/monthly (Formative) assessment: 10 marks/paper

Theory examinations: Class assessment, Home assignments, Case studies, Quiz test, Seminar, Comprehension/Listening Test, Open Book Assignment, Oral Tests, Paper Presentations, Comprehensive Viva.
Practical examinations: Lab Note Book (practical classes), Surveys book (under DSEC practical in 4th semester)
Projects examinations: Project work write-up (under DSEC paper in 4th semester)

(II) Semester End Assessment (80%) : 40 marks/paper

Theory examinations: Written test: Total 13 papers/four semesters
Practical examinations: Real-time hands-on experiment with written presentation (principle, protocol, results, calculations, interpretation) & viva: Total 7 papers/four semesters
Project examination (4th semester only): Seminar presentation & Interaction

Ratio between the theory and practical/project marks

1st, 2nd and 4th semesters - 60:40 (Total marks 450:300)
3rd Semester - 80:20 (Total marks 200:50)
Full course (4 semesters/2 year) – 65:35 (Total marks 650:350)

Detailed Syllabus

CORE COURSE (CC)

Subject code Subject/Topics

FIRST SEMESTER

HPY-CC11-TH-P01 **Systems Physiology-I**

[Marks: 50, Contact Hrs:60, Credit:04]

11011 **BLOOD & HEMODYNAMICS**

1. Formed elements of blood: Physiology and biochemistry, kinetics, function and life span; hematopoiesis: abnormalities.
2. Hemostasis & Thrombosis: Structure-function relationships of factors/proteins, pathways involved in hemostasis: abnormalities; Types of thrombi: molecular basis. Anti-clotting mechanisms, anticoagulants.
3. Immuno-hematology and blood transfusion: Antigen systems in red cells, platelets and leukocytes and their implications in transfusion; complications in blood transfusion.
4. Hemorheology: Macro- and Micro-Rheological Properties of Blood, viscosity, shear rate, shear stress, viscoelasticity, Newtonian and Non-Newtonian fluids, laminar & turbulent flow, Reynolds' number, Bernoulli and Poiseuille's equations, erythrocyte deformability and erythrocyte aggregation.
5. Hemodynamics: Blood flow, blood pressure, hydraulic system and resistances to flow, haemodynamics in different phases of the cardiac cycle, heart sounds, mechanical power of heart.

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

11013 **RESPIRATORY PHYSIOLOGY**

1. Evolution of the atmosphere and evolution, Anatomy of Respiratory System
2. Principles of respiratory mechanisms and regulations: Elastic forces, lung volumes, Pressure/volume relationship
3. Respiratory system resistance : Physical principles of gas flow and resistance; Lung function tests

4. Non respiratory functions of the lung: Filtration, Defence against inhaled substances; the endocrine lung, Immune function of lungs and inflammatory mechanism of airway diseases.
5. Physiology of pulmonary disease, Artificial Ventilation, Lung transplantation

11014 **RENAL PHYSIOLOGY**

1. Functional Anatomy and Cellular peculiarity of human excretory System; Significances of Juxta Glomerular Apparatus.
2. Glomerular Filtration, Determination. Renal blood flow and its peculiarities, Regulation, Tubuloglomerular feedback, Regulation by Angiotensin II, Nitric Oxide, Prostaglandins, Endothelin, Bradykinin and other factors.
3. Kidney functions, Tubular Functions, Solute and Water Reabsorption, aquaporins, Structure function relationship across the Nephron, Renin Angiotensin System (RAS), The aldosterone paradox, Atrial natriuretic peptide (ANP) and brain natriuretic peptide (BNP).
4. Control of Body Fluid Osmolality and electrolytes: Urine Concentration and Dilution, Antidiuretic hormone (ADH, AVP) and cellular actions, Control of Extracellular Fluid Volume and Regulation of Renal NaCl Excretion. Renal regulation of electrolytes: Potassium, Calcium, and Phosphate Homeostasis. Acidosis – diabetic ketoacidosis, Anion gap.
5. Neural control of renal functions: Distribution and functions of Renal nerves, Autoregulation, Micturition and reflexes, Atonic Bladder and Incontinence.

11015 **GASTROINTESTINAL PHYSIOLOGY**

1. Regulation of GI functions: Molecular signalling for salivary secretion, gastric acid secretion & H^+-ATPase pump, bicarbonate secretion, intestinal movement, intestinal water absorption & aquaporins.
2. Role of defensive and aggressive factors, Paracrine function & intercellular factors including heat-shock proteins for gastroadaptation & gastroprotection
3. Immune functions of GI Tract, Gut microbiomes & use of prebiotic, probiotic, symbiotic agents
4. Gut-brain interaction: Gut-liver-brain axis, neuronal & endocrine regulations, role of microbiomes, role of phytochemicals including phytoestrogen, phytoinsulin & phytopolyphenoles
5. Pathophysiology of GI tract: Secretary diarrhoea, ulceration, irritable bowel syndrome & Crohn's diseases

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HPY-CC12-TH-P02 **Biomolecules & Biochemical Pathways**

[Marks: 50, Contact Hrs:60, Credit:04]

11021 **BIOMACROMOLECULES AND THEIR PRINCIPLES OF INTERACTIONS**

1. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
2. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
3. Principles of biophysical chemistry (pH, buffer, reaction kinetics, colligative properties).

4. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
5. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids.

11022 **ENZYMOLOGY**

1. Techniques for purification and characterization of enzymes, Clinical Enzymology, Diagnostic and therapeutic uses of enzymes
2. Technical approaches to the study activities of enzymes
3. Structural and molecular basis of enzyme activity and kinetics: Role of active sites, Coenzymes, Activators, Inhibitors
4. Allosteric enzymes and their regulation.
5. Mechanism of enzyme induction and repression.

11023 **METABOLISM-I**

1. Carbohydrate metabolism-I: Glycolysis, pentose phosphate pathway and TCA cycle
2. Carbohydrate–II: Mitochondrial function in gluconeogenesis; Biosynthesis and degradation of polysaccharides and current concepts of their regulation; Disorders of glycogen metabolism and their molecular mechanism
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

11024 **METABOLISM-II**

1. Nucleotide Metabolism: Regulation of Synthesis of purine and pyrimidine nucleotides
2. Membrane Metabolism: Structural organisation and functions; Membrane receptors; Membrane damage and repair. Spontaneous and active re-sealing of injured membrane, Role of Calcium, Survival of mammalian membrane from bacterial pore forming toxins
3. Organ Specific Metabolism: Brain and Nervous System, Cardiac, Muscle, Liver, Kidney : Metabolic pathways of glucose utilization in neurons and astrocytes, Glucose entry and glycogen formation in astrocytes, The hypothesis of astrocyte-neuron lactate shuttle, Fatty acid and glucose metabolism in cardimyocytes, Energy provision in skeletal muscle during exercise, The three energy system of muscle ATP generation, Regulation of hepatic glucose, glycogen and lipid metabolism, Mechanisms of kidneys in maintaining glucose homeostasis, intra-renal Cori cycle.
4. Organ Specific Metabolism: Endocrine organs, Reproductive Organs: Metabolic effects of hormones, The hormonal regulation of carbohydrate metabolism, Mechanism of insulin and glucagon on carbohydrate metabolism; Major differences in fat metabolism associated to gender, Male and female predominant metabolic traits,
5. Metabolic alteration in pathophysiological states: Pathophysiological mechanisms in metabolic syndrome, Effects of obesity, Insulin Resistance, Dyslipidemia, Hypertension and chronic low grade inflammation on the development of metabolic syndrome, Concept of metabolomics.

11025 **BIOENERGETICS**

1. System, boundary, and surroundings, Energy distribution and transformation, Concepts of free energy, universal features of cells on earth, free energy sources of life processes, and strategies of energy metabolism;
2. Laws of Thermodynamics as it applies in life systems, cells and molecules, and High-energy biomolecules and coupling phenomenon, energy-rich bonds, weak interactions, group transfer,
3. Biological energy transducers and bioenergetics; The fundamental route of electron transport, Electron transport chains in Mitrochondria and Chlorplast, (Oxidative phosphorylation and Photosynthesis)
4. Oxygen toxicity and endogenous and exogenous antioxidant systems.
5. Thermodynamics of small systems, Formation of the first biological macromolecules, Thermodynamic optimization in biology- in ribosome, protein folding,

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HPY-CC13-TH-P03

Community Health-I & computational Physiology

[Marks: 50, Contact Hrs:60, Credit:04]

11031 **BIOSTATISTICS**

1. Basis concepts: Variable, population, sample, sampling methods, data: parametric and non-parametric; significance of statistical analysis of biological data.
2. Method of data collection, measure of central tendency and dispersion; standard score, degrees of freedom; Probability and distribution: normal distribution, student's t distribution.
3. Testing of hypothesis, errors of inference, levels of significance, t-test, z score, Chi-square test.
4. Parametric & non-parametric statistics: Analysis of variance (ANOVA): models and types, one-way & two-way ANOVA, Kruskal Wallis non-parametric ANOVA; Multiple comparison t, Schiff f test, Mann-Whitney U test; Pearson's product-moment correlation, multiple correlation, partial correlation, Spearman's rank difference correlation; Regressions: linear and non-linear; Logistic regression and multivariate analysis; Meta-analysis.
5. Design of experiment: Data Presentation- graphical representation.

11032 **ERGONOMICS & HUMAN FACTORS**

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.

11033 **SPORTS & EXERCISE PHYSIOLOGY**

1. Classification of physical exercise, sports, workloads etc; concept of physical fitness; Cardiorespiratory changes during different grades of exercise.
2. Muscle fibre type classification and its relevance to athletic / sport activities
3. Cardiorespiratory, haematological and muscular adaptations following athletic training.
4. Measurement of work and power, measurement of energy expenditure
5. Exercise metabolism with special reference to fuels for exercise, bioenergetics, Lactate threshold, OBLA; EPOC; Cross-over point, etc.

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

11035 **BIOINFORMATICS in HUMAN HEALTH & DISEASES**

1. Introduction to Bioinformatics & Computational Biology: Definition, Historical perspective & conceptual vision, Translational bioinformatics.
2. Bioinformatics Resources: Biological Databases and search engines
3. Structural Bioinformatics: Modelling, Molecular docking, Molecular dynamics, Drug designing.
4. Systems Biology: Biological networks, simulation of pathways, databases and software for systems biology.
5. Virtual physiological human & physiome project

HPY-CC14-PR-P04 **PRACTICAL: EXPERIMENTAL PHYSIOLOGY**

[Marks: 50, Contact Hrs:60, Credit:04]

1. Experiments on cardiac muscle: Kymographic recording:
   (a) Effect of vagal stimuli on the movements of perfused heart of toad with and without application of atropine.
   (b) Effect of excess calcium on the movements of perfused heart of toad.
2. Experiments on smooth muscle (Dale's Experiment): Kymographic recording:
   (a) Effect of acetylcholine on the movements of intestinal movements of albino rat with and without application of atropine.
   (b) Effects of oxytocin on uterine contractions of albino rat.
3. Experiments on skeletal muscle: Kymographic recording of movements of Gastrocnemius-sciatic nerve preparation and genesis of tetanus using stimuli.
4. Experiments on animal handling (rat/mice):
   (a) Measurement of rectal temperature
   (b) Oral dosing (Gavage)
   (c) Intraperitoneal injection

HPY-CC15-PR-P05 **PRACTICAL: CLINICAL BIOCHEMISTRY**

[Marks: 50, Contact Hrs:60, Credit:04]

A. Basic Instruments:

(Hands on and Demonstration)

1. Principles of Colorimeter
2. Principles of Spectrophotometer
3. Principles of Fluorescence spectrophotometry
4. Principles of automated-analysis (haematological)
5. Polyacrylamide Gel Electrophoresis
6. Principles of Chromatographic Techniques
7. Basic Flow cytometry

B. Clinical Biochemistry

1. Lipid Profile: Estimations of Cholesterol, Triglyceride, HDL, LDL
2. Liver function test (LFT): Estimations of ALT, AST, ALP, AP
3. Renal Profile: Estimations of Creatinine, Bilirubin, Na, K, Ca
4. Estimation of blood glucose by Nelson Somogyi Method
5. Protein Estimation: Preparation of BSA standard curve and estimation of serum protein through Lowry's method.
6. Determination of optimum pH for maximum activity of the supplied enzyme sample.
7. Determination of optimum temperature for maximum activity of the supplied enzyme.

SECOND SEMESTER

HPY-CC21-TH-P06 **Systems Physiology-II**

[Marks: 50, Contact Hrs:60, Credit:04]

12061 **IMMUNE SYSTEM**

1. "lmmunogens", "Haptens" and "antigens": Properties of antigenicity and immunogencity, Role of adjuvants in increasing the immunogenicity, Mechanisms of antigen recognition by the innate and adaptive immune systems.
2. Structure and function of antibody molecules: Different regions of antibody molecule and their function, Mechanism for synthesis of immunoglobulin bearing a single specificity by B cells, Properties of antibody secreting plasma cells, B cell memory.
3. Primary and secondary immune response, Role of cytokines, chemokines and complement: Th1 and Th2 subsets for cytokine production, Cytokine-mediated generation and cross regulation of Th1/Th2 subsets, Properties of cytokines and signal transduction mediated by them, Role of chemokines and complements in leukocyte trafficking and inflammation,
4. Infection and immunity: Co-operation between innate and adaptive immune system towards killing of intracellular and extracellular microbial pathogens, Strategies used by intracellular and extracellular pathogens to evade host immune responses with

suitable examples, Major mechanisms of host immune defence against extracellular and intracellular opportunistic microorganisms.

5. Vaccine development: Active and passive immunization, classical vaccine development pathway, Properties of different types of vaccines, Mechanism of persistent production of vaccine-specific antibody and B-cell memory, Features of four phases of vaccine clinical trials, Concept of "Herd Immunity" and its relation to vaccination.

12062 **NERVOUS SYSTEM**

1. Neurophysiology of planning, programing & execution of motor tasks; Disinhibition circuits in brain and their physiological relevance.
2. Neurophysiology of spasticity & rigidity: experimental models & clinical significances
3. Thalamo-cortical projections and its influence on evoked cortical activity, origin of Brain Waves, EEG
4. Modern concepts of sleep & wakefulness.
5. Mechanism of development of degenerative diseases: Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, Amyotrophic Lateral Sclerosis

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 Biochemical events.
3. 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.

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 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. Cellular and molecular basis of learning & memory; Sensory learning & motor learning.
2. Plasticity: Spine plasticity, Synaptic plasticity, Neuronal plasticity, Glial plasticity, Brain plasticity.
3. Emotion & Behavior: cellular and molecular underlying of cognitive interaction, amygdala and higher brain circuits.
4. Neural mechanisms of human behavior: altruism, social communication & social dominance, parental care, aggressive behavior.
5. Behavioural abnormalities, psychiatric disorders, schizophrenia and depression.

HPY-CC22-TH-P07

Cellular & Molecular Physiology

[Marks: 50, Contact Hrs:60, Credit:04]

12071 **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.

12072 **MOLECULAR BIOLOGY**

1. Genetic Element and its evolution: C-value paradox, Eukaryotic Chromosomes, and Genomes, Organization, C_0T Kinetics.
2. DNA Replication, Repair, and Recombination

3. Reading the Genome: RNA to Protein, Eukaryotic Gene Regulation, The Catalytic RNA, Post Transcriptional Modification, coding and non-coding RNA
4. Protein Synthesis: Prokaryotic and Eukaryotic, Experimental evidences of individual phenomena, Accuracy in Translation, Quality Control Mechanisms, Protein Folding and post translational and proteasomal modifications,
5. Fundamental and applied aspects of Genomics and Proteomics: Techniques applied for OMICS studies.

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.

12074 **HUMAN GENETICS**

1. Mendelian principles and extensions of Mendelian principles: Dominance, segregation, independent assortment. Allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles - Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
2. Organization of human chromosomes: Normal chromosomal constitution, Autosomal & Sex chromosome. Karyotype, Karyogram, Ideogram, Chromosomal abnormalities, mechanism of sex determination. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.
3. Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, Pedigree analysis, lod score for linkage testing
4. Mutation and genetic disorders – Types of mutation, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Genetic disorders- Sickle cell anemia, hemophilia, thalassemia, cystic fibrosis, Huntington disease, Colour blindness, Phenylketonuria. Cancer Genetics.
5. Immunogenetics: Blood Groups, Histocompatibility and Organ Transplantations.

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
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

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HPY-CC23-TH-P08 **Community Health-II**

[Marks: 50, Contact Hrs:60, Credit:04]

12081 **PHYSIOLOGICAL CONCEPTS IN INDUSTRIAL MANAGEMENT**

1. Work and health: Definition of health and its relation with respective work
2. Design of workstation: Anthropometry and basic regulations on workstation design.
3. Psycho-physiological aspects of work: An idea on Stress, Motivation, Anxiety and their effects on the performances of workers
4. Industrial Productivity: Time study, Ineffective time and reduction of ineffective time for improvement of productivity in formal and informal sectors
5. Safety, Health and Environment management: Concepts of Safety. Interventions for management of industrial health and environment.

12082 **SPORTS MEDICINE & DRUG ABUSE**

1. **Physician's Interest in the Physiology of Exercise:** Historical perspectives of evolution of Sports and Exercise Physiology, contributions made by physicians.
2. **Sports Medicine Team:** Concept of sports medicine team, central and peripheral members, role of sports medicine experts in sports medicine team.
3. **Principles of Safety in Physical Activity and Sports:** Prevention of sports injuries: principles and other preventive procedures e.g., role of conditioning, importance of correct coaching, basic concepts about the use of protective equipments, following the rules, availability of emergency care, general guidelines to prevent sports injuries in children and adults.
4. **Management of Illness and Injury sustained in Exercise Activities:** Sports injury assessment procedures, e.g., SOAP, HOPS, RICER, etc., on the field assessment, chronic and acute sports injuries, types of bone, ligament, muscle and tendon injuries, First–aid procedures, Sports injury rehabilitation procedures.
5. **Drug abuse in sports:** Economic and social causes of drug abuse, History of using Dope substances in sports, Classification of Dope substances (drugs used in sports), Doping Methods and Mechanism of action, Fundamental rational for the world anti-doping code, Rules of testing and investigation procedures, Drug tolerance, sensitivity and vulnerability, Treatment of drug abuse, viable prophylaxes and rehabilitation procedure.

12083 **HIGH ALTITUDE, AVIATION AND SPACE PHYSIOLOGY**

1. **Atmosphere- Composition and Altitude Physiology:** Air Pressure**,** O_2, CO_2, Temperature and Relative humidity; National and International development of Altitude Physiology studies, Physiological and cellular effects of high altitude, altitude illness, basis of pulmonary edema, Genetics and genomics of exposure to high altitude.

2. **Physiologic Responses to Hypoxia:** Acclimatization, Pulmonary gas exchange, effects on different Physiological and cellular systems, HIF and its role in different physiological responses.
3. **Human tolerances to stresses in space including space flight:** Acceleration, Deceleration, Weightlessness, Thermal Extreme, High 'g', Ionizing Radiation, Meteorites. The Cabin Atmosphere in Space flights: Living and Working in Space, Physiological effects.
4. **The Environment of Space Exploration:** Physiological Adaptations and cellular basis, Performance; Adaptation, Pathophysiology, Rehabilitation, and Countermeasures with respect to different physiological systems and cellular basis. General Medical Emergencies, Waste removal and/or storage. Nutritional issues.
5. **Research areas on high altitude and Space Physiology:** Research Studies on high altitude explorers and residents. Principles of space crew health monitoring and care, Occupational hazards and countermeasures, Simulations and Analogs, Training modules for High altitude and Space travels, Commercial Space Tourism and Space as a Biomedical Laboratory.

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. Biological significance of thioredoxin cycle, 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. Role of Nrf2 transcription factor in stress regulation. 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.

12085 **MICROBES & MICROBIOL PHATHOLOGY**

1. General Microbiology: Classification; morphology, and physiology of bacteria. Bacterial chemotaxis and quorum sensing. Biofermenter.
2. Microbial fermentation and production of small and macro molecules.
3. Microbes in mineral cycling, microbiology of water, air, soil and sewage. Bioremediation and biofertilizer.
4. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes, Homologous and non-homologous recombination including transposition.
5. Host-microbe interactions: Commensals, beneficials, parasites and pathogenic microbes. Normal microbial flora. Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell

behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases, cell-cell fusion in both normal and abnormal cells.

HPY-CC24-PR-P09 **PRACTICAL: HISTOLOGY, HISTOCHEMISTRY, HISTOPATHOLOGY & HAEMATOLOGY** **[Marks: 50, Contact Hrs:60, Credit:04]**

1. **Histology of different mammalian tissues**:
   (a) Tissue preparation, histological sectioning & permanent slide preparation.
   (b) Haemotoxylin/Eosine staining of histological sections.
2. **Histochemistry of different mammalian tissues**:
   (a) Detection of nucleic acids (DNA): Feulgan staining, Methyl green- pyronine method.
   (b) Detection of proteins: Coomassie blue, mercuric-bromophenol blue method
   (c) Detection of enzyme: Alkaline phosphatase staining by cerium-DAB method or azo-coupling method
3. **Histopathology**: Histological and/or histochemical studies of mammalian tissues/organs under different treatment conditions.
   (a) Hepatotoxicity by CCl_4
   (b) Nephrotoxicity by gentamicin
4. **Histometry**:
   (a) Measurement of cellular diameter and, diameters of seminiferous tubules and thyroid follicles using Camera lucida drawing.
   (b) Demonstration: cellular morphometry by computer based shoftware e.g. ImageJ.
5. **Hematology**:
   (a) Blood film preparation and Leishman's staining; assessment of RBC morphology; DC of leucocytes
   (b) Histochemical methods for enzymes in leucocytes: Alkaline phosphatase in granulocytes, Esterase in monocytes and T-cells.

HPY-CC25-PR-P10 **PRACTICAL: HUMAN PHYSIOLOGY/ COMPUTER APPLICATIONS AND BIOSTATISTICS** **[Marks: 50, Contact Hrs:60, Credit:04]**

HUMAN PHYSIOLOGY, COMPUTER APPLICATIONS AND BIOSTATISTICS

1. Determination of heart rate in supine, sitting and standing posture
2. Determination of blood pressure before and after a submaximal exercise
3. Determination of recovery cardiac cost
4. Determination of hand grip strength of both the hands in horizontal and vertical (upward and downward) postures
5. Experiments on pulse rate and blood pressure in relation with exercise (fixed).
6. Anthropometry and body composition by skinfold measurement.
7. Static and dynamic pulmonary function measurements.
8. Determination of Hb before and after exercise.
9. Determination of diurnal variation of pulse rate and respiratory rate.

Computer and its application in biological problems:

1. Basic concept of computer: hardware and software; memory, processor, monitor, printer, input devices; operating system: windows, Linux.

2. Microsoft office: MS Word, Excel, and Power Point operation: preparation of CV, problem solving with proper statistical interpretation, preparation of presentation.

Practical applications of statistics in biological problems.

1. Correlations: linear, partial, multiple, Kendall's rank correlation.
2. Regression: linear,multiple, biserial r, point biserial r.
3. ANOVA: one-way, two-way, Kruskal-Wallis; Mann-Whitney Test.

THIRD SEMESTER

HPY-CC31-TH-P11 **Systems Physiology-III**

[Marks: 50, Contact Hrs:60, Credit:04]

23111 **ENDOCRINOLOGY**

1. **Principles and Chemistry Hormones:** Individual structure function relationships, Receptors and subtypes, Hormone receptor interactions; Storage, release, transport and degradation of steroids, amines and peptide hormones. Cytokines and growth factors of hormones.
2. **Mechanism of hormone actions:** Membrane bound and intercellular receptors; steroid hormone-receptor interactions; membrane bound hormone-receptor interactions; second messenger in hormone action/signal transduction; recycling of receptors.
3. **Hormones in immune responses:** Autoimmune endocrine disorders. Non-Conventional Endocrine Molecules in Health & Disease
4. **Hormonal regulation of metabolism:** Carbohydrate, protein, lipid, water, minerals/electrolyte etc. Metabolic and lifestyle disorders.
5. General principles of cell communication as applied to different physiological phenomena, tissue renewal, growth, differentiation, modalities of extracellular signaling and response to endocrine components, morphogens, nuclear receptors, orphan receptors, GPCR, Calcium signaling.

23112 **NEUROENDOCRINOLGY& CHRONOBIOLOGY**

Neuroendocrinology:

1. Hypothalamic neuronal circuits, neurotransmitters & relevant brain functions.
2. Metabolic regulation of hypothalamic function and role of tanycytes; Neuroendocrine disorders

Chronobiology:

3. Human Circadian Rhythms & Chronotypes
4. SCN, photic and non-photic entrainment neuronal pathways, neurotransmitters, photoperiodicity of sleep-wakefulness cycle.
5. Advance concept of control of circadian rhythms: Cellular and molecular mechanisms

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 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 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.
2. Gametogenesis, fertilization & early development, Morphogenesis & organogenesis.
3. Programmed cell death, ageing and senescence.
4. Definition and types of stem cell; genesis and differentiation of stem cells in different organs
5. Stem cells: Applications and future in Modern Biology and Health Sciences.

HPY-CC32-TH-P12 **Community Health-III: Hazards and Prevention**

[Marks: 50, Contact Hrs:60, Credit:04]

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

23122 **DESIGN ERGONOMICS & DECISION MAKING MODELS**

1. **Ergonomics in Design :** Concept of Detailed and Total Design
2. **Design Process :** Concept, Scheme Design, Post production
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).

23124 **ENVIRONMENTAL POLLUTION, XENOBIOTICS AND ITS MANAGEMENT**

1. Environmental Air Pollution, Noise Pollution, Water Pollution and its control.
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.

HPY-CC33-PR-P13 **Practical: Advanced Techniques in Physiology**

[Marks: 50, Contact Hrs:60, Credit:04]

1. **Biochemical estimations**
   (a) Determination of Km & Vmax of an enzyme activity.
   (b) Preparation and estimation of concentration of antioxidant(s) by preparing a standard curve using different methods.
2. **Applied Endocrinology and Reproductive Physiology**
   (a) Designing of Primers: (essentially of Endocrine related genes)
   (b) PCR and agarose gel electrophoresis
3. **Ergonomics in estimation of occupational health disorders**
   (a) Application of MSD questionnaire among workers in different occupations for evaluation of work related musculoskeletal disorders.
   (b) Evaluation of working postures during different work activities
4. **Immunological estimations & microbial tests**
   (a) Isolation of murine splenic, peritoneal macrophages and assessment of murine macrophage functions: bactericidal enzyme (Lysozyme) release
   (b) Identification of unknown bacteria by biochemical tests
5. **Molecular Cell Biology & estimations**
   (a) Cell counting using Hemocytometer
   (b) Cell Viability Assay using vital dye exclusion (Trypan Blue)
6. **Neurophysiological tests in human/animal.**
   Evaluation of the performances in learning/memory task(s) with sensory stimuli.
7. **Nutritional estimations**
   (a) Body composition assessments
   (b) Food adulteration detection
8. **Assessment of motor fitness parameter**
   Determination of agility, flexibility and explosive leg strength
9. **Rheological studies:** Measurement of viscosity

Demonstrations

1. *Two dimensional paper chromatography*
2. *ECG and analysis*
3. *Real Time PCR/ Imaging techniques; Cell Extraction and Purification of Hormone Techniques and PAGE*
4. *Cytokine ELISA & Immunoblot*
5. *Basic cell culture techniques using either primary or established cell lines*
6. *Brain imaging (histomorphological*/confocal/EEG/MRI/MRS)
7. Routes of drug delivery and nanomaterials in drug delivery
8. Heath Carter somatotyping

HPY-GEC31-TH-P14 **GENERIC ELECTIVE COURSE (GEC)**
[Marks: 50, Contact Hrs:60, Credit:04]
Physiology Students will opt GEC offered by other Department

HPY-GEC32-TH-P15 **GENERIC ELECTIVE COURSE (GEC)**
[Marks: 50, Contact Hrs:60, Credit:04]
Physiology Students will opt GEC offered by other Department

FOURTH SEMESTER

HPY-CC41-TH-P16 **Modern Techniques in Physiology**
[Marks: 50, Contact Hrs:60, Credit:04]

24161 **APPLICATIONS OF GENETIC ENGINEERING & CONCEPTS OF OMICS**

1. Principles of cloning, Restriction Enzymes, Transformation
2. PCR and Real Time PCR, site directed mutagenesis.
3. Hybridisation, Immunoblotting, micro-array, Principles and applications of Classical and Modern DNA Sequencing
4. Gene Therapy, CRISPR and other Regenerative technologies in biology
5. Online tools and applications of techniques for OMICS study; Analysis by "Omics" softwares

24162 **CELL/ TISSUE CULTURE & IMMUNOLOGICAL TECHNIQUES**

1. In vitro cell culture, Cell line, cell clone, cell fusion. Cell and Tissue culture media; Cell transformation and Properties of transformed cells
2. Practical application of cell culture: Gene transfer methods in animal cells; Hybridoma Technology
3. *In vitro* and *in vivo* techniques to study of cell mediated and humoral immune response
4. Immunoassay and Immunoblotting
5. FACS and Flow Cytometry techniques

24163 **INVASIVE AND NON-INVASIVE TECHNIQUES IN IDENTIFICATION OF OCCUPATIONAL RELATED DISEASES**

1. Qualitative and Quantitative Assessment of occupational diseases : an introduction
2. Analysis of Working Postures
3. Identification of noise induced hearing loss
4. Evaluation of Physical and Mental Stress during work and exercise
5. Evaluation of Pulmonary functions and maximum consumption of oxygen during work and exercise.

24164 **BIOPHYSICAL CHEMISTRY, ELECTROPHYSIOLOGY & BIOMEDICAL INSTRUMENTATION**

1. Overview of electromagnetic spectrum, Vis and UV-Vis absorption spectroscopy, fluorescence spectroscopy.
2. Separating techniques: electrophoresis, chromatography; radioisotopes and their application in research.

3. Electrical properties of the cell membrane- membrane potential- driving force, membrane resistance, membrane capacitance; Electronic model of the plasma membrane. Overview of electrophysiological techniques, patch clamp technique: configurations; voltage clamp and current clamp.
4. Transducers: classifications: active, passive; transducers for measurement of body temperature, blood pressure, heart rate.
5. Over view of recording systems.

24165 **NANOTECHNOLOGY & NERO-IMAGING TECHNIQUES**

1. Definition, Principles of Nanotechnology, Nanoparticles - Biophysical and Biochemical Characteristics
2. An idea of nanotechnological solutions to problems in tissue engineering, molecular imaging, Biosensor and diagnostics.
3. 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.
4. Concept of surface polymerization
5. Principles and applications of neuroimaging techniques including EEG, CT, MRI, BOLD images, PET, SPECT.

HPY-DSEC41-TH-P17	**DISCIPLINE SPECIFIC ELECTIVE COURSE(THEORY)*** **Students will opt DSEC offered by Parent Department** **[Marks: 50, Contact Hrs:60, Credit:04]**
HPY-DSEC42-TH-P18	**DISCIPLINE SPECIFIC ELECTIVE COURSE(THEORY)*** **Students will opt DSEC offered by Parent Department** **[Marks: 50, Contact Hrs:60, Credit:04]**
HPY-DSEC43-PR-P19	**DISCIPLINE SPECIFIC ELECTIVE COURSE(PRACTICAL)*** **Students will opt DSEC offered by Parent Department** **[Marks: 50, Contact Hrs:60, Credit:04]**
HPY-DSEC44-PS-P20	**DISCIPLINE SPECIFIC ELECTIVE COURSE(PROJECT AND SEMINAR)*** **Students will opt DSEC offered by Parent Department** **[Marks: 50, Contact Hrs:60, Credit:04]**

* List of **DISCIPLINE SPECIFIC ELECTIVE COURSES (DSEC)**:

(I)	Biochemistry	(VII)	Immunology & Microbiology
(II)	Biophysics & Electrophysiology	(VIII)	Molecular Cell Biology
(III)	Biostatistics and Analytics	(IX)	Neurophysiology
(IV)	Endocrinology & Reproductive Physiology	(X)	Nutrition & Dietetics
(V)	Environmental Physiology	(XI)	Sports & Exercise Physiology
(VI)	Ergonomics & Work Physiology		

**** Details of the DISCIPLINE SPECIFIC ELECTIVE COURSES (DSEC) are given next pages***

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSEC)

I. BIOCHEMISTRY (BC)

Orientation of the DSE Course BIOCHEMISTRY (BC)

Subject code & (Unit code)	Subject	Marks	Contact Hours	Credit
HPY-DSEC41-TH-P17	**BIOCHEMISTRY–I (Theory)**	**50**	**60**	**04**
4117-1BC	Cell Biology, Molecular Biology and Genetics	10	12	
4117-2BC	Proteins, Proteomics and Functional Genomics	10	12	
4117-3BC	Membrane Biology and Enzymes	10	12	
4117-4BC	Photosynthesis and Nitrogen Fixation	10	12	
4117-5BC	Free Radical Biology in Health and Disease	10	12	
HPY-DSEC42-TH-P18	**BIOCHEMISTRY–II (Theory)**	**50**	**60**	**04**
4218-1BC	Neurobiochemistry and Biochemical basis of Neuropharmacology	10	12	
4218-2BC	Hormonal Biochemistry	10	12	
4218-3BC	Immunobiochemistry	10	12	
4218-4BC	Stem Cells, Molecular Biology of Cancer and Applied Biochemistry	10	12	
4218-5BC	Microbiology and Biochemical Toxicology	10	12	
HPY-DSEC43-PR-P19	**BIOCHEMISTRY–III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**BIOCHEMISTRY–IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE Course; BIOCHEMISTRY (BC)

Subject Code & Unit Code	**Subject & topics**	**[Marks/Contact Hrs/Credit]**
HPY-DSEC41-TH-P17	**BIOCHEMISTRY–I (Theory)**	**[Marks: 50, Contact Hrs:60, Credit:04]**
4117-1BC	**Cell Biology, Molecular Biology and Genetics**	**[Marks: 10, Contact Hrs:12]**

(a) Sub-cellular fractionation, Specialised cells, Molecular basis of motility, Cell cycle, Cell differentiation and transformation, Tissue culture-concepts and techniques.
(b) Replication of DNA *in vivo*; mechanisms and regulation, DNA synthesis *in vitro*, Base sequence of DNA, its significance and different methods for its determination, Genetic expression and its control. Repair of DNA. Vectors, Cloning of DNA, Genomic and c-DNA library and their 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- its clinical significance, Bacterial and viral genetics.

4117-2BC **Proteins, Proteomics and Functional Genomics [Marks: 10, Contact Hrs:12]**

(a) Protein synthesis; mechanism 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- (i) Structures of cytochromes c (ii) 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. Concept of protein data bank.
(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. Nano-Biotechnology. Concept of gene library; GEN Bank.

4117-3BC **Membrane Biology and Enzymes [Marks: 10, Contact Hrs:12]**

(a) Structure of membranes, membrane-bound enzymes and cell surface receptors, Mitochondria and mitochondrial membranes; structure and functions, endoplasmic reticulum membranes; structure and functions, Golgi body; structure and function, concept of synthetic cell.
(b) Mechanism of membrane transport and cell signaling.
(c) Serine proteases: Mechanism of action, events at the active site. The digestive serine protease- 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.

4117-4BC **Photosynthesis and Nitrogen Fixation [Marks: 10, Contact Hrs:12]**

(a) Photochemical reactions in the membrane. Photo-oxidation of chlorophyll. Protein-bound chlorophyll. Cyclic electron-transport chain. Chloroplasts - photosystem I and II; functions and significance. Carbon fixation – The reductive pentose cycle; functions and significance. Ribulose biphosphate carboxylase/oxygenase; structure, mechanism of action and function. Photo-respiration and C_4 cycle.
(b) Biochemistry and Enzymology of nitrate assimilation and nitrogen fixation. The Nitrogenase complex; structure and function. Regulation of nitrogen fixation – influence of ATP/ADP ratio, identification of nif genes, repression of nif genes.

4117-5BC **Free Radical Biology in Health and Disease [Marks: 10, Contact Hrs:12]**

(a) Chemistry of biologically important radicals and non-radicals. Measurement of reactive oxygen species (ROS) and reactive nitrogen species (RNS) through different techniques. EPR Spectroscopy; concept and significance.
(b) Cellular responses to oxidative stress: adaptation, damage, repair, senescence and death. Reactive species and diseases. Antioxidant defences: endogenous and diet derived. Molecular mechanisms of aging; special emphasis on free radical theory of ageing.
(c) Physiological significance of and mechanism of action of Superoxide Dismutase, Catalase, Glutathione Peroxidase, Glutathione Reductase, Glutathione-S-Transferase; their role in combating oxidative stress. Thioredoxin peroxidases. Thioredoxin reductase.
(d) Different types of stress proteins and their functions. Pro-oxidant enzymes; their mechanism of action. Role of NRF2 in regulating stress. Hydrogen peroxide as a signalling molecule. Role of nitric oxide in stress mechanisms and management.

HPY-DSEC42-TH-P18 **BIOCHEMISTRY–II (Theory)** **[Marks: 50, Contact Hrs:60, Credit:04]**

4218-1BC **Neurobiochemistry and Biochemical basis of Neuropharmacology [Marks: 10, Contact Hrs:12]**

Biochemistry of the nervous tissue. 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.

4218-2BC **Hormonal Biochemistry [Marks: 10, Contact Hrs:12]**

Biochemistry of hormones. Biosynthesis and molecular mechanism of action of hormones. Hormone-receptor interactions and signal transduction. Biochemistry of Insulin and Glucagon; structure, mechanism of action and Physiological significance. Type II Diabetes; Mechanisms and Management. Hormones in genetic regulation. Radioimmunoassay of hormones. Hormonal replacement therapy.

4218-3BC **Immunobiochemistry [Marks: 10, Contact Hrs:12]**

(a) 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.
(b) Immune cells expressing functionality in cancer. Cancer and immune system; how they interact with each other and regulatory mechanism(s). Malignant transformation. Immunity status during metastasis. Oncogenes; their functions and significance. Biochemistry of immune editing in cancer. Immune mechanism of tumour cell killing. Immunobiologicals, Vaccines, Immunodiagnostics (methods).

4218-4BC **Stem cells, Cellular and molecular biology of cancer cells, and Applied Biochemistry [Marks: 10, Contact Hrs:12]**

(a) Biology of stem cells; structure and functional significance. Stem cell engineering. Apoptosis; Concepts and Mechanisms. Thymus gland; structure and function. Properties of cancer cells. Concept of oncogenes, Carcinogenesis, Treatment of cancers: present and future. Tumor markers. Tumour immunology. Angiogenesis; mechanism and significance.
(b) Biochemical effects of food, toxins, edible oils and environmental pollutants on human health. Biochemistry of Nutrition related disorders.
(c) Advanced Biochemical Techniques: Auto-analyzer, Spectroscopy, Mass Spectroscopy, (FAB-MS), Liquid crystal Mass Spectroscopy (LC-MS), Fast Atom Bombardment, NMR.

4218-5BC **Microbiology and Biochemical Toxicology [Marks: 10, Contact Hrs:12]**

(a) Microbiology: 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 the gastrointestinal tract and their role in health and

disease. Germ-free life. Methods of sterilization with special reference to thermolabile substance and tests for sterility.
(b) Biochemical toxicology: Acute and chronic toxicity testing. LD_{50} determination. Therapeutic index. Routes of administration of drugs. Drug kinetics, tolerance and excretion. Biochemical basis of detoxification.

HPY-DSEC43-PR-P19 **BIOCHEMISTRY – III [Marks: 50, Contact Hrs:60, Credit:04]**
(Practical)

(A) Methods of protein estimation:
(i) Folin-Lowry's Method
(ii) Bradford Method
(iii) Ultraviolet Absorbance Method
(iv) Microkjeldahl Method.

(B) Biochemical Separation Techniques:
(i) Separation of amino acids by paper chromatography (Ascending, descending and two dimensional).
(ii) Separation of sugars by paper chromatography.
(iii) Separation of amino acids and lipid fractions by thin layer chromatography.
(iv) Purification of proteins by salt precipitations and column chromatography.
(v) Separation of proteins from a mixture by Sephadex Gel Filtration (column).
(vi) Separation of proteins by Polyacrylamide Gel Electrophoresis (PAGE).
(vii) Separation of proteins by Agarose gel electrophoresis
(viii) Immunization and production of antibody (Theoretical and demonstration).
(ix) Agglutination and hemagglutination (demonstration only)
(x) Immuno-eleectrophoresis and Immunodiffusion techniques and/ or Western Blotting technique (demonstration only)

(C) Experiments on enzymes kinetics:
(i) Effects of pH
(ii) Effect of temperature and determination of Q_{10}
(iii) Effects of substrate concentration on enzyme activity; (a) Michaelis- Menten Plot, (b) Lineweavor-Burk Plot, (c) Eddie-Hofstee Plot.
(iv) Determination of Km, Vmax.
(v) Studies on the effect of competitive and non-competitive inhibitors on enzyme activity.
(vi) Studies on the determination of the activities of allosteric enzyme(s).
(vii) Studies on the determination of activity of some mitochondrial enzymes related to energy metabolism, like succinic dehydrogenase and alpha-keto glutarate dehydrogenase in presence or absence of inhibitors.

(D) Determination of the activities of some clinically relevant enzymes:
(i) Determination of the activities of SGOT and SGPT.
(ii) Determination of the activity of serum lipase.
(iii) Determination of the activity of serum creatine phosphokinase.
(iv) Use of differential centrifugation techniques to isolate sub-cellular fractions.
(v) Determination of Isoelectric pH of proteins.

(E) Cell and tissue culture techniques:
(i) Acquiring knowledge on the preparation of different types of cell culture media, cell counting and plating.
(ii) Transfection with a GFP vector and monitoring by immunofluorescence microscope (demonstration only).
(iii) Determination of cellular stress using COMET assay –Apoptosis, Necrosis and DNA damage. **(iv)** Acquiring knowledge on short-term culture of eukaryotic cells.
(v) Experiments to study 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 (demonstration only).

(F) Studies on the analysisi of food macro and micro nutrient content (like, protein, carbohydrate, fat and ascorbic acid. Ca, PO4, Fe etc.).

(G) Training program / Laboratory visit
A report on the basis of a visit in Research institutes or laboratories of national importance.

HPY-DSEC44-PS-P20	**BIOCHEMISTRY–IV Credit:04] (PROJECT AND SEMINAR)**	**[Marks: 50, Contact Hrs:60,**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

II. DSEC: BIOPHYSICS AND ELECTROPHYSIOLOGY (BE)

Orientation of the DSE Course [BIOPHYSICS AND ELECTROPHYSIOLOGY (BE)]

Subject Code (Unit Code)	**Subject**	**Marks**	**Contact Hours**	**Credit**
HPY-DSEC41-TH-P17	**Biophysics and Electrophysiology- I (Theory)**	**50**	**60**	**04**
4117-1BE	Properties of biological macromolecules	10	12	
4117-2BE	Fluid dynamics	10	12	
4117-3BE	Mechanics in pulmonary system	10	12	
4117-4BE	Advance electrophysiology	10	12	
4117-5BE	Bioenergetics and kinetics	10	12	
HPY-DSEC42-TH-P18	**Biophysics and Electrophysiology- II (Theory)**	**50**	**60**	**04**
4218-1BE	Physiology at extreme environment	10	12	
4218-2BE	Bioelectronics and bioinformatics	10	12	
4218-3BE	Separation and purification techniques	10	12	
4218-4BE	Ultrasound and ionizing radiations	10	12	
4218-5BE	Modern spectroscopic techniques	10	12	
HPY-DSEC43-PR-P19	**Biophysics and Electrophysiology- III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**Biophysics and Electrophysiology- IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE Course [BIOPHYSICS AND ELECTROPHYSIOLOGY (BE)]

Subject code (Unit Code)	Subject & topics [Marks/Contact Hrs/Credit]
HPY-DSEC41-TH-P17	**Biophysics and Electrophysiology- I [Marks: 50, Contact Hrs: 60, Credit: 04] (Theory)**

4117-1BE **Properties of biological macromolecules [Marks: 10, Contact Hrs: 12]**

1. Water: Molecular structure, physico-chemical properties of water, state of water in bio-structures and its significance.
2. Acids and Bases: Molarity & normality, weak and strong acids and bases, Henderson-Hasselbalch equation, pKa, pH, pH meter.
3. Buffer systems, buffer capacity, titration curve; acetate buffer, phosphate buffer, tris buffer.
4. Structural level of proteins & stabilizing forces, conformational properties of polypeptides, Ramachandran Plot, proteins in solution.
5. Double helical structure of DNA, conformational parameters of nucleic acids and their constituents, DNA supercoiling, circular DNA.

4117-2BE **Fluid dynamics [Marks: 10, Contact Hrs: 12]**

1. Hydrodynamics and Hemodynamics: Principle and application in biological system, pressure-flow relationship in rigid and in vascular systems. Static pressure and dynamic pressure.
2. Viscosity, factors affecting viscosity; viscoelasticity. Viscometry: Ostwald viscometer, concept of fluidity & micro-viscosity.
3. Newtonian and non-Newtonian fluids. Laminar and turbulent flow, Reynold's number, critical closing pressure, Development of turbulence in flowing blood and its significance. Poiseuille's law, Bernoulli's law: Korotkoff sound, phonation.
4. Hemodynamics in different phases of the cardiac cycle. Heart sounds. Mechanical power of heart.
5. Peripheral resistance, PRU, resistance in series and parallel; measurement of peripheral resistance, factors affecting; airway resistance, pulmonary vascular resistance; measurement of pulmonary resistance, factors affecting.

4117-3BE **Mechanics in pulmonary system [Marks: 10, Contact Hrs: 12]**

1. Mechanics in breathing: Elasticity of lung and thorax, their role in breathing; chest-lung interaction, pressure-volume relationship; work of breathing.
2. Lung volumes and capacities, lung compliance, specific lung compliance; static and dynamic lung compliances; surface tension; determination of lung volumes: spirometry, body plethysmograph.
3. Osmosis: osmotic pressure, osmole, osmolality, osmolarity, Van't Hoff's law, determination of osmotic pressure, effects.
4. Diffusion: kinetics of diffusion; Graham's law and Fick's law of diffusion; Factors affecting diffusion.
5. Ventilation and perfusion: Ideal gas equation, Dalton and Henry' laws for partial pressures; ventilation-perfusion relationship and mismatching; hypoventilation, diffusion abnormality.

4117-4BE **Advance electrophysiology [Marks: 10, Contact Hrs: 12]**

1. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane proteins, fluid mosaic model, structure and function of lipid rafts and caveolae; ion channels and ion pumps.
2. Electrical properties of membranes: membrane potential- Nernst equation, Chord Conductance equation, Goldman–Hodgkin–Katz flux equation; capacitance, resistance, RC circuit. Electrical potentials in cardiac muscle, skeletal muscle and brain, EEG, EMG.
3. Electrophysiological techniques: single fiber and microelectrode techniques – patch clamp and voltage clamp.
4. Sensory transduction, generation potential, action potential, conduction velocity of nerve, cold block, anodal block.
5. Electrocardiography, advance vector analysis of ECG, 3D ECG. Normal and abnormal ECGs, ECG in oxygen deprivation and myocardial ischemia.

4117-5BE **Bioenergetics and kinetics [Marks: 10, Contact Hrs: 12]**

1. Laws of Thermodynamics, living body as a thermodynamic system, concept of free energy, unavailable energy and entropy, negative entropy, changes in living system, heat content of food, Bomb calorimetry.
2. Energy generation & energy transfer processes in biochemical reactions, metabolism of glucose and formation of ATP.
3. Dynamics of receptor-ligand interactions.
4. Enzymes: properties, criteria for being enzyme, enzyme-substrate reaction kinetics; enzyme inhibition kinetics; effect of pH and temperature.
5. Differential scanning calorimeter, isothermal titration calorimetry.

HPY-DSEC42-TH-P18 **Biophysics and Electrophysiology- II [Marks: 50, Contact Hrs: 60, Credit: 04] (Theory)**

4218-1BE **Physiology at extreme environment [Marks: 10, Contact Hrs: 12]**

1. Effect of low oxygen pressure on body, mountain sickness, clinical lessons at high altitude. Oxygen toxicity. Role of HIF_{α} gene in hypoxia.
2. Physiology in deep sea diving and other high-pressure operations, narcosis, SCUBA driving.
3. Gravitational fields: Concept, acceleratory forces, G forces and their effects on living system.
4. Radiation and temperature: problems at space, weightlessness in space, physiological adaptation to space flight.
5. Impact of acceleration and deacceleration; physical lever systems and their application in human body.

4218-2BE **Bioelectronics and bioinformatics** **[Marks: 10, Contact Hrs: 12]**

1. 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.
2. Basic principles of modulation and demodulation, AM and FM modulation.
3. Basic idea of integrated circuits, logical operations: AND, OR, NOR, NAND. Boolean-algebra, binary units, basic ideas of analog and digital computers.
4. Basic computer knowledge, Linux operating system- installation of programs, restriction mapping, BLAST, ExPasy.
5. Basic concept of bioinformatics, proteomics, genomics, their applications, molecular modelling: AutoDock.

4218-3BE **Separation and purification techniques** **[Marks: 10, Contact Hrs: 12]**

1. Chromatography: principle of thin layer, paper, column and gas chromatography, HPLC.
2. Centrifugation: principle, rpm, rcf, sedimentation rate; classification, different types of rotors; application; density gradient centrifugation.
3. Ultracentrifugation: analytical and preparatory ultracentrifuges; construction, application.
4. Isoelectric focusing, potentiometry, conductometry**.**
5. Electrophoresis: principle of separation of protein and nucleic acids; agarose gel, polyacrylamide gel electrophoresis (PAGE): denaturing and native; urea gel; 2D gel electrophoresis.

4218-4BE **Ultrasound and ionizing radiations**

1. Sound: physical properties of sound; ultrasound, infrasound: interaction with human body.
2. Application of ultrasound: diagnostic: ultrasonography-A, B, M scans and real time imaging; ultrasound therapy; effects on physiological system. Ultrasonic blood flow meter; Echocardiogram
3. Ionizing radiations: different forms of ionizing radiation, source of ionizing radiation; application of ionizing radiation: diagnostic, therapeutic and research.
4. Detection of radiation by ionization chamber: GM counter, proportional counter, liquid scintillation counter, gamma-counter, alpha-counter.
5. Electromagnetic field and microwaves: effect on biological system.

4218-5BE **Modern spectroscopic techniques**

1. Absorption spectroscopy: molecular basis of light absorption, Lambert-Beer's law; working principle of UV-Vis absorption spectrophotometer, application of UV-visible spectroscopy; principle of construction of single beam and dual beam spectrophotometers; bandwidth, monochromators.
2. Fluorescence spectroscopy: Jablonski diagram; Stokes shift; intrinsic and extrinsic fluorescence; fluorescence emission, excitation and emission bandwidths, principle of construction of spectrofluorimeter.
3. Advance fluorescence spectroscopy: fluorescence quenching, drug-protein interaction, dynamics of interaction, Stern-Volmer plot, Lehrer plot, determination of thermodynamic properties, binding sites, nature of binding; fluorescence resonance energy transfer (FRET).
4. CD Spectroscopy and ORD: principle of circular dichroism (CD) and optical rotatory dispersion (ORD), advantages of CD relative to ORD; CD spectra of interacting chromophores; electronic transitions of the peptide group; CD spectral signatures for different conformations of proteins; principle of construction of CD and ORD instruments; applications.
5. Mass spectroscopy: principle of mass spectroscopy; types of mass spectroscopy and their uses; MALDI-TOF, SELDI-TOF, Tandem MS.

HPY-DSEC43-PR-P19 **Biophysics and Electrophysiology- III [Marks: 50, Contact Hrs: 60, Credit: 04] (Practical)**

1. Preparation of Buffers: Acetate buffer, Phosphate buffer: different pH and concentrations; titration.
2. Purification of protein using column chromatography, spectrophotometric and spectrofluorimetric analysis of purified protein, determination of extinction coefficient, λ_{max}.
3. Determination of protein concentration using Lowry method, using extinction coefficient.
4. Gel Electrophoresis: denaturing and native gels: separation and analysis of proteins, DNA.
5. Measurement of viscosity of biological and non-biological samples: Ostwald viscometer.
6. Determination of osmotic pressure of biological and non-biological samples.
7. Recording of ECG in normal conditions and under different postures; determination of mean electrical axis.
8. Computational biology: Linux operating system: overview, program installation; Three dimensional structures of biomolecules: download and viewing; drug-protein interaction: AutoDock.
9. Determination of strength-duration curve: Rheobase and Chronaxie, measurement of contraction kinetics of excitable tissues, measurement of conduction velocity of nerve fiber.
10. Determination of isometric twitch-tetanus of toad with different drugs. Calculation of work done by muscle.

Training program / Laboratory visit

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

HPY-DSEC44-PS-P20	**Biophysics and Electrophysiology- IV [Marks: 50, Contact Hrs: 60, Credit: 04] (Project and Seminar)**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

III. BIOSTATISTICS and ANALYTICS (BA)

Orientation of the DSE course (BA)

Subject code (Unit code)	**Subject**	**Marks**	**Contact Hours**	**Credit**
HPY-DSEC41-TH-P17	**Biostatistics & Analytics–I (Theory)**	**50**	**60**	**04**
4117-1BA	**Quantitative Approach in Understanding Human Physiology**	10	12	
4117-2BA	**Statistics and Analytics: Application in Human Physiology**	10	12	
4117-3BA	**Quality Issues in Physiological Data Management**	10	12	
4117-4BA	**Public Health Analytics**	10	12	
4117-5BA	**Human Body Segment Measurement : Anatomical and Physiological Basis of Product Design and Development**	10	12	
HPY-DSEC42-TH-P18	**Biostatistics & Analytics–II (Theory)**	**50**	**60**	**04**
4218-1BA	**Mathematical Modeling**	10	12	
4218-2BA	**Analytics of Human Performance and Pattern Recognition in Physiological Data**	10	12	
4218-3BA	**Accidents Analytics**	10	12	
4218-4BA	**Analytics of Public Health Policies**	10	12	
4218-5BA	**Multivariate and Non Parametric Data Analyses Techniques**	10	12	
HPY-DSEC43-PR-P19	**Biostatistics & Analytics–III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**Biostatistics & Analytics –IV (Project and Seminar)**	**50**	**60**	**04**
Grand Total		**200**	**240**	**16**

Detailed Syllabus of the DSE course (BA)

Subject code (Unit code)	**Subject**
HPY-DSEC41-TH-P17	**Biostatistics & Analytics–I (Theory)** **[Marks: 50, Contact Hrs:60, Credit:04]**
4117-1BA	**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
4117-2BA	**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
4117-3BA	**Quality Issues in Physiological Data Management** o Concept of Quality o Quality Issues in Design of Experiments o Quality Considerations in Data Management o Concept of six sigma
4117-4BA	**Public Health Analytics** o Epidemiology, o Incidence and Prevalence of different disease Assessing diseases Risk o Clinical Data analyses – statistics of clinical tests o Analyses of Time and Event data o Human Development Indicators
4117-5BA	**Human Body Segment Measurement : Anatomical and Physiological Basis of Product Design and Development** • Principles of Human Body Segment Measurements • Error minimization • Concept of Constant Body ratio • Concept of product Designing • Anthropomorphic products and their design
HPY-DSEC42-TH-P18	**Biostatistics & Analytics–II (Theory)** **[Marks: 50, Contact Hrs:60, Credit:04]**
4218-1BA	**Mathematical Modeling** • Foundations of Mathematical Modeling • Development of Mathematical models for Application in Disease Indicationand in establishing physiological relationship • Validation of Models, Confidence Intervals • Sensitivity Analyses

4218-2BA **Analytics of Human Performance and Pattern Recognition in Physiological Data**

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

4218-3BA **Accidents Analytics**

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

4218-4BA **Analytics of Public Health Policies**

- Analyses of different Public Health Policies, having Implications in Human health, of National and International Bodies, like UN, WHO and ILO

4218-5BA **Multivariate and Non Parametric Data Analyses Techniques**

Principles and Application of Multivariate and Non parametric data analytical techniques in Human Physiological Studies

HPY-DSEC43-PR-P19 **Biostatistics & Analytics–III (Practical)** **[Marks: 50, Contact Hrs:60, Credit:04]**

- 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

HPY-DSEC44-PS-P20 **Biostatistics & Analytics –IV (Project and Seminar)** **[Marks: 50, Contact Hrs:60, Credit:04]**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

IV. ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY (ER)

Orientation of the DSE course (ER)

Subject code (Unit code)	Subject	Marks	Contact Hours	Credit
HPY-DSEC41- TH-P17	**ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY –I (Theory)**	**50**	**60**	**04**
4117-1ER	Contemporary Techniques for Bioassays of Hormones and related biomarkers	10	12	
4117-2ER	Cellular Physiology and Molecular Components of Endocrine Organs	10	12	
4117-3ER	Physiology and Pathophysiology of Endocrine Organs	10	12	
4117-4ER	Translation research of Hormone and Behavioural Studies	10	12	
4117-5ER	Special Issues of Hormones	10	12	
HPY-DSEC42-TH-P18	**ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY –II (Theory)**	**50**	**60**	**04**
4218-1ER	Neuroendocrinology	10	12	
4218-2ER	Sex determination and differentiation	10	12	
4218-3ER	Female reproductive Health	10	12	
4218-4ER	Fertilization, Capacitation and Reproductive Senescence	10	12	
4218-5ER	Translational research on reproductive system	10	12	
HPY-DSEC43-PR-P19	**ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY –III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY –IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE course (ER)

Subject code	Subject & topics [Marks/Contact Hrs/Credit]
HPY-DSEC41-TH-P17	Endocrinology and Reproductive Physiology–I [Marks: 50, Contact Hrs:60, Credit:04] (Theory)

4117-1 ER Techniques for Bioassays of Hormones and related biomarkers

[Marks: 10, Contact Hrs:12]

1. Principles of Hormone Bioassays, Pharmokinetics and its basis.
2. Structural-functional relationship of hormone and receptor kinetics, determining the Affinity of Hormone Receptor Interaction
3. Evolution of endocrine system and Phylogenetic analysis
4. Modern Tools and techniques for Endocrine and Neuroendocrine and Behaviour research
5. Cell signaling and Cellular communications: general principles of intracellular and extracellular cell communications, neurotransmission and its regulation, exosomes.

4117-2 ER Cellular Physiology and Molecular Components of Endocrine Organs
[Marks: 10, Contact Hrs: 12]

1. Peptide and protein hormones Structure-function relationship, purification
2. Steroid Hormones: Structure-function relationship, purification
3. Genetic control of hormone biosynthesis
4. Contemporary aspects of signaling and signal attenuation, Discovery of receptors in target tissues
5. Molecular aspects of hormonal control of tissues, Cells and gene expression.

4117-3 ER Physiology and Pathophysiology of Endocrine Organs

[Marks: 10, Contact Hrs: 12]

1. Hypothalamus and Pituitary
2. Thyroid
3. Pancreas
4. Adrenal
5. Thymus, Parathyroid and others

4117-4 ER Translation research of Hormone and Behavioral Studies

[Marks: 10, Contact

Hrs: 12]

1. Contemporary case studies on Hormone research and disorder management, Hormonal Integration, Sodium, Calcium and Water balance
2. Research Design to manage specific hormonal issues, Obesity and body fuel Metabolism
3. Behavioural Traits, Cognition, Performance, Anxiety, Adaptation, Depression
4. Gut Brain Axis: its importance in health and behaviors, aging population,
5. Genome wide analysis: Protein DNA interaction-ChIP-chip; Chormosome Wide Analysis of Protein binding, Detection of sumoylated proteins.

4117-5 ER Special Issues of Hormones [Marks: 10, Contact Hrs: 12]

1. The Adrenal Cortex and Endocrine Hypertension; Aging and Hormones, Metabolism and Hormones: Bones and Kidney Stones
2. Autoimmunity and endocrine disorders – generation of specificity, recognition of antigens, tolerance of self antigens, mechanism of autoimmunity,
3. Non-endocrine function of endocrine molecules, non-conventional endocrine molecules in health and disease. Endocrine disruption,
4. Humoral manifestations of malignancy, Gut Endocrine Tumors, Endocrine-Responsive Cancer
5. In vitro and in vivo models for Hormone research, Transgenic , Receptor Mouse, real time non invasive imaging of stem cells, explants etc.

HPY-DSEC42-TH-P18 **Endocrinology and Reproductive Physiology–II [Marks: 50, Contact Hrs:60, Credit:04] (Theory)**

4218-1 ER Neuroendocrinology [Marks: 10, Contact Hrs: 12]

1. Neuronal control of glandular secretion; Neuroendocrine Axes, regulation of secretion of tuberohypophysial hormones; feedback concept in neuroendocrinology,
2. Pineal gland; circumventricular organs, neuro-endocrine-immune interaction.
3. Neurone as target cells for hormone action, neuronal modification of hormone metabolism and regulation of neuronal function, Effects of ion channels, electrical events.
4. Hormones and Brain Plasticity: Hormones and the Mutable Brain,Plascity and Melatonin,Thyoid, Corticosteroids,Sex Steroids, Peptide Hormones, Life

Stages and hormonal remodeling of brain.

5. Biorhythms of Hormones: SAD, Light resetting and human behavior, sleep disorder, Circadian Clocks and Immune Functions, Clock Genes and Cancer.

4218-2 ER Sex determination and differentiation [Marks: 10, Contact Hrs: 12]

1. Basis of sex determination
2. sexual differentiation, Differentiation of gonads and differentiation of genital tract
3. Leptin as reproductive hormone, Role of Neurosteroids
4. Male reproductive system- Cellular and Molecular basis, Male sterility and infertility, Azoospermia, Oligozoospermia, Asthenzoospermia, Varicocele,
5. Pathogenesis of Sexual functions: Case studies and remedial management

4218-3 ER Female Reproductive Health [Marks: 10, Contact Hrs: 12]

1. Female reproductive hormones and Brain remodeling
2. Cellular and Hormonal basis of Menstrual cycle and its disorders, Endocrine Changes in Pregnancy and lactation
3. The Physiology and Pathology of Female Reproductive Axis, Ovarian Endocrine Activity: Role of Follistatin, Activin, and Inhibin,
4. Ovarian Function and Failure: The Role of the Oocyte and Its Molecules, Molecular Control of Corpus Luteum Function
5. Female reproductive health: Case studies from contemporary contexts, occupation and management.

4218-4 ER Fertilization, Capacitation and Assisted Reproduction [Marks:10, Contact rs: 12]

1. Fertilization, sperm-egg fusion, activation of eggs, prevention of polyspermy, implantation, parturition
2. Acrosomal reaction Capacitation and its molecular basis
3. Contraception leading to prevention of fertilization – surgical, hormonal and immuno contraception.
4. Assisted Reproduction: Contemporary research, diagnosis and therapy.
5. Stem cells in Reproductive system

4218-5 ER Translational research on reproductive system [Marks: 10, Contact Hrs: 12]

1. Principle and techniques of animal cloning. Different assisted reproduction procedures
2. Major sexual dysfunctions and their remedial measures

3. Endocrine Tumors, Multiple Endocrine Neoplasia, Immunoendocrinopathy Syndromes, Paraendocrine and Neoplastic Syndromes,
4. Carcinoid Tumors, Carcinoid Syndrome, and Related Disorders
5. Appropriate Research Methodologies for Hormones and Reproductive research, Epigenetic Mechanisms of reproductive Gene Regulation, Gene Therapy for Reproductive disorders.

HPY-DSEC43- PR-P19 Endocrinology and Reproductive Physiology– III
[Marks: 50, Contact Hrs:60, Credit:04] (Practical)

I. Surgical Techniques and Histology
II. Bioassays and cell culture
III. Molecular Endocrinology
IV. Behavioural Analysis
V. Translational Research

I. Surgical Techniques and Survival Surgery

1. Thyroidectomy, 2. Adrenalectomy, 3. Ovariectomy,
4. castration, 5. Pancreatectomy,
6. Cryptorchidism

II. Bioassays and cell culture

1. Bioassay of oxytocin on uterine contraction
2. Bioassay of adrenaline on intestinal contraction
3. Bioassay of adrenaline
4. Assay hormone by ELISA
5. Purification of peptide hormones from animals endocrine organs
6. Principles of Primary cell culture
7. Cell Culture of immortal cells

III. Molecular Endocrinology

1. DNA and RNA isolation from mammalian cells
2. Western blot for hormonal assays
3. PCR (semiquantitative or QPCR)
4. flow cytometry technique for cell cycle, mitochondrial health or oxidative state analysis from bone marrow, spleen, thymus or cell cultures
5. Microscopic techniques to identify subcellular structures and localizations using immunohistochemistry/cytochemistry
6. Scanning/Transmission Electron Microscopy as demo or Project research
7. Confocal Microscopy as demonstration or project research
8. Computer assisted analysis of genes
9. Microarray analysis

IV. **Behavioural Study of Small Animals**

Behaviour of small animals (rat or mouse) like Anxiety, Stress, Sleep or Drug effects studies by brain cortical waves, different maze or open field test to correlate the hormonal issues.

V. **Translational Research**

Replication of different hormonal or behavioral traits in animal models and/or cell cultures. Application of Stereotaxic techniques for surgical or for brain behavior studies and hormonal assays.

VI. **Training program / Laboratory visit:** A report on the basis of a visit in Research institutes or laboratories of national importance.

HPY-DSEC44-PS-P20	**Endocrinology and Reproductive Physiology–IV (PROJECT AND SEMINAR)** **[Marks: 50, Contact Hrs:60,Credit:04]**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

V. ENVIRONMENTAL PHYSIOLOGY (EP)

Orientation of the DSE course (EP)

Subject code (Unit code)	Subject	Marks	Contact Hours	Credit
HPY-DSEC41-TH-P17	**ENVIRONMENTAL PHYSIOLOGY–I (Theory)**	**50**	**60**	**04**
4117-1EP	**INTERACTION BETWEEN MAN AND ENVIRONMENT**	10	12	
4117-2EP	**ENVIRONMENTAL TEMPERATURE AND PHYSIOLOGICAL SYSTEMS: HEAT AND COLD**	10	12	
4117-3EP	**BAROMETRIC PRESSURE AND PHYSIOLOGICAL SYSTEMS : Hypobaric and Hyperbaric Physiology**	10	12	
4117-4EP	**ADVANCED ISSUES IN SPACE PHYSIOLOGY**	10	12	
4117-5EP	**ADVANCED TECHNICAL APPROACHES and ITS APPLICATION in ENVIRONMENTAL PHYSIOLOGY**	10	12	
HPY-DSEC42-TH-P18	**ENVIRONMENTAL PHYSIOLOGY –II (Theory)**	**50**	**60**	**04**
4218-1EP	**ENVIRONMENTAL FACTORS AND THEIR IMPACT ON PHYSIOLOGICAL SYSTEMS**	10	12	
4218-2EP	**TOXINS : Genotoxicity and mutagenesis**	10	12	
4218-3EP	**PHYSIOLOGICAL ASPECTS OF MICROBIAL INVASION**	10	12	
4218-4EP	**ENVIRONMENTAL ISSUES : Current concerns**	10	12	
4218-5EP	**WORK ENVIRONMENT AND LEGISLATION**	10	12	
HPY-DSEC43-PR-P19	**ENVIRONMENTAL PHYSIOLOGY –III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**ENVIRONMENTAL PHYSIOLOGY –IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE course (EP)

Subject code (Unit code)	**Subject**
HPY-DSEC41-TH-P17	**ENVIRONMENTAL PHYSIOLOGY–I [Marks: 50, Contact Hrs:60,Credit:04] (Theory)**

4117-1EP **INTERACTION BETWEEN MAN AND ENVIRONMENT**

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.

4117-2EP **ENVIRONMENTAL TEMPERATURE AND PHYSIOLOGICAL SYSTEMS: HEAT AND COLD**

- 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.

4117-3EP **BAROMETRIC PRESSURE AND PHYSIOLOGICAL SYSTEMS : Hypobaric and Hyperbaric Physiology**

- 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.
- 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.

4117-4EP **ADVANCED ISSUES IN SPACE PHYSIOLOGY**

- 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.

4117-5EP **ADVANCED TECHNICAL APPROACHES and ITS APPLICATION in ENVIRONMENTAL PHYSIOLOGY**

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

HPY-DSEC42-TH-P18 ENVIRONMENTAL PHYSIOLOGY–II [Marks: 50, Contact Hrs:60,Credit:04] (Theory)

4218-1EP **ENVIRONMENTAL FACTORS AND THEIR IMPACT ON PHYSIOLOGICAL SYSTEMS**

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.

4218-2EP **TOXINS : Genotoxicity and mutagenesis**

- 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.

4218-3EP **PHYSIOLOGICAL ASPECTS OF MICROBIAL INVASION**

- 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.

4218-4EP **ENVIRONMENTAL ISSUES : Current concerns**

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.

4218-5EP **WORK ENVIRONMENT AND LEGISLATION**

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.

HPY-DSEC43-PR-P19 **ENVIRONMENTAL PHYSIOLOGY–III [Marks: 50, Contact Hrs:60,Credit:04] (Practical)**

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.

HPY-DSEC44-PS-P20	**ENVIRONMENTAL PHYSIOLOGY –IV [Marks: 50, Contact Hrs:60,Credit:04] (Project and Seminar)**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

VI. ERGONOMICS AND WORK PHYSIOLOGY (EWP)

Orientation of the DSE course (EWP)

Subject code (Unit code)	Subject	Marks	Contact Hours	Credit
HPY-DSEC41-TH-P17	**ERGONOMICS AND WORK PHYSIOLOGY**–I **(Theory)**	**50**	**60**	**04**
4117-1EWP	PRINCIPLES OF TECHNIQUES USED IN ERGONOMICS	10	12	
4117-2EWP	ANTHROPOMETRY	10	12	
4117-3EWP	PRINCIPLES OF DESIGN AND COGNITIVE ERGONOMICS	10	12	
4117-4EWP	OCCUPATIONAL ERGONOMICS	10	12	
4117-5EWP	PSYCHO-PHYSIOLOGY OF WORK	10	12	
HPY-DSEC42-TH-P18	**ERGONOMICS AND WORK PHYSIOLOGY**–II **(Theory)**	**50**	**60**	**04**
4218-1EWP	ENVIRONMENTAL ERGONOMICS	10	12	
4218-2EWP	ERGONOMICS IN SAFETY	10	12	
4218-3EWP	PERFORMANCE IN ADVERSE CONDITIONS	10	12	
4218-4EWP	BIOMECHNICS IN ERGONOMICS	10	12	
4218-5EWP	ORGANIZATIONAL ERGONOMICS	10	12	
HPY-DSEC43-PR-P19	**ERGONOMICS AND WORK PHYSIOLOGY**–III **(Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**ERGONOMICS AND WORK PHYSIOLOGY**–IV **(Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE course (EWP)

Subject code (Unit code)	Subject & topics	[Marks/Contact Hrs/Credit]

HPY-DSEC41-TH-P17 **ERGONOMICS AND WORK PHYSIOLOGY–I (Theory)** **[Marks: 50, Contact Hrs:60, Credit:04]**

4117-1EWP PRINCIPLES OF TECHNIQUES USED IN ERGONOMICS **[Marks: 10, Contact Hrs:12]**

1.Application of Checklist and Questionnaires in evaluation of workstation and work station related disorders.
2.Method Study and Work Measurements
3.Double handed process chart
4.Evaluation of working Posture
5.Evaluation of human Cognitive performances

4117-2EWP ANTHROPOMETRY **[Marks: 10, Contact Hrs:12]**

1.Physical dimensions of the human body as a working machine.
2.Static and dynamic body measurements.
3.Application of anthropometry in design.
4. Concept of Percentiles.

117-3EWP **PRINCIPLES OF DESIGN AND COGNITIVE ERGONOMICS** **[Marks: 10, Contact Hrs:12]**

1.Design
1.1 Design characteristics of controls (shape, size, color, layout) and effect on performance.
1.2Design characteristics of visual, auditory and other displays, quantitative and qualitative information, multiple displays and layout;
1.3Warnings, signs and labels;
1.4Control room ergonomics;
1.5Designing for special populations;
1.6Work-station evaluation, designing an efficient and ergonomic workstation.
2.Cognitive Ergonomics
2.1Cognitive Ergonomics - information processing, memory, situation awareness, attention.
2.2 Decision making process
2.3 Methods for determination of the usability of products : HTA, Cognitive walkthrough.

4117-4EWP **OCCUPATIONAL ERGONOMICS** **[Marks: 10, Contact Hrs:12]**

1.Musculo- Skeletal Disorders
1.1 Causative factors for the development of Work Related Musculo Skeletal Disorders (WRMSD),
1.2 Cumulative Trauma Disorder (CTD);
1.3 Repetitive Stress Injuries (RSI);

1.4 Preventive measures

2. Manual Material Handling

2.1 Types of Manual material handling

2.2 NIOSH lifting equation

4117-5EWP PSYCHO-PHYSIOLOGY OF WORK [Marks: 10, Contact Hrs:12]

1. Occupational Stress - causes, effects and preventive measures;
2. Learning time, learning curve, problems of Ageing and compensatory measures;
3. Rating of Perceived Exertion (RPE), BORG Scale;

HPY-DSEC42-TH-P18 ERGONOMICS AND WORK PHYSIOLOGY (Theory)–II **(Theory) [Marks: 50, Contact Hrs:60, Credit:04]**

4218-1EWP ENVIRONMENTAL ERGONOMICS [Marks: 10, Contact Hrs:12]

1. Thermal work environment - Clothing, subjective assessments - thermal comfort and discomfort, heat disorders, thermal protective suiting.
2. Illumination- Level of illumination in work performances; Glare : type and effect in work; Control and uses of light sources.
3. Work environmental Noise –Noise Induced Hearing Loss (NIHL), Hearing Conservation Programmes (HCP), effect of noise on performance, Non-auditory effects of noise exposure.
4. Vibration - Whole Body vibration, Hand Arm vibration, effects of vibration on the human body, measurement and control.
5. Ionising and Non-Ionising Radiations in the work environment. Maximum exposure standards and methods of control.
6. Chemical aspects of the work environment - dust, fumes, vapours and gases : effects and control.

4218-2EWP ERGONOMICS IN SAFETY [Marks: 10, Contact Hrs:12]

1. Safety and Ergonomics
2. Accident: definition, types, impact, theories ;
3. Ergonomics in Use of PPE
4. Ergonomics in prevention and management of accidents, Case Studies
5. Ergonomics in Risk Mitigation and Hazard control

4218-3EWP PERFORMANCE IN ADVERSE CONDITIONS

[Marks: 10, Contact Hrs:12]

1. Physiology in High Altitude, Space, Aquatic, Desert and Arctic conditions.
2. Effects of high and low barometric pressures, physiological adaptation of high altitude dwellers, physiology of mountaineering, High Altitude Pulmonary Oedema (HAPO);
3. Effects of acceleration and deceleration, positive and negative G forces, weightlessness and performance, gravitational cues;
4. Physiology of deep-sea diving, problems of pressurization and decompression, Caisson disease and its prevention;
5. Shift work – zeitgebers, circadian rhythms, Shift systems. Performance in shift system.

4218-4EWP **BIOMECHNICS IN ERGONOMICS** **[Marks: 10, Contact Hrs:12]**

1. Static and Dynamic biomechanics ; Base support; Centre of Gravity; Line of Gravity, Balance and Equilibrium;
2. Biomechanical considerations of the human musculo- skeletal system and development of disorders.
3. Analysis of motion and gait using force platforms and digital motion capture and analysis systems

4218-5EWP **ORGANIZATIONAL ERGONOMICS**
[Marks: 10, Contact Hrs:12]

1. **Work study: Principles of Industrial, Production**
Method Study, Work Measurement, Ineffective time and Productivity.

2. NATIONAL , INTERNATIONAL REGULATIONS AND STANDARDS related to ERGONOMICS
Factories Act
Workmen Compensation Act
Ergonomics in ISO standards;

HPY-DSEC43-PR-P19 **ERGONOMICS AND WORK PHYSIOLOGY- III**
(Practical) [Marks: 50, Contact Hrs:60, Credit:04]

1. Determination of body dimensions by anthropometric equipment.
2. Ergonomic evaluation of the design of different control knobs, hand tools (screw drivers, pliers, scissors),etc.
3. Methods of measurements of illumination and sound level.
4. Determination of thermal conditions of the environment.
5. Analysis of Posture through OWAS, REBA,RULA methods
6. Uses of Checklist and Questionnaire for determination of work environment and development of MSD
7. Identifications of ergonomic problems of work environment of different informal sectors and probable solutions.
8. Group Project: Industry/ Institution visit

HPY-DSEC44-PS-P20 **ERGONOMICS AND WORK PHYSIOLOGY** II
(Project & Seminar) **[Marks: 50, Contact Hrs:60, Credit:04]**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

VII. IMMUNOLOGY AND MICROBIOLOGY (IM)

Orientation of the DSE course (IM)

Subject code (Unit code)	Subject	Marks	Contact Hours	Credit
HPY-DSEC41-TH-P17	**Immunology and Microbiology–I (Theory)**	**50**	**60**	**04**
4117-1IM	Understanding of basic immunology	10	12	
4117-2IM	Components of the immune system and their roles in defense	10	12	
4117-3IM	Molecular immunology	10	12	
4117-4IM	Immunogenetics	10	12	
4117-5IM	The immune system in human health and diseases	10	12	
HPY-DSEC42-TH-P18	**Immunology and Microbiology–II (Theory)**	**50**	**60**	**04**
4218-1IM	Host pathogen interaction in the microbial world	10	12	
4218-2IM	Microbial physiology and metabolism	10	12	
4218-3IM	Microbial genetics	10	12	
4218-4IM	Multidrug resistance in microbes and its control by antimicrobial agents	10	12	
4218-5IM	Applied and industrial microbiology	10	12	
HPY-DSEC43-PR-P19	**Immunology and Microbiology –III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**Immunology and Microbiology –IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE course (IM)

Subject code (Unit Code)	Subject& topics	[Marks/Contact Hrs/Credit]
HPY-DSEC41-TH-P17	**Immunology and Microbiology–I (Theory)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

4117-1IM **Understanding of basic immunology** **[Marks: 10, Contact Hrs:12]**

1. Historical background of Immunology, Fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory, diversity.
2. Pathogen associated molecular pattern, pattern recognition receptors, first line of defense - innate / nonspecific immunity, adaptive / specific immunity.
3. Lymphocyte trafficking, theories of antibody formation: instructive, selective, clonal selection theories.
4. Generation of immune response, mechanism of cell mediated and antibody medicated immune responses.
5. Recent advances in innate immune response especially bi-directional communication between Neuro-endocrine-immune interaction

4117-2IM **Components of the immune system and their roles in defense** **[Marks: 10, Contact Hrs:12]**

1. Cells and tissues of the immune System, Cell-cell communication and cellular interactions, immune effecter mechanisms.
2. MHC molecules and antigen presentation, Peptide loading and expression of MHC-I and MHC-II molecules by antigen presenting cells.
3. Antigen recognition by T- lymphocytes and T-cell mediated immunity, Antigen receptors and accessory molecules, Cytotoxic T cell function.
4. Humoral immunity mediated by B cells and antibodies, B-Lymphocyte Activation and signal transduction.
5. Regulation of the immune response, cytokines, chemokines, cellular adhesion and their interactions

4117-3IM **Molecular immunology** **[Marks: 10, Contact Hrs:12]**

1. T-Lymphocyte development and expression of antigen receptors (TCR), T cell education, affinity maturation.
2. B-Lymphocyte development and expression immunoglobulin receptors (BCR), molecular basis of receptor editing, class switching, affinity maturation, immunological memory.
3. Characteristics of T helper (Th) and T cytotoxic (Tc) and B cell peptide.
4. T cell subtype: Regulatory T cell, Suppressor T cells. Th17 cells and their interaction, signal transduction.
5. Molecular mechanism of immune response to tissue damage, inflammation, leukocyte recruitment

4117-4IM **Immunogenetics** **[Marks: 10, Contact Hrs: 12]**

1. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2), MHC polymorphism, Genetic Basis of Antigen Recognition.

2. Molecular mechanisms responsible for generating diversity of antibodies, Organization of Immunoglobulin (Ig) gene loci, Regulation of Ig gene transcription.
3. Organization of TCR gene loci, Generation of TCR diversity.
4. Organization of HLA complex, Structure of class I and II HLA molecules, Expression of HLA genes, HLA polymorphism.
5. Hybridoma technology and monoclonal antibodies, antibody engineering, Chimeric antibodies, transgenic animals and their use in immunology, Molecular modelling and Bioinformatics

4117-5IM **The immune system in human health and diseases [Marks: 10, Contact Hrs: 12]**

1. Breakdown of Self tolerance, autoimmunity, autoimmune diseases.
2. Immunodeficiency, genetic immune deficiencies, transplantation immunology, tissue grafting and organ transplantation.
3. Molecular mechanism of immune malignancies/tumor immunology, stem cell therapy, cancer immunotherapy.
4. Infectious disease immunology and vaccinology, concept of immunotherapy.
5. Allergy, Hypersensitivities, Ageing and stress related immunoscenesence/ immunocompromized state (Stress, ageing and immune response)

HPY-DSEC42-TH-P18	**Immunology and Microbiology–II (Theory)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

4218-1IM **Host pathogen interaction in the microbial world [Marks: 10, Contact Hrs: 12]**

1. Host microbe relations – symbiosis Koch's posulates, Define pathogenicity and virulence; Quantitative measures of virulence: minimal lethal dose (MLD), LD50, ID50, Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative / obligate intracellular pathogens.
2. Ribosomal RNA analyses for tracing microbial evolution, genetic basis of evolution, Taxonomy, binomial nomenclature, types of bacterial classification systems, new approaches to bacterial taxonomy (numerical taxonomy, ribotyping).
3. Understanding of diversity of the microbial world, Bacterial diversity, bacterial populations relevant to nutrient cycles in environmental systems, microbial evolution and systematic phylogenetic trees. Methods of studying microbial diversity (Conventional and molecular tools)
4. Mechanisms of bacterial resistance to host cellular (phagocytosis) and humoral Defences. Immune escape mechanisms, Molecular basis of bacterial pathogenecity – cytoskeletal modulation of host cell, virulence genes and pathogenecity island, Host-pathogen specificity and genetics of host pathogen interactions
5. Pathogenesis of viral infection: Stages of infection, Patterns of some viral diseases- epidemiology, transmission, infection, symptoms, risk, transformation and oncogenesis, emerging viruses. Anti-viral strategies-prevention and control of viral diseases: Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections, Contributions of various host defense mechanisms in viral infections.

4218-2IM **Microbial physiology and metabolism [Marks: 10, Contact Hrs: 12]**

1. History and major events in the development of microbiology, Structure, Function, Growth and Cell Division
2. Regulation of Metabolic pathways, Metabolism of C1, carbohydrates, lipids, nucleotides, amino acids, Regulation and energetics of hexose and pentose metabolism. Peptidoglycan synthesis.

3. Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in some heterotrophic and chemolithotrophic bacteria. Bacterial anaerobic respiration: Electron transport chains in some anaerobic bacteria.
4. Response to environmental stress, Catalase, super oxide dismutase, mechanism of oxygen toxicity, Heat-Shock responses, pH homeostasis, osmotic homeostasis.
5. Nutrition as indication of physiological complexity: growth requirements, Nutrient requirements, nutrient mutants as physiological probes, Nutrient transport: Transport of solutes across the membrane, Active and Passive transport, Drug export systems, Carrier mediated transport mechanism, thermodynamics of transport process

4218-3IM **Microbial genetics** **[Marks: 10, Contact Hrs: 12]**

1. Organisation of genomes – Repeated sequences - C value – cot curves" Multigene families; Molecular markers (RFLP and RAPD) Polymorphisms.
2. Mutagenesis: mutagenic agents, Types of mutations, mutagens, mechanism of mutation, Mutagenesis, induction and isolation of mutants, Expression of mutations- gene mutation, Control of gene expression in bacteria, Positive gene regulation, negative gene regulation and attenuation, using the lactose, arabinose and tryptophane operons with emphasis on recent advances.
3. Bacterial genetics – Inheritance of characteristics and variability. Phenotypic changes due to environmental alterations. Genotypic changes. Transposable genetic elements, Bacterial recombination. Bacterial conjugation. Transduction – Generalized and specialized transductions. Bacterial transformation, PBR 322 and other synthetic plasmids - isolation and uses, Linkage map of bacterial chromosome, Transposons in prokaryotes and eukaryotes.
4. T4 virulent phage: structure, life cycle, genetic map and DNA replication. Lamda temperate phage, Structure of Bacteriophages and their use in the study of molecular genetics – lytic cycle replication, Lysogeny and its regulation, Transfection and cosmids, Bacterial defence (CRISPR-Gene turning on).
5. Microbial genomics, Genetic mapping applications of Bacteriophages in microbial genetics.

4218-4IM **Multidrug resistance in microbes and its control by antimicrobial agents**
[Marks: 10, Contact Hrs: 12]

1. Concepts of microbial diseases, pathogens and epidemiology, Global warming lead increase in vector-borne and water-borne infectious diseases; Impact of increasing urbanization, international travel and trade on infectious diseases.
2. Physiology of antimicrobial chemicals, Diagnosis and tracking of microbe, General idea of control of microorganisms.
3. Multidrug resistance in Microbes: importance & mechanism, Antibiotic/Drug resistance- origin, cause and clinical implication with special references of multidrug resistant tuberculosis and MRSA; Recent concepts – Multidrug efflux pumps, extended spectrum β-lactamases (ESBL), XMDR M. tuberculosis, Methacillin-resistant S. aureus (MRSA).
4. Screening and development strategies for new antimicrobial agents acting on bacterial cell wall, cell membrane, nucleic acid and protein metabolism, Bioassay of antibacterial agents in liquid media and in agar media using standard guidelines (e.g. National Committee for Clinical Laboratory Standards (NCCLS) /Clinical and Laboratory Standards Institute (CLSI)), Factors affecting bioassay, Laboratory methods to assess activity of antimicrobial combinations (antagonism, synergism and additive effect).
5. Methodologies for testing of antimycobacterial, antifungal, antiparasitic and antiviral drugs (in vivo and in vitro infectivity mode.

4218-5IM **Applied and industrial microbiology [Marks: 10, Contact Hrs: 12]**

1. Sources of industrially important microbes, strain development, Microbial strain improvement, Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, Real-time PCR, diagnostic sequencing and mutation detection, molecular typing methods, array technology.
2. Types of fermentation and fermenters, process optimization, and recent developments in fermentation technology.
3. General concept of Microbial biotechnology, Microbial production of Antibiotics: penicillin, streptomycin; Microbial products from genetically modified (cloned) organisms ex: insulin.
4. Production of ethyl alcohol. Microbial leaching – role of microorganisms in the recovery of minerals (uranium, copper) from ores. Microbial groups involved in biogas production.
5. Patenting: Concept and its composition & protection of right and their limitation, intellectual property rights (IPR); patenting biotechnology inventions

HPY-DSEC43-PR-P19 - Immunology and Microbiology – III (Practical) [Marks: 50, Contact Hrs:60, Credit:04]

Experiments on Immunology:

a) Demonstration of animal handling for experimental purposes: cervical dislocation, dissection of rat and mice: cardiac puncture, blood sample preparation and its handling.
b) Production of polyclonal antibodies against bacterial cell suspension, SRBC as particulate antigen and BSA as soluble antigen and determination of antibody titer; Diagnostic immunologic principles and methods: Demonstration of antigen-antibody reaction by agglutination, hemagglutination and precipitation reaction.
c) Study of cell mediated immune response by delayed type hypersensitivity reaction.
d) Separation of human lymphocytes, monocytes and neutrophils from whole blood
e) Isolation of murine splenic, peritoneal and resident bone marrow macrophages.
f) Assessment of murine macrophage functions: Phagocytosis, bacterial killing, bactericidal enzyme (Lysozyme) release, tests for intracellular killing, respiratory burst response.
g) SDS-PAGE: Separation of Protein & Western Blot
h) Animal experiment for testing pathogenicity or virulence using hospital strains of bacteria, Animal experiment for testing endotoxic shock using purified bacterial Lipopolysaccharide (LPS): animal model for inducing inflammation
i)Demonstration of cytokine ELISA.
j)Cell separation by FACS/Flow Cytometry (demonstration only).

Experiments on Microbiology:

1. Cleanliness, media preparation, sterilisation, culturing methods, dilution technique, and isolation of pure culture- techniques Serial dilution, Pour plate method, Spread plate method and streak plate method; Staining techniques for bacteria and yeast: Gram Staining and Spore staining for bacteria; Methylene blue staining for Yeast
2. Bacterial growth curve: serial dilution plating and turbidity measurement, Enumeration of bacteria – Quantitative estimation of microorganisms – total and viable counts. Growth curves, Bacterial growth measurement, viable count by spread plate method, colony count. Enumeration by dry weight and turbidometric methods.
3. Culture characteristics of microbes, identification of unknown bacteria by biochemical tests. To study pathogenicity of *Staphylococcus aureus* by coagulase test, Starch hydrolysis assay for the identification amylase-producing microorganisms, Gelatin hydrolysis assay for the identification protease-producing microorganisms
4. Microbiological Assay of antibiotics, Bioassay of chloremphenicol/streptomycin by plate assay method or turbidiometric assay method, Determination of minimum inhibitory concentration (MIC) of an antibiotic for pathogenic bacteria.

5. Determination of antibiotic resistance profile by disc agar diffusion (DAD) technique
6. Determination of Km, Vmax with and without inhibitors using bacterial alkaline phosphatase or any other enzyme.
7. Determination of BOD of water sample. Determination of indices of pollution by measuring BOD/COD of different effluents/waste water samples, Study the microbiological quality of water samples from different sources.
8. Isolation of bacterial DNA, Estimation of DNA and purity determination by UV absorption method, Agarose gel electrophoresis and detection of bacterial DNA.
9. Separation of amino acids by Paper Chromatography (demonstration only).
10. Use of Internet/software for sequence analysis of nucleotides and proteins; Studies of public domain databases for nucleic acid and protein sequences. Concept of various web based bimolecular specific databases used in Bioinformatics, Idea of homology modeling and docking with their relevance to drug designing, Exposure to different sequence/structural/Genome database through web (NCBI, SWISS-PROT, PDB, JCVI/CMR, IMG, EBI, GOLD etc.); Sequence similarity searching by different types of BLAST, Genome sequence analysis (Demonstration only)

Training program / Laboratory visit

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

HPY-DSEC44-PS-P20	**Immunology and Microbiology–IV (PROJECT AND SEMINAR)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

VIII. MOLECULAR CELL BIOLOGY (MCB)

Orientation of the DSE Course MOLECULAR CELL BIOLOGY (MCB)

Subject code (Unit code)	Subject	Marks	Contact Hours	Credit
HPY-DSEC41-TH-P17	**Molecular Cell Biology – I (Theory)**	**50**	**60**	**04**
4117-1MCB	Introduction to cell biology	10	12	
4117-2MCB	Integration of cellular macromolecules, vesicular trafficking and protein sorting	10	12	
4117-3MCB	Cell-to-cell communication and cell signaling	10	12	
4117-4MCB	The Cell Cycle and Programed Cell Death	10	12	
4117-5MCB	Stem Cell Biology	10	12	
HPY-DSEC42-TH-P18	**Molecular Cell Biology – II (Theory)**	**50**	**60**	**04**
4218-1MCB	Genome organization; Transcription; Translation and Post-Translational Modifications	10	12	
4218-2MCB	Mutations, Oncogenes and Tumor Suppressor Genes	10	12	
4218-3MCB	Cancer and Oncogenesis	10	12	
4218-4MCB	Components of Cellular Defense Systems	10	12	
4218-5MCB	Techniques in Molecular Cell Biology	10	12	
HPY-DSEC43-PR-P19	**Molecular Cell Biology – III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**Molecular Cell Biology – IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE course (MCB)

Subject code (Unit code)	Subject & topics	[Marks/Contact Hrs/Credit]
HPY-DSEC41-TH-P17	**Molecular Cell Biology –I (Theory)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

4117-1MCB **Introduction to cell biology [Marks: 10, Contact Hrs:12]**

1. Cell Theory Origin of life, chemical evolution and theories of origin of life
2. General structure of cells; Visualization of cells, ultrastructure and molecules
3. Organization of the biological membrane; Transport across membranes; Ion Channels
4. 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.
5. 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

4117-2MCB **Integration of cellular macromolecules, vesicular trafficking and protein sorting [Marks: 10, Contact Hrs:12]**

1. Cytoskeleton – components of Cytoskeleton, Microtubules, Intermediate filaments – Microfilaments,
2. DNA, RNA and proteins; basic structure, assembly and organization
3. Cellular compartments and functions, protein sorting
4. Vesicular traffic inside the cells: Transport of macromolecules between the nucleus and cytosol; Transport of macromolecules between the cytosol and mitochondria; Transport from ER to Golgi complex; identifying features
5. Molecular mechanisms of membrane transport and the maintenance of compartmental diversity

4117-3MCB **Cell-to-cell communication and cell signaling [Marks: 10, Contact Hrs:12]**

1. Concepts of signal molecules; Gap and tight junctions and cell signaling; receptors, G protein linked receptors and G protein mediated signaling; Second messengers; Role of Calcium, lipid signaling, Phospholipase and Phosphoinositides signaling; Signaling through enzyme linked cell surface receptors
2. Cytokine receptors and JAK-STAT pathway; Receptor tyrosine kinases, Map kinase pathways,
3. Wnt, Notch and Hedgehog signaling cascades
4. Steroid receptor and TLR pathways
5. Integration of signals and experimental approaches for building a comprehensive view of signal induced responses

4117-4MCB **The Cell Cycle and Programed Cell Death [Marks: 10, Contact Hrs:12]**

1. Overview of cell cycle: Components of the cell cycle control system - the checkpoints; Cyclins and Cdks

2. Intracellular control of cell cycle: Regulation and deregulation of the cell cycle machinery
3. The mechanics of cell division Mitosis and cytokinesis
4. Cell death : apoptosis versus necrosis; Programmed cell death– intrinsic and extrinsic signals and cascades
5. Detection of apoptosis

4117-5MCB **Stem Cell Biology [Marks: 10, Contact Hrs:12]**

1. Stem cells: Concept, types, self-renewal, pluripotency, differentiation; Commitment and Specification; Adult, embryonic, induced pluripotent and cancer stem cells
2. Isolation and characterization of stem cells; Stem cell culture; principles for identification, purifications, assessment of proliferation long-term maintenance and characterization; Niche and stem cell engineering
3. Cell - cell interaction and signaling during morphogenesis in early embryo; Pattern formation and Morphogenic gradients in development; Oogenesis, spermatogenesis
4. Molecular mechanisms of animal development: homeotic genes, DNA methylation and epigenetic gene regulation
5. Gene therapy and therapeutic application of stem cells Neurodegenrative disorders, spinal cord injury, diabetes, burns and orthopedic applications of stem cells; Genetic Manipulation of stem cells, overview of different methods of introduction: micronuclear injection method, transduction with recombinant retroviruses, targeted gene insertion, cre-LoxP recombination and production of transgenic animals

HPY-DSEC42-TH-P18 **Molecular Cell Biology - II (Theory) [Marks: 50, Contact Hrs:60, Credit:04]**

4218-1MCB **Genome organization; Transcription; Translation and Post-Translational Modifications [Marks: 10, Contact Hrs:12]**

1. Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; DNase I hypersensitive regions; DNA methylation & Imprinting
2. Replication initiation, elongation and termination; Enzymes and accessory proteins; Fidelity; Gene targeting; Cre/Lox recombination. Transcription unit; Promoters; Operators; Regulatory elements; Initiation; Attenuation; Termination Anti-termination
3. 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
4. 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.
5. 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

4218-2MCB **Mutations, Oncogenes and Tumor Suppressor Genes**

[Marks: 10, Contact Hrs:12]

1. Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens
2. Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation
3. Viral and cellular oncogenes
4. Tumor suppressor genes; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins
5. Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators

4218-3MCB **Cancer and Oncogenesis** **[Marks: 10, Contact Hrs:12]**

1. Chemical carcinogenesis; Biochemistry and molecular biology of cancer; Classification through gene expression profiling
2. Initiation, promotion, progression, cell behaviour; Benign versus malignant tumors
3. EMT; Angiogenesis and Metastasis
4. Cancer immunology
5. Cancer-critical genes and epigenetic mechanisms
6. Treatment strategies

4218-4MCB **Components of Cellular Defense Systems** **[Marks: 10, Contact Hrs:12]**

1. Inflammation and immunity
2. Cells of immune system: Hematopoeisis, surface molecules, NK cells, dendritic cells, macrophages, T and B lymphocytes; Cell-cell cooperation
3. Immune responses generated by B and T lymphocytes
4. Immunoglobulins: classes and subclasses, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily
5. Immunological basis of self/non-self-discrimination
6. 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.
7. Cytokines: properties, receptors and therapeutic uses
8. Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.
9. Immunosuppression and immunodeficiency

4218-5MCB **Techniques in Molecular Cell Biology** **[Marks: 10, Contact Hrs:12]**

1. Cell culture techniques, transfection and infection of cells
2. Protein purification and characterization
3. Nucleic acids, RNA interference miRNAs and siRNAs
4. Immunohistochemistry
5. Microscopy and imaging (light, fluorescence, confocal, EM)
6. Fluorescence activated cell sorting
7. Transgenics and Knock-outs
8. Western Blot,
9. PCR
10. ChIP; FISH; FRAP; RAPD;RFLP,
11. Cloning, restriction enzymes, plasmids: selection and isolation, transfection in vivo knock-out and knock-in
12. Cell based reporter assays

HPY-DSEC43-PR-P19	**Molecular Cell Biology - III (Practical)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

1. 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
2. Introduction to flow cytometry and fluorescence microscopy
    a. Cell cycle phase distribution of nuclear DNA by Flow cytometry
    b. CD4/CD8 profiling
3. Nuclear staining by DAPI
4. Development of tumor model: Intra-peritoneal tumor passage, intra-muscular tumor cell injection, evaluation of tumor volume
5. Evaluation of cell cytotoxicity and redox status: LDH, ALP, SGOT, SGPT,
6. DHE standard curve, ROS by fluorimetry,
7. NO standard curve, Nitric Oxide scavenging Assay,
8. Glutathione cycle;
9. DPPH Assay of known antioxidants (Vitamin C/NAAC/tBHQ
10. 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
11. Electrophoresis: SDS PAGE, Agarose DNA gel electrophoresis,
12. Western blot
13. PCR
14. **Training program / Laboratory visit**
    A report on the basis of a visit in Research institutes or laboratories of national importance.

HPY-DSEC44-PS-P20	**Molecular Cell Biology – IV (Project and Seminar)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

IX. NEUROPHYSIOLOGY (NP)

Orientation of the DSE course (NP)

Subject code (Unit code)	**Subject**	**Marks**	**Contact Hours**	**Credit**
HPY-DSEC41-TH-P17	**Neurophysiology–I (Theory)**	**50**	**60**	**04**
4117-1NP	Organization of Neurophysiology	10	12	
4117-2NP	Developmental Neurobiology	10	12	
4117-3NP	Cellular Neurophysiology and Neurochemistry	10	12	
4117-4NP	Ion Channels and Neuronal Signaling	10	12	
4117-5NP	Brain Plasticity	10	12	
HPY-DSEC42-TH-P18	**Neurophysiology–II (Theory)**	**50**	**60**	**04**
4218-1NP	Motor and Sensory systems	10	12	
4218-2NP	Regulatory systems	10	12	
4218-3NP	Cognitive Neurosciences	10	12	
4218-4NP	Neuropharmacology	10	12	
4218-5NP	Applied Neurophysiology	10	12	
HPY-DSEC43-PR-P19	**Neurophysiology–III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**Neurophysiology–IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE course (NP)

Subject code (Unit code)	Subject & topics	[Marks/Contact Hrs/Credit]
HPY-DSEC41-TH-P17	**Neurophysiology–I (Theory)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

4117-1NP Organization of Neurophysiology [Marks: 10, Contact Hrs:12]

1. History and Scope of Neurophysiology.
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.

4117-2NP Developmental Neurobiology [Marks: 10, Contact Hrs: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.

4117-3NP Cellular Neurophysiology and Neurochemistry [Marks: 10, Contact Hrs: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.

4117-4NP Ion Channels and Neural signaling [Marks: 10, Contact Hrs: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.

4117-5NP Brain Plasticity [Marks: 10, Contact Hrs:12]

1. Organizational levels of plasticity: pruning of synapses, dendritic spines, axonal sprouting, changes in brain activity.
2. Cellular and molecular basis of plasticity.
3. Plasticity in sensory and motor systems. Cortical maps and experience. Visual deprivation and amblyopia. Whiskers barrels in mouse.
4. Endocrine regulation of plasticity. Critical periods of plasticity.
5. Plasticity in learning, memory and behaviour. Training in enriched environment on brain anatomy, neurochemistry and behavior. Rehabilitation and retraining influence plasticity.
6. Plasticity of brain and spinal cord after injury.

HPY-DSEC42-TH-P18 Neurophysiology–II (Theory) [Marks: 50, Contact Hrs:60, Credit:04]

4218-1NP Motor and Sensory systems [Marks: 10, Contact Hrs: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.

4218-2NP Regulatory systems [Marks: 10, Contact Hrs:12]

1. Neurotransmitters and receptors: Neural pathway carrying glutamate, glycine, GABA, Ach, dopamine, norepinephrine, serotonin, endorphin. Distribution of the receptors of these neurotransmitters.
2. Thalamocortical regulatory system: Thalamic neurons as pacemaker. Neural basis of partial and generalized epilepsy.
3. Central neural control of autonomic functions: Hypothalamus, Medulla, Limbic cortex and Cerebellum.
4. Sleep and wakefulness and Chronobiology: Recent advances in sleep physiology, molecules to systems approach of sleep, sleep disorders and sleep studies; Chronobiology, sleep and synaptic rhythms, Impact of environmental factors, entrainment and biological rhythms; Chronobiological therapy, Drug effectiveness and toxicity, Susceptibility to trauma and toxins, implication for diagnosis.
5. 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.
6. Recent concepts of neuroendocrinology, endocrinology of Brian, Neuroimmunomodulation

4218-3NP Cognitive Neuroscience [Marks: 10, Contact Hrs: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. Decision.
4. Emotion and behavior: Theories of emotion, Neural representation of feeling- Limbic system, orbito-frontal cortex, hypothalamus, amygdala. Fear and rage. Sexual behavior. Aggression. Motivation and reward, Dopamine and lateral hypothalamic syndrome, Reinforcement system, Brain aversion syndrome. Cognitive control (moods and anxiety) Disorder of moods and anxiety, unipolar and bipolar depression. Different types of anxiety disorders.
5. Language and communication: Universal design of language, language development in children, Neural organization of language, Alexia, Dyslexia, Aphasia, Neural structures of animal communication system.
6. Consciousness: Brain-mind interaction, Hypothesis relating to brain mind problem. Neural basis of consciousness, Perceptual illusion, Consciousness in other species, Theories of consciousness. Intelligence & perception
7. Cognitive rehabilitation, Neurophysiology of Exercise and Yoga,

4218-4NP Neuropharmacology [Marks: 10, Contact Hrs:12]

1. Drugs affecting peripheral Neurohumoral transmission: Agonist and antagonist of sympathetic, parasympathetic and cholinergic systems, Ganglionic stimulators and blockers, Neuromuscular blocking agents

2. Drug acting on central nervous system: Sedatives-hypnotics, Antipsychotic agents, Antianxity agents, Mood altering drugs, CNS stimulants, Narcotic analgesics, Agents use for treatment of epilepsy, Parkinsonian Disease, Alzheimer's Disease and migraine
3. Drug abuse: dependence and addiction, neurobiology of drug dependence and addiction. Hallucinogens, PCP, Ketamine, Alcohol, Opiate, Marijuana, Hashish
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.

4218-5NP Applied Neurophysiology [Marks: 10, Contact Hrs:12]

1. Anaesthesia: local anaesthetics and general anaesthetics.
2. Techniques in Cellular & Molecular neurophysiology: Qualitative and quantitative approaches for health and diseases, Brian-Omics and therapeutic approaches, *in vitro* culture of brain cells and tissues, brain cell lines, brain organoid; *In vivo* therapeutic approach for Neuro-diseases.
3. Methodologies to study brain systems: Basic assumptions and approaches, Measuring neural activity (electrophysiology, brain imaging), Shutting down neural activity (lesions, pharmacological inactivation, optogenetics), Perturbing of neural activity (microstimulation and opto-stimulation), Opening the loop at the behavioral and neural levels.
4. Neuroinformatics: Bioinformatics to databasing the brain, *In silico* methods for biomarker based evaluation of drug therapy for neurodiseases, Computational neurosciences and Artificial Intelligence
5. Basic concepts and application on Nanotechnology and neurophysiology, Evolutionary neurophysiology.

HPY-DSEC43-PR-P19 Neurophysiology – III (Practical) [Marks: 50, Contact Hrs:60, Credit:04]

1. Anatomical studies of mammalian brain

Dissection and identification of different regions of rat brain.
Anatomical localization of human brain structure in MR-images.

2. Histological studies

Staining of neurons by Cresyl violet and Nissl fast violet stain in the paraffin section.
Golgi-Cox method for neuron, neuronal processing and glial cells staining
Bulchawosky method for neural processing.
Fink- Heimer procedure for degenerating neurons
Vital staining of nerve fiber by Methylene blue method.

3. Neurobehavior studies

Locomotor movement in open field, Elevated plus maze for anxiety measurement, learning/memory task in open filed, Lordosis behavior, Pentobarbital induced sleeping time, Exploratory behavior in hole board apparatus.

4. Neurochemistry and Molecular Neurophysiology studies

Preparation of brain tissue homogenate (Post mitochondrial fraction) and collection of serum
DNA (mitochondrial and nuclear) and RNA (total) isolation from brain tissue
Estimation of protein in brain tissue homogenates by spectrophotometer
Estimation and determination of purity of DNA and RNA by spectrophotometer.
Measurement of neurotransmitters: Spectroflurometric method for measuring acetylcholine, epinephrine, nor-epinephrine, dopamine, serotonin in microdissected brain regions of rats.

5. Neuroendocrine functions and Experimental Chronobiology studies

Recording of 24 hours body temperature to study the circadian rhythm of body temperature.
Recording of heart rate to study circadian rhythm of resting heart rate.

6. Neuroimmunological studies

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

7. Neuroinformatics, Neurocomputational & Simulation studies

Database navigation: NIH database, metadata searching (Molecular, Morphometric and Biophysical), Allen Brain Atlas, Human Connectome Project.
Modelling of neurone, neural network, complexity and learning.
Molecular simulation of protein-ligand binding associated with neuronal function.

8. Training program / Laboratory visit

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

DEMOSTRATION

1. Animal preparation (Spinal preparation, decerebration, cerebelectomy).
2. Experimental stimulation/lesion in amygdala, septum, cerebellum, hypothalamic nuclei on estrous cycle, ovary, adrenal, blood cortisol.
3. Stereotaxic Technique: Animal preparation by aspiration, electrolytic and chemical lesion. Stimulation of different brain areas by electrical and chemical methods.
4. Electrophysiology: ECG, EMG & EEG studies in human/animal during different conditions (resting vs. stress, sleeping vs. awakfulness, Epilepsy)
5. Autonomic tone: EI ratio, Orthostatic test, Valsalvamaneuver, Cold pressor test, Study of Galvanic skin response (GSR).
6. Molecular Neurophysiology: SDS-PAGE gel electrophoresis of protein, Agarose gel-electrophoresis of DNA after digestion with restriction endonuclease, PCR Reverse transcription (RT) of total RNA isolated from brain tissue to cDNA, Primer designing & PCR, HPLC method for measuring neurotransmitters.

HPY-DSEC44-PS-P20	**Neurophysiology–IV (PROJECT AND SEMINAR)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

X. NUTRITION AND DIETETICS (ND)

Orientation of the DSE course (ND)

Unit code	**Subject**	**Marks**	**Contact Hours**	**Credit**
HPY-DSEC41-TH-P17	**Nutrition and Dietetics –I (Theory)**	**50**	**60**	**04**
4117-1ND	Public health and community nutrition	10	12	
4117-2ND	Diets and dietetics	10	12	
4117-3ND	Nutritional biochemistry	10	12	
4117-4ND	Nutritional immunology	10	12	
4117-5ND	Review of recent advances	10	12	
HPY-DSEC42-TH-P18	**Nutrition and Dietetics –II (Theory)**	**50**	**60**	**04**
4218-1ND	Molecular nutrition	10	12	
4218-2ND	Nutraceuticals and functional food	10	12	
4218-3ND	Emerging trends in nutrition	10	12	
4218-4ND	Case studies on nutrition	10	12	
4218-5ND	Tools of nutritional research	10	12	
HPY-DSEC43-PR-P19	**Nutrition and Dietetics –III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PS-P20	**Nutrition and Dietetics –IV (Project and Seminar)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE course (ND)

Subject code (Unit code)	Subject& topics	[Marks/Contact Hrs/Credit]
HPY-DSEC41-TH-P17	**Nutrition and Dietetics –I (Theory)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

4117-1ND **Public health and community nutrition** **[Marks: 10, Contact Hrs:12]**

1. The concept of community; public health and nutrition. Demography, population dynamics, vital statistics; indicators of health/ health index; burden of disease. Assessment/ evaluation of nutritional status of a community.
2. Major nutritional problems in India: Undernutrition(PEM), micronutrient deficiencies (Fe,I,Vit A), overnutrition(dual burden). Gender dimension of nutrition and food security.
3. National and International organisations and research Institutes working in the field of health and nutrition. Role of NGOs.
4. National Nutrition Policy, Govt. of India. National Nutritional Intervention Programmes :ICDS, MDM, PDS, FFW, Supplementation programme, Food programme (WFP), Pillars of Food security.
5. Economics of nutrition: per capita income, BPL, APL ,NITI Aayog. Growth and development. Development index: HDI, MDG, SDG, Hunger index.

4117-2ND **Diets and dietetics** **[Marks: 10, Contact Hrs:12]**

1. 1. Balanced diet, sustainable diet, dietetics
2. Diet trends and fad diets, Convenience foods, junk foods
3. Principles, classification and applications of therapeutic diets
4. Diet in Cardiovascular, hepatic, renal, bone and bowel diseases, genetic disorders and diabetes
5. Diet in sports and weight management

4117-3ND **Nutritional biochemistry** **[Marks: 10, Contact Hrs:12]**

1. Vitamins and vitamin signaling
2. Carbohydrate metabolism and nutritional relevance
3. Protein metabolism and nutritional relevance
4. Antioxidants and nutritional relevance.
5. Stress, oxidative stress and nutritional relevance

4117-4ND **Nutritional immunology** **[Marks: 10, Contact Hrs:12]**

1. Metabolic syndrome and inflammation, Immune profiling in metabolic diseases
2. Malnutrition and Diet induced obesity: infection and immunity
3. Nutritional disorder and alteration in immune cell signalling, The metabolic cost of infection and inflammation
4. Nutrients in immune-modulation
5. Food allergy

4117-5ND **Review of recent advances** **[Marks: 10, Contact Hrs:12]**

HPY-DSEC42-TH-P18	**Nutrition and Dietetics –II (Theory)**	**[Marks: 50, Contact Hrs:60, Credit:04]**

4218-1ND **Molecular nutrition** **[Marks: 10, Contact Hrs:12]**

1. Nutrigenomics, Nutrigenetics
2. Nutriepigenomics
3. Measurement of the nutritional phenotype
4. Nutrient Sensing mechanism
5. Genetic approach for studying nutritional disorders

4218-2ND **Nutraceuticals and functional food** **[Marks: 10, Contact Hrs:12]**

1. Bioactive substances in food, Synthetic functional food
2. Biological Activities and Health Effects
3. Probiotics prebiotics and synbiotics as functional food
4. Application of delivery systems and nanotechnology
5. Nutritional therapy in chronic diseases

4218-3ND **Emerging trends in nutrition** **[Marks: 10, Contact Hrs:12]**

1. Food technology
2. Food safety
3. Nutritional pharmacology
4. Bromatology
5. Chrononutrition

4218-4ND **Case studies on nutrition** **[Marks: 10, Contact Hrs:12]**

1. Case Study Research Basics & Definitions
2. Case Study Research in Nutrition
3. Designing Case Study Research
4. Generalization & Theory Building
5. Standards for Quality & Rigor in Case Study Research

4218-5ND **Tools of nutritional research [Marks: 10, Contact Hrs:12]**

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

HPY-DSEC43-PR-P19	**Nutrition and Dietetics – III [Marks: 50, Contact Hrs:60, Credit:04] (Practical)**	

Basic Biochemical, Histological and molecular biological techniques

Chromatography – paper, thin layer, gel filtration, ion exchange

1. Ammonium sulphate ppt and dialysis
2. Electrophoresis– acrylamide gel (native & SDS),
3. MW determination by SDS-PAGE
4. Zymography

5. DNA and RNA isolation
6. Western blot, PCR
7. Single cell preparation from blood, bone marrow, spleen, thymus and flow cytometry detection
8. Macrophage culture, viability and bioassay
9. Hematological parameters, Platelet and reticulocyte count
10. Collagen staining, PAS
11. Immunohistochemistry
12. Preparation of nano particle, nanoconjugation and size estimation

Food, Nutrients and Nutritional assessments

1. Animal models: Development of diabetes, anemia, hepatotoxicity and nephrotoxicity models in experimental animal, Studying the Urinary, Serum parameters, Preparation of tissue homogenate and measurement of relevant parameters
2. Biochemical assessment of nutrients
3. Adulteration, Sensory evaluation of food
4. Biostatistics in nutritional assessment
5. Anthropometry for nutritional assessment
6. 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.

HPY-DSEC44-PS-P20	**Nutrition and Dietetics –IV [Marks: 50, Contact Hrs:60, Credit:04] (PROJECT AND SEMINAR)**

COURSE OFFERED BY PHYSIOLOGY DEPARTMENT
FOR STUDENTS OF PHYSIOLOGY DEPARTMENTS

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

XI. SPORTS AND EXERCISE PHYSIOLOGY (SE)

Orientation of the DSEC course (SE)

Subject Code (Unit Code)	**Subject**	**Marks**	**Contact Hours**	**Credit**
HPY-DSEC41-TH-P17	**Sports and Exercise Physiology-I (Theory)**	**50**	**60**	**04**
4117-1SE	System Physiology in Sports and Exercise	10	12	
4117-2SE	Skeletal Muscle in Sports and Exercise	10	12	
4117-3SE	Bioenergetics and Sports Nutrition	10	12	
4117-4SE	Exercise Metabolism and Body Composition	10	12	
4117-5SE	Sports and Exercise Psychology	10	12	
HPY-DSEC42-TH-P18	**Sports and Exercise Physiology-II (Theory)**	**50**	**60**	**04**
4218-1SE	Athletic Training	10	12	
4218-2SE	Exercise Prescription for Health and Fitness	10	12	
4218-3SE	Sports Injury and Doping	10	12	
4218-4SE	Exercise in Different Environmental and Climatic Conditions	10	12	
4218-5SE	Biomechanics, Kinesiology and Management in Sports and Exercise Performance	10	12	
HPY-DSEC43-PR-P19	**Sports and Exercise Physiology-III (Practical)**	**50**	**60**	**04**
HPY-DSEC44-PJ-P20	**Sports and Exercise Physiology-III (Project)**	**50**	**60**	**04**
	Grand Total	**200**	**240**	**16**

Detailed Syllabus of the DSE Course (SE)

Subject Code	Subject	
HPY-DSEC41-TH-P17	**Sports and Exercise Physiology-I (Theory)**	**[Marks: 50 Contact Hours: 60 Credit: 04]**

4117-1SE **SYSTEM PHYSIOLOGY IN SPORTS AND EXERCISE**

- **Respiration During Exercise**
  - Anatomical Structure of Lung, Mechanics and Mechanism of Breathing, Rest-to-Work Transitions
  - Ventilation-Perfusion Relationships, O_2 and CO_2 Transport in Blood, pH Balance
  - Pulmonary Volumes and Capacities
  - Diffusion of Gases and Blood Flow to the Lung, Ventilatory and Blood-Gas Responses to Exercise
  - Ventilatory Regulation at Rest and Exercise
  - Ventilation and Energy Demands in Exercise, Energy Cost of Breathing, Pulmonary Adaptation following Exercise Training

- **Cardiovascular and Circulatory Responses to Exercise**
  - Organization of the Circulatory System, Cardiopulmonary and Circuits
  - Myocardium, Cardiac Cycle, Blood Pressure, Cardiac Output, Regulation of the Heart Rate and Stroke Volume
  - Hemodynamics and Electrical Activity of the Heart
  - Changes in Oxygen Delivery to Muscle During Exercise
  - Changes in Cardiac Output During Exercise
  - Changes in Arterial-Mixed Venous O_2 Content During Exercise
  - Redistribution of Blood Flow During Exercise
  - Regulation of Local Blood Flow During Exercise
  - Circulatory Responses to Exercise during Transition from Rest to Exercise, Recovery
  - from Exercise, Incremental Exercise, Arm versus Leg Exercise, Intermittent Exercise, Prolonged Exercise
  - Regulation of Cardiovascular Adjustments to Exercise

- **The Nervous System: Structure and Control of Movement**
  - General Organisation of the Nervous System
  - Structure and Electrical Activity of the Neurons
  - Sensory Information, Proprioceptors, Muscle Chemoreceptors, Reflexes
  - Somatic Motor Function
  - Vestibular Apparatus and Equilibrium
  - Control of Motor Functions – Role of Brain Stem, Cerebrum and Cerebellum
  - Motor Functions of the Spinal Cord
  - Autonomic Nervous System
  - Exercise Enhances Brain Health

- **Acid-Base Balance During Exercise**
  - Acids, Base, and pH

- Hydrogen Ion Production During Exercise
- Intracellular and Extracellular Buffer System - Acid-Base Regulation During Exercise
- Respiratory and Renal Influence on Acid-Base Balance

- **Hormonal Responses to Exercise**
  - Neuroendocrinology
    - Blood Hormone Concentration
    - Hormone-Receptor Interaction
  - Hormones: Regulation and Action
  - Hypothalamus and Pituitary Gland
  - Thyroid Gland, Adrenal Gland, Pancreas
  - Testes and Ovaries
  - Resting and Exercise Induced Endocrine Secretions
  - Exercise training and endocrine function
  - Resistance training and endocrine function
  - Opiod Peptides and Physical Activity
  - Physical activity, Infectious Illness, Cancer and Immune Response
  - Hormonal Control of Substrate Mobilization During Exercise
    - Muscle Glycogen Utilization
    - Blood Glucose Homeostasis during Exercise
    - Hormone-Substrate Interaction

4117-2SE **SKELETAL MUSCLE IN SPORTS AND EXERCISE**

- Structure of Skeletal Muscle
  - Neuromuscular Junction
  - Muscular Contraction
- Overview of the Sliding Filament Model
  - Energy for Contraction
  - Regulation of Excitation-Contraction Coupling
- Fibre Type
  - Biochemical and Contractile Characteristics of Skeletal Muscle
  - Characteristics of Individual Fibre Type
  - Fibre Type classification and performance
  - Alterations in Skeletal Muscle Due to Exercise Inactivity, and Aging
    - Exercise-Induced Changes in Skeletal Muscles
    - Muscle Atrophy Due to Inactivity
    - Age-Related Changes in Skeletal Muscle
- Muscle Actions
  - Speed of Muscle Action and Relaxation
  - Force Regulation in Muscle
  - Force-Velocity/Power-Velocity Relationships
  - Receptors in Muscle: Muscle Spindle, Golgi Tendon Organs
- Muscular Fatigue
  - Central and Peripheral Fatigue
  - Factors Limiting All-Out Anaerobic Performances
  - Ultra Short-Term Performances [Less than Ten Seconds]
  - Short-Term Performances [10 to 180 Seconds]
- Factors Limiting All-Out Aerobic Performances

- Moderate-Length Performances [Three to Twenty Minutes]
- Intermediate-Length Performances [Twenty-One to Sixty Minutes]
- Long Term Performances [One to Four Hours]

4117-3SE **BIOENERGETICS AND SPORTS NUTRITION**

- Biological Energy Transformation
  - Cellular Chemical Reactions
  - Oxidation-Reduction Reactions
  - Enzymes
- Fuels for Exercise
  - Carbohydrates
    - Kinds and sources of Carbohydrates
    - Recommended Intake of Carbohydrates
    - Role of Carbohydrates in the Body
    - Carbohydrate Dynamics in the Exercise
  - Fats
    - The Nature of Lipids
    - Kinds and Sources of Lipids
    - Recommended Lipid Intake
    - Role of Lipid in the Body
    - Fat Dynamics during Exercise
  - Proteins
    - The Nature of Proteins
    - Kinds of Proteins
    - Recommended Protein Intake
    - Role of Protein in the Body
    - Dynamics of Protein Metabolism
    - Nitrogen Balance
    - Protein Dynamics in Exercise and Training
- Anaerobic and aerobic ATP Production
- Efficiency of Oxidative Phosphorylation
- Control of ATP-PC System, Glycolysis, Krebs Cycle and Electron Transport Chain
- Interaction between Aerobic/Anaerobic ATP Production
- Nutritional Guidelines
- Standards of Nutrition
- Classes of Nutrients
  - Water
  - Vitamins
  - Minerals
  - Carbohydrates
  - Fats
  - Protein
- Evaluating the Diet
  - Popular Diets
  - Meeting the Dietary Guidelines
- Pre-competition Diet
- 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.

SE4

- Nutritional Supplementation
- 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

4117-4SE **EXERCISE METABOLISM AND BODY COMPOSITION**

- Exercise Metabolism
  - Energy Requirements at
    - Rest
    - Rest-to-Exercise Transitions
    - Recovery from Exercise: Metabolic Responses
  - Metabolic Responses to Exercise: Influence of Duration and Intensity
  - Estimation of Fuel Utilization During Exercise
  - Factors Governing Fuel Selection
    - Exercise Intensity and Fuel Selection
    - Exercise Duration and Fuel Selection
    - Interaction of Fat/Carbohydrate Metabolism
    - Body Fuel Sources
- Body Composition and Performance
  - Body Composition Assessment
    - Overweight, Overfatness and Obesity
    - The Body Mass Index
    - Composition of the Human Body
    - Techniques to Assess Body Composition
    - Average Percentage Body Fat
- Two-Component System of Body Composition
- Body Fatness for Health and Fitness
    - Determining Goal Body Weight
- Physique, Performance and Physical Activity
  - Physiques of Champion Athletes
  - Upper Limit for Fat-Free Body Mass
- Overweight, Obesity, and Weight Control
  - Obesity
    - Historical Perspective
    - Obesity Remains a Worldwide Epidemic
    - A Progressive Long-Term Process
    - Genetics Influences Body Fat Accumulation
    - Physical Inactivity: A Crucial Component in Excessive fat Accumulation
    - Health Risks of Excessive Body Fat
    - Criteria for Excessive Body Fat
- Principles of Weight Control: Diet and Exercise
  - Energy Balance: Input Versus Output
  - Dieting for Weight Control
  - Factors that Affect Weight Loss
  - Exercise for Weight Control
  - Effectiveness of regular Physical Activity
  - Weight Loss Recommendations for Wrestlers and Other Power Athletes
  - Gaining Weight: The Competitive Athlete's Dilemma

- Somatotype

4117-5SE **SPORTS AND EXERCISE PSYCHOLOGY**

- 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, Relaxation, Self-talk

HPY-DSE42-TH-P18 **Sports and Exercise Physiology-II (Theory)** **[Marks: 50 Contact Hours: 60 Credit: 04]**

4218-1SE **ATHLETIC TRAINING**

- Principles of athletic training
- General Strength Training Principles
- Components of a Training Session: Warm-Up, Workout and Cool Down
- Training to Improve Aerobic Power
- Endurance Training and physiological adaptations of different Physiological Systems Endurance Training Effects on Biochemical parameters
- Molecular Bases of Exercise Training Adaptation
- Specificity of Exercise Training Responses
- Detraining Following Endurance Training
- Structural and Functional Adaptations to resistance Training
- Comparative Training Responses in Men and Women
- Physiological Effects of Strength Training
- Combined Strength and Endurance-Training Programs
- Gender Differences in Response to Strength Training
- Detraining Following Strength Training
- Concurrent Strength and Endurance Training
- Maintenance of Aerobic Fitness Gains
- Overtraining
- Muscle Soreness and Muscle Stiffness
- Training for Improved Flexibility
- Year-Round Conditioning for Athletes: Off-Season, Pre-Season and In-Season Conditioning

Training for the Female Athletes and Children

- Factors Important to Women Involved in Vigorous Training
  - Exercise, Training and Menstruation
  - Female Athlete and Eating Disorders

- Bone Mineral Disorders and the Female Athlete
- Training During Pregnancy

- Sports Conditioning for Children: Cardiopulmonary and Musculoskeletal System

4218-2SE **EXERCISE PRESCRIPTION FOR HEALTH AND FITNESS**

Risk Factors for Heart Disease
- Inherited/Biological
- Environmental
- Behaviours

Coronary Heart Disease
Physical Inactivity as a Risk Factor
Inflammation and Coronary Heart Disease
Obesity, Inflammation and Chronic Disease
Drugs, Diet and Physical Activity
The Metabolic Syndrome
General guidelines for exercise prescription
- Screening
- Dose-Response
- Physical Activity and Health
- General Guidelines for Improving Fitness
- Progression
- Warm-Up, Stretch and Cool-Down, Stretch
- Exercise Prescription for CRF
  - Frequency, Duration, Intensity

Sequence of Physical Activity
- Walking
- Jogging
- Running

- Strength and Flexibility Training
- Environmental Concerns

Exercise for Special Populations
- Exercise for patients with
  - Diabetes mellitus
  - Hypertension
  - Chronic Obstructive Pulmonary Disease
  - Cardiac problems and coronary artery diseases: Rehabilitation aspect
- Physical Activity Guidelines and exercise programmes for older people

Exercise during Pregnancy
Competitive Training for Diabetics
Training for Asthmatics
Epilepsy and Physical Training
- Does Exercise Promote Seizures?
- Risk of Injury due to Seizures

4218-3SE **SPORTS INJURY AND DOPING**

- 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
- 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
- Ergogenic Aids and Doping in Sports
    - Research Design Concerns
    - Dietary Supplements as ergogenic aids
    - Oxygen as an ergogenic aid
    - Blood Doping
    - Banned methods of doping in sports
    - Doping, dope substances and drug abuse in sports
        - Classification of dope substances
        - Mechanism of action of different Dope substances
    - Health hazards or side effects of different dope sunstances
    - Special Aids to Exercise Training and Performances

4218-4SE **EXERCISE IN DIFFERENT ENVIRONMENTAL AND CLIMATIC CONDITIONS**

- Altitude: Definition and Classification
- Atmospheric Pressure at different layers of high altitude
- Physiological responses following short term and long term exposure to high altitude
- Anaerobic and aerobic performance in high altitude
- Maximal Aerobic Power and Altitude
- Adaptation to High Altitude
- Training for Competition at Altitude
- The Quest for Everest
- The Stress of Altitude
- Acclimatization following exposure to medium and high altitude
- Metabolic, Physiologic, and Exercise Capacities at Altitude
- Altitude Training to improve performance at Sea-Level
- Combine Altitude Stay with Low-Altitude Training
- Deep Exercise and Thermal Stress
    - Mechanisms of Thermoregulation
    - Thermal Balance
    - Hypothalamic temperature Regulation
    - Thermoregulation in Cold Stress
    - Thermoregulation in Heat Stress: Heat Loss
    - Effects of Clothing on Thermoregulation

- Thermoregulation and Environmental Heat Stress During Exercise
  - Exercise in the Heat
  - Maintaining Fluid Balance: Rehydration and Hyperhydration
  - Factors that Modify Heat Tolerance
  - Complications from excessive Heat Stress
- Thermoregulation and Environmental Cold Stress During Exercise
  - Exercise in the Cold
  - Acclimatization to Cold
- Factors influencing environmental stress
  - Environmental Factors
  - Insulating Factors
  - Energy Production
  - Dealing with Hypothermia
- Deep Sea Diving
  - Acclimatization in divers
  - Scuba Diving
  - Diseases occurring in divers
- Sports Diving
- Jet lag and Microgravity
- Air pollutants as environmental stress factors affecting exercise performance

4218-5SE **BIOMECHANICS, KINESIOLOGY AND MANAGEMENT IN SPORTS AND EXERCISE PERFORMANCE**

- 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
  - Centre of Gravity , Static Balance and Dynamic Equilibrium
  - Pattern Recognition and Usage , Skill Analysis
  - Skill Error Analysis and Correction
- Sports Management
  - 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 of National International Standards
  - Management of Sports Events

HPY-DSE43-PR-P19 **Sports and Exercise Physiology-III (Practical)** **[Marks: 50 Contact Hours: 60 Credit: 04]**

SE9

1. Introduction to practical experiments on human subjects and Standardization 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-Astrand Nomogram by Bicycle ergometry
10. Determination of VO_2 max with Margaria Nomogram 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 at steady state heart rate.
23. Study report of visiting institute of repute for exposure to modern techniques, etc.

HPY-DSE44-PS-P20	**Sports and Exercise Physiology-IV (Project & Seminar)**	**[Marks: 50 Contact Hours: 60 Credit: 04]**

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 CBCS 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.