

# SYLLABUS

## 2 Year MASTER OF SCIENCE PHYSIOLOGY

NEP  
(2026-28)



SEMESTER (Course Code)	Name of course	Credits	Marks	Total
<b>SEMESTER I</b>				
PHY2PCOR01T	Homeostasis & Stress	4	50	<b>Marks : 300</b>
PHY2PCOR02T	Physiological System I (Nervous System, Special Sense, Cardiovascular & Respiratory System)	4	50	
PHY2PCOR03T	Biochemistry & Metabolism	4	50	<b>Credits : 22</b>
PHY2PCOR04T	Cell Biology & Biotechnology	4	50	
PHY2PCOR05P	Practical I	4	50	
PHY2PAEC01M	Scientific Communication	2	50	
<b>SEMESTER II</b>				
PHY2PCOR06T	Computational Biology, Bioinformatics & Biostatistics	4	50	<b>Marks : 250</b>
PHY2PCOR07T	Physiological System II (Endocrinology, Reproduction, Gastro-intestinal System, Renal Physiology)	4	50	
PHY2PCOR08T	Haematology & Immunology	4	50	<b>Credits : 20</b>
PHY2PCOR09T	Environmental Physiology	4	50	
PHY2PCOR10P	Practical II	4	50	
<b>SEMESTER III</b>				
PHY2PCOR11T	Ergonomics & Occupational Health	4	50	<b>Marks : 300</b>
PHY2PCOR12T	Microbial & Molecular Biological Techniques	4		
PHY2PCOR13T	Biophysics & Biomedical Instrumentation	4	50	<b>Credits : 22</b>
PHY2PDSE01T	A. Lifestyle & Therapeutic Nutrition or / B. Physiology based Decision in Health	4	50	
PHY2PCOR14P	Practical III	4	50	
PHY2P1SEC01M	Physiological & Pathological Monitoring Techniques	2	50	
<b>SEMESTER IV</b>				
PHY2PCOR16T	Sports & Exercise Physiology	4	50	<b>Marks : 300</b>
PHY2PCOR17T	Pathophysiology & Pharmacology	4	50	
PHY2PDSE02T	A. CAM & Yoga or B. Medical Analytics	4	50	<b>Credits : 24</b>
PHY2PDSE02P	Practical IV A. DSE A or B. DSE	4	50	
PHY2PCOR19M	Project	4	50	
PHY2PCOR20M	Project Seminar & Grand Viva	4	50	

## SEMESTER-I

### PHY2PCOR01T (4 credits)

#### Homeostasis & Stress:

Control system: physical and physiological control system, Components, Regulatory mechanisms, Different feedback mechanisms in physiological system. Integrated regulation of ions, electrolytes and osmotic balance of body fluids. Transport and exchange of gases and nutrients. Sensory system - from receptor to perception. Neuroendocrine regulation of metabolism including energy balance, Autonomic control of visceral organs.

Homeostasis vs stress vs diseases: risk factors, lifestyle components related to development of diseases.

Mechanism of human physiological stress response - acute and chronic, etiology, indicators and pathophysiology of stress hormones. Neuroendocrine control - its management and adaptation. Prenatal stress. Cellular response to stress.

*CO: Deviation in the homeostasis causes disease manifestation hence its understanding would help in the management of disease processes. Homeostasis, the key principle of physiology helps in understanding interconnection between different components within a particular system or across systems.*

### PHY2PCOR02T (1+1+1+1 credits)

**Physiological system-I** (Nervous system, Special Sense, Cardiovascular system, Respiratory system)

**Nervous System:** Brain anatomy, neurogenesis & gliogenesis. Neuronal basis of behavior. Neuroimmunology. Regulatory function of cerebellum with special reference to autonomic function, thalamocortical projections and its influence on evoked cortical activity, Anaesthesia, startle reflex. Functional Interpretation of EEG and brain waves. Neural stem cell and Neural Plasticity. Higher functions of brain and cognition.

**Sensory Organs:** Molecular mechanisms associated with Taste, Olfaction, Visual sense, Auditory & Cutaneous sense.

**Cardiovascular System:** Evolution of heart on comparative basis, Rhythmicity of heart, Junctional tissue, Role of autonomic nervous system on heart, Cardiovascular reflexes, Cardiac metabolism and the role of hormones, ECG – its principle and significance, ECG in cardiac abnormalities: Analysis of Electrocardiography, Angiogenesis and Angiography.

**Respiratory System:** Anatomy and abnormalities of respiratory system, Lung Mechanics, Neural and chemical regulation of respiration, Functional characteristics of lung functions.

*CO: Physiological systems-based knowledge that helps in systems-based design of therapy. Basic understanding of physiological processes about Nervous system, Special Senses, Cardiovascular system, Respiratory system.*

### **PHY2PCOR03T (4 credits)**

#### **Biochemistry & Metabolism**

**Enzymes.** Evidential basis of - Enzyme properties, Michaelis-Menten kinetics, Allosteric modulation. Mechanisms of enzyme actions.

**Protein Conformation.** Structure of atoms, molecules and chemical bonds. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.), Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds). Conformation of nucleic acids (A-, B-, Z-, DNA, t-RNA, micro-RNA).

**Metabolism.** Structural basis of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Metabolism of carbohydrates, lipids, amino acids, nucleotides; Integration of carbohydrate, fat and amino acids metabolism. Regulation and integration of metabolic pathways. Role of vitamins and minerals in metabolism of carbohydrate, protein, fat and nucleic acid metabolism.

*CO: This creates the foundation of employing physiological parameters to therapeutic nutrition. It also helps in understanding of the biochemical basis of physiology and different human diseases.*

### **PHY2PCOR04T (4 credits)**

#### **Cell Biology & Biotechnology**

Structure function correlation of cell membrane, extra-chromosomal inheritance, lysosomes diseases, function of peroxisomes, cytoskeleton proteins. Cell movement and chemotaxis analysis. Chromatin structure. Apoptosis. Cellular differentiation. Regulation of cell cycle. Regeneration and degeneration. Cellular cross-talk. Receptor mediated signal transduction - growth factors. Transport across membranes; Endocytosis. Hybridoma technology. Cellular dynamics - Movements of macromolecules, organelles and whole cells. Protein targeting.

Stem Cell Biology (renewal, potency, differentiation, plasticity etc). Embryonic and adult stemcells. Induced pluripotent stem cell (iPS). Tissue regeneration for regenerative medicine, Tissue specific stem cells. Telomeres and stem cells, Planaria stem cells, Regeneration in vertebrates. Mesenchymal stem cells, Hematopoietic stem cells. Stem cells and cancer.

Technology for isolation and purification of RNA, DNA (genomic and plasmid) and

proteins. Molecular cloning of DNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences. Genomic and cDNA libraries. Plasmid map, phage, cosmid, BAC and YAC vectors. Isolation, separation and analysis of carbohydrate and lipid molecules. Microarray. Transcriptomics and Proteomics. Gene Therapy. CRISPR technology.

*CO: This prepares for an advanced research field with modern technology. This would help pursue cutting edge research or join R&D of biotechnology industry*

### **PHY2PCOR05P (4 credits)**

#### **Practical – I**

Experiments with computational tools and open source software for analysis of anatomy, biostatistics and bioinformatics.

Preparation of Buffers. Phosphate saline buffer, HBSS, HEPES buffer

Anatomical Visualization. Use of non-invasive method for visualization and characteristics features identification of different parts of human brain and human lungs

Functional Characterization of Physiological Systems. Human ECG and human EEG waves analysis.

Cellular Characterization. Quantitative characterization of cellular features – shape, volume, diameter. Advanced techniques – Cytochemistry, Fluorescence and ultrastructure.

*CO: The course Practical – I gives an exposure to different advanced research techniques in cell biology and physiological systems; thus, prepares students for different biomedical research laboratories and pharmaceutical and healthcare industries. This would provide hands-on experience with computer software, biostatistical applications in day-to-day life, application of different sports and ergonomical parameters and practical knowledge of the theoretical units studied.*

*CO: The course Practical – I gives an exposure to different advanced research techniques in cell biology and physiological systems; thus, prepares students for different biomedical research laboratories and pharmaceutical and healthcare industries.*

### **PHY2PAEC01M (2 credits) 50 marks**

#### **AECC: Scientific Communication**

Computational skills: Word processor -basic operation and its application in biological sciences; MS excel – basic operation and its application in biological sciences; MS PowerPoint – steps of PowerPoint presentation, slide preparation for biological items. Reading, understanding, presenting and writing scientific material for publication.

## SEMESTER-II

### **PHY2PCOR06T (2+2 credits)**

#### **Computational Biology, Bioinformatics & Biostatistics**

**Computational Biology:** Basic concept of computer hardware, software, Operating System, use of open source software and internet, basics of programming.

**Bioinformatics:** Concept of Bioinformatics - field of application, common bioinformatics sites in www.biological databases, data acquisition, retrieval of biological data – Entrez , DBGET, LinkDB, Database searches - FASTA, BLAST. Sequence analysis tools.

Major Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB, knowledge of various databases and bioinformatics tools available at these resources, organization of databases: data contents and formats, purpose and utility in Life Sciences, Open access bibliographic resources and literature databases: Open access bibliographic resources related to Life Sciences viz., PubMed, BioMed Central, Public Library of Sciences (PloS), Principles of BLAST, sequence analysis and alignment, primer designing, vector design.

**Biostatistics:** Biostatistics as applied to public health problems principles, use of classical statistical approaches to describe the health of populations. Basic concepts of statistics, approaches and methods, Mean, Median, Mode, t-test (one tail, two tail), Chi-square test, ANOVA (one way & two way), parametric and nonparametric statistics, correlation and regression analysis, trend analysis, operational research, mathematical models, research related to health economics, medical geography, sources of biological information and database.

*CO: This prepares the background for Medical Analytics that are presently important to Pharma-IT industry. Course contents help in understanding of genome, morphological and physiological functional data; its manipulation and analysis.*

### **PHY2PCOR07T (1+1+1+1 credits)**

**Physiological System II** (Endocrine System, Reproductive System, Gastro-intestinal System, Renal Physiology)

#### **Endocrine System:**

Endocrine functions of the hypothalamus; Molecular actions and regulation of Pituitary hormones, Adrenal hormones, pancreatic hormones, Adipose tissue hormones; Regulation and action of Parathyroid and calcitonin, calcium and phosphate regulation. Non-conventional endocrine molecules in health & disease.

#### **Reproductive System:**

Testosterone & male sex hormones –Molecular mechanism, spermatogenesis, prostate

function; Male infertility and its treatment; Female sex hormones –cellular and molecular mechanisms of action, gametogenesis, folliculogenesis, embryonic development of gonads and genital ducts, sex determination; Reproductive hormones and their role in fertilization, Implantation, Hormonal regulation of pregnancy, parturition and lactation; Umbilical cord blood and stem cells in health & disease; Placenta and placental hormones; menopause and andropause; Infertility and its treatment, assisted reproduction (IVF, ET), extra-uterine pregnancy, Hyper & hypogonadism; Puberty.

#### **Gastrointestinal System:**

Histomorphology of Gastrointestinal tract, gastrointestinal hormones, Role of hepatobiliary system in gastrointestinal functions, Hepatic circulation, Endoscopy.

#### **Renal System:**

Electron microscopic and molecular structure of filtering membrane. Peculiarities of glomerular circulation. Transport mechanism of ions and molecules in kidney during physiological and pathological condition. Tubulo-glomerular feedback. Renal blood flow. Counter-current-exchanger and multiplier system, Assessment of renal functions. Kidney perfusion techniques, Peritoneal dialysis, Artificial kidney, Non-excretory functions of kidney. Urine formation, Waste elimination. Respiration and excretion on comparison.

*CO: Physiological systems-based knowledge helps in therapy based on system organizations. Basic understanding of physiological processes of Endocrine System, Reproduction, Gastro-intestinal System and Renal Physiology.*

### **PHY2PCOR08T (4 credits)**

#### **Haematology & Immunology**

Erythrocytes development, haemoglobin, iron-ferritin-transferrin system. Erythropoietin. Blood transfusion. Leukocytes development, Homeostatic regulation of blood cells development. Role of transcription factors in blood cell development, cross-talks between immunocytes.

Innate and adaptive immunity, Cell-mediated immunity. Humoral immunity. Antibody types and structure, Vaccination, Lymphatic system, Major Histocompatibility Complex-Types and detection techniques, Regulation of its expression, Immunogenetics and its applications. Role of Complement in immunological defence, Evolution of immune system. Haematological & Immunological techniques. Cell and Tissue Culture, Role of cytokines on immunocytes. Infectious immunity, Cancer immunity, Reproductive Immunity, Brain immunity. Basic mechanism of autoimmune disorder.

*CO: Most of the pathological investigations are blood based. This course is the foundation of diagnostic and disease preventive area. Combined knowledge of hematology and*

*immunology is the foundation of different diseases – from infectious diseases to cancer and autoimmunity.*

### **PHY2PCOR09T (4 credits)**

#### **Environmental Physiology:**

Human health and environment - environmental factors and general health, effects on growth and development. Environmental diseases – cancer, birth defects, reproductive damage, respiratory diseases, etc. Environment and allergy – different allergens, Allergic reaction on skin and respiratory tract- immediate and delayed reactions.

Metallic pollutants-mercury, lead, cadmium, arsenic and fluoride toxicity. Acute and chronic effects on health. Chelating agents and their characteristics, use of chelator to control metal pollution.

Environmental noise: sources – industrial, transport, construction services, domestic, Noise induced hearing loss, cardiac effects, sleep disturbances, noise and body stress, noise and unborn. Management of noise pollution – noise exposure mapping, control approaches, precautionary measures.

Waste disposal: Human excreta disposal; Solid waste disposal-hazards & protection; Hospital and biomedical wastes – hazards & protection, Recycling of waste, Radioactive waste, electronic waste & techno trash hazards and protection.

*CO: Environmental aspect is a major knowledge point that would help know the effects that the ever-changing climatic conditions would have on human. Equipped with the knowledge of environmental toxicants that are harmful for human health, helps in increasing awareness about pollutants and importance of conservation of nature. This would also assist in gaining access to jobs in authorities concerned with environmental issues.*

### **PHY2PCOR10P (4 credits)**

#### **Practical-II**

Students are to individually prepare and present two peer-reviewed publications of high repute. Students are to submit the review documents and present them.

Bioinformatics. Databases – sequence of protein and gene, sequence alignment, Multiple sequence alignment.

Biostatistics. Use of spreadsheets for biostatistical analysis.

Computational Biology. Different open-source platforms – GNU-Octave, R and Python, IDE, Installation of IDE and packages integration, Numerical programming and statical applications.

Preparation of Visit Report. Students should prepare a visit report from –

- 1) industrial establishments for ergonomic evaluation of man-machine-environment system,
- or, 2) different advanced National level laboratories
- or, 3) different hospitals

or, 4) A community survey maybe undertaken considering growth monitoring of children, anthropometry and /or nutritional status. The student shall submit a report during practical examination.

*CO: The course Practical – II gives an exposure to quantitative aspects of molecular information and exposes them to real life problems associated with human health. Thus students will be prepared to cope up for the future working environment. CO: This includes practical activities beyond laboratory work. This unit helps students to be at par with the latest research, comprehend and present it. Scientific writing skill is also developed. Group activities also develop interpersonal relations necessary for adjustment at multiple levels.*

## SEMESTER III

### PHY2PCOR11T (4 credits)

#### Ergonomics & Occupational Physiology

##### **Course Objective:**

*To equip students with the advanced physiological and biomechanical frameworks necessary to analyse complex man-machine-environment systems. The course focuses on the cellular and molecular mechanisms of occupational health, the math-intensive applications of Newtonian anthropometry, and the systemic management of occupational stress and chrono-disruption.*

**Advanced Biomechanics & Newtonian Anthropometry:** Kinetic Anthropometry: Application of Newtonian anthropometry in design; 3D modelling of body segments; Static vs. Dynamic link systems. Biomechanics of Loading: Biomechanical models of the lower back; intra-abdominal pressure as a factor in spinal stability; intervertebral disc pressure during complex handling tasks. High-Precision Interface: Advanced design of VDT (Visual Display Terminal) workstations; ergonomics of specialized input devices (keyboards, tactile sensors).

**Cognitive Ergonomics & Mental Workload:** Information Uptake: Elements of "brain work"; sensory-motor integration in high-speed skilled work; uptake and processing of complex display information. Vigilance & Memory: Physiological basis of sustained alertness; memory constraints in man-machine interaction; design of information systems to prevent cognitive overload. Boredom & Monotony: The physiology of boredom; fragmented work organization and its impact on mental health and precision.

**Occupational Bioenergetics & Skilled Work:** Physiological Cost of Work: Energy consumption during heavy muscular work; Efficiency of heavy work; Heart rate as a definitive measure of workload. Acquisition of Skill: Physiological principles of motor learning; Maximum control of skilled movements; Designing tools for high-precision manual tasks. Nutritional Ergonomics:

Interaction between eating habits, working hours, and physiological performance; nutrition for metabolic efficiency in industrial practice.

**Molecular Chronobiology & Shift Work:** The Biological Clock: Cellular and molecular mechanisms of the circadian clock; role of Photoperiodism and Synchronizers (Zeitgebers). Chrono-disruption: Pathophysiology of Jet Lag and Shift-work Maladaptation Syndrome; Seasonal Affective Disorder (SAD) in occupational settings. Temporal Organization: Recommendations for the physiological organization of night work and rotating shifts to minimize health risks.

**Advanced Occupational Health & Hazard Management:** Complex Hazards: Mechanical, chemical, and biological hazards; toxic substances and explosive materials in specialized industries. The "System-Accident": Theories of accident causation; failure of system design; analysis of human error in high-risk environments. Unorganized Sectors: Ergonomic challenges in agriculture, shoe mending, jewellery designing, and building construction; tailored PPE (Personal Protective Equipment) for diverse labour forces.

**Occupational Stress & Job Design:** Stress Pathophysiology: Molecular and hormonal markers of occupational stress; the relationship between stress and VDT operation. Job Design Principles: Alternatives to fragmented work; principles of job enrichment and enlargement to reduce psychological strain. Measurement of Stress: Advanced quantitative techniques for assessing occupational stress in industrial practice.

**Course Outcomes:**

*Upon completion, students will be able to:*

- a. Apply Newtonian and dynamic anthropometry to high-precision workstation design.*
- b. Analyse the molecular basis of circadian rhythms to design health-optimized shift-work schedules.*
- c. Evaluate energy expenditure and biomechanical load in heavy industry and unorganized sectors.*
- d. Implement advanced "system-accident" theories to prevent industrial disasters and occupational hazards.*

**PHY2PCOR12T (4 credits)**

**Microbial & Molecular Biological Techniques (2+2 credits)**

**(Microbiology)**

Taxonomic classification, nomenclature and identification of bacteria, archaebacteria, Structure and characteristics of Bacterial cell wall, Gram positive and gram negative bacteria, Bacterial chromosomes and Plasmids, Flagella and Ion pump. Microbial culture, microbial growth, yield and characteristics. Strategies of cell division, stress response, structure of spores.

Microbial genetics (Transformation, Conjugation, Transduction, Recombination and Transposition), microbial fermentation, industrial production of alcohol, lactic acid, drugs. Microbe-human interaction: beneficial and harmful, mycobacterium.

Virus – structure, classification and replication of Phage virus, Adenovirus, Herpes virus, Retrovirus. Virion. Prion.

Fungus – structure and reproduction of Yeast, Aspergillus, Penicillium, Candida. Protozoa – Identification and life cycle of malaria, leishmania, filaria. Biosensors. Prebiotics and probiotics.

### **(Molecular Biology)**

Structure of Chromosome, Nucleic acid Structure and Metabolism.

DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms.

RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post-translational modification of proteins.

Control of gene expression at transcription and translation level. Control of viral, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression. Methylation and gene silencing. Metagenomics.

*CO: Microbiological knowledge and its manipulation at the molecular level is the seed for public health, pharmaceutical and biotechnological industry. This course will provide basic principles of microbiology, parasitology and the molecular principles of life process.*

### **PHY2PCOR13T (4 credits)**

#### **Biophysics & Biomedical Instrumentation**

Colligative properties, Filtration, Centrifugation, pH and Buffer, Thermodynamics – adiabatic, isothermal, quasibatic changes, Entropy & Enthalpy, Information Entropy. Bioenergetics and energy transduction.

Tracer techniques in biological experimentation and medical applications.

Recording instruments – Galvanometers. Microscopy – Light, Phase contrast, fluorescence and confocal; Electron microscopy; Staining Techniques; Spectroscopic principles – UV/light, fluorescence, ORD/CD, Magnetic resonance imaging; IVP, PET and CT scanning. Image analysis.

Use of sound in diagnosis: Echocardiography, ultrasound.

Chromatography and Electrophoresis – application in separation and characterization of biomolecules. Biophysical principles and applications of blotting techniques. Amino acids, Protein and Nucleic acid sequencing. Genomics. Gene amplification – PCR. Gene knockout and In vitro mutagenesis Technique. Endonuclease, Plasmid map. Gene Expression Analysis, Post-translational modification – application of Proteomics.

*CO: This unit deals with the biophysical principles for understanding of physiological parameters and measurement technology. This prepares for an advanced research and professional field.*

### **PHY2PDSE01T** (4 credits)

#### **A. Lifestyle & Therapeutic Nutrition**

Lifestyle: Definition, components, factors influencing, importance of lifestyle on health and environment. Health and disease, Current Issues in health and fitness.

Chronobiology, Activity, Nutrition, Psycho-social health as lifestyle factors. Incidence, etiology, pathology, metabolic changes, clinical manifestations and complications in lifestyle induced pathological complications. Diagnostic and rehabilitation guidelines for pain, burn patients and recurrent spontaneous abortion.

Concept of malnutrition and deficiency disorders, balanced diet, meal planning, energy intake, therapeutic diet. Importance of dietary fibers, phytochemicals, nutraceuticals and antioxidants and nanoceuticals. Geriatric nutrition.

Nutritional assessment in patient care, physical and psychological aspects of patient feeding. Routine hospital diets: basic concepts and method of oral feeding, tube feeding, parental feeding, intravenous feeding, pre and post-operative diets, diets in surgical conditions and burns.

*CO: This knowledge encompasses the nutritional management of common diseases. Diet planning for disease conditions shall be a practical approach for training as a nutritionist or dietician.*

**OR**

#### **B. Physiology based Decision in Health**

Clinical decision making under Evidence Based Medicine. Scientific Approach to diagnosis – different hierarchical levels of diagnosis. Empirism versus quantitative approach. Experiment versus investigation – in vitro model, model organism, and human diseases - Translational Medicine. Precautionary measures. Importance and limitation of static data and dynamic data.

Etiology of disease. Solving strategy, Rule based reasoning, Bayesian logic, cognitive logic. Qualitative data collection. Empirical data collection. Quantitative data collection. Systematic Review - Linear versus nonlinear – pathology versus pathophysiology based decision. Time varying dynamical system. Application of Biostatistics in clinical decision making. Utilization of on-line resources. Therapy Planning - Uncertainty – Socio-economic consideration in optimization – patient’s role in medical decision – Cost effective and cost benefit analysis and decision, Quality of Life. Importance of prediction and optimization in therapy decision, Control analysis model, Cognitive model – Role of domain knowledge - rationalization. Case Studies.

*CO: Technicality of integrating clinical data, population data helps in Medical Analysis towards rational therapeutic design for individual cases that enhances opportunity in Pharma based IT industry. Course content exposes towards technicality of amalgamation of qualitative clinical data, population based data and superimposition of individual case data help in clinical decision making.*

**PHY2PCOR14P** (4 credits)

### **Practical III**

Evaluation of occupational stress - development of questionnaire, quantitative evaluation technique, Measurement of different heat stress indices: WBGT, ET, CET, P4SR; measurement of relative humidity. Anthropometric measurements - static and dynamic, anthropometric measurements for different design consideration- design of seat, work station, consumer products, personal protective equipments hand-tools, etc. Static and dynamic balance test, Determination of steady state, endurance time.

Biochemical study of work posture, joint angle study, determination of spinal curvature, analysis of posture by videographic method – OWAS, REBA, RULA, OCRA etc.

Determination of maximal heart rate, cardiac cost and cardiac efficiency by step test method, and treadmill. Recording and interpretation of EMG at rest and working condition. Measurement of body temperature, (oral, axial, skin) at rest and different working condition. Recording and interpretation of ECG at rest and working condition, effects of posture on ECG. Studies of blood pressure in humans: a) Effect of posture changes on blood pressure and heart rate. (b) Effect of vestibular stimulation on blood pressure and heart rate (c) Valsalva maneuver. Spirometric analyses of lung function test.

Experiment on Chronobiology: Recording of 24 hours body temperature to study circadian rhythm of body temperature a) Recording of heart rate to study circadian rhythm of resting heart rate.

Determination of hearing loss of different groups of workers by audiometric method. Measurement of illumination level by lux meter in different working areas. Measurements of noise level in different working stations. Measurement of vibration level.

Survey on: Child nutrition / Geriatric health survey or physiological adaptation at high altitude /cold / high temperature.

### **PHY2PSEC01M (2 credits)**

#### **Physiological and Pathological Monitoring Techniques**

Estimation of ascorbic acid in biological samples (blood, tissues etc.) by methods using different oxidizing agents, Bio-assay of oxytocin and epinephrine, Hormone assay-ELISA. Study of localization steroidogenic enzymes in testis, ovary and uterus by histochemical methods.

Separation of amino acids and sugars by paper chromatography; Separation of amino acids and lipid fractions by thin layer chromatography. Separation of proteins by Polyacrylamide Gel Electrophoresis (PAGE). Agarose gel electrophoresis of plasmid DNA.

Perimetry: visual field determination with different colours in perimeter in resting and stressful condition. Audiometry: study of frequency threshold curve in humans.

Biofeedback: EMG biofeedback studies.

*CO: This unit deals with hardcore physiological techniques. This would provide opportunity to work in industries based on ergonomic designing or undertake research work. Here students will learn different techniques that are associated with routine clinical laboratory work. This would help one to be a researcher or pathologist.*

## **SEMESTER IV**

### **PHY2PCOR16T (4 Credits)**

#### **Sports & Work Physiology**

##### **Course Objective:**

*To provide students with an in-depth understanding of the molecular, cellular, and systemic adaptations to physical activity. The course aims to bridge the gap between theoretical exercise science and clinical application, focusing on metabolic regulation, chronobiology, and specialized population dynamics.*

**Molecular Bases of Neuromuscular Function:** Neuromuscular Integration: Advanced motor unit recruitment patterns (Size Principle vs. Selective Recruitment), Rate Coding, and Electromechanical Delay. Muscle Fibre Plasticity: Molecular signalling pathways for muscle growth (mTOR pathway), fibre type shifting (IIX to IIA), and the role of satellite cells in repair. Fatigue Mechanisms: Central vs. peripheral fatigue; ionic disturbances (H<sup>+</sup>, K<sup>+</sup>, Pi accumulation) and the "Governor" theory of fatigue.

**Advanced Metabolic Regulation & Bioenergetics:** Hormonal Control of Metabolism: Role of catecholamines, insulin, and glucagon in substrate partitioning during prolonged vs. high-intensity exercise. Intracellular Signalling: Regulation of PGC-1 alpha in mitochondrial

biogenesis; the glucose-fatty acid cycle (Randle Cycle) during exercise. Lactate Dynamics: Lactate as a signalling molecule (Lactate Shuttle Theory) and advanced buffering capacity in elite sprinters.

### **Physiological Adaptations to Resistance & Power Training**

Structural Adaptations: Changes in pennation angle, tendon stiffness, and bone mineral density (Mechano-transduction). Neural Adaptations: Cross-education effect, bilateral deficit reduction, and changes in spinal reflex excitability (H-reflex). Overtraining Syndrome (OTS): Sympathetic vs. Parasympathetic OTS; biochemical markers (Creatine Kinase, Cortisol/Testosterone ratios) and recovery monitoring.

### **Environmental Chronobiology & Applied Sports Physiology**

Circadian Typology in Sport: Impact of chronotypes on peak performance timing; biological clock regulation and melatonin's role in recovery. Chrono-disruption: Management of Jet Lag and Social Jet Lag in traveling athletes; light therapy and nutritional timing for phase-shifting. Extreme Environments: Cellular responses to heat shock proteins (HSPs); physiological limitations of performance at extreme altitude (above 5000m).

### **Physiology of Special Populations**

Paediatric & Adolescent Physiology: Maturation-associated changes in anaerobic capacity; growth plate considerations and thermoregulation in children. Female Athlete Triad & Beyond: Impact of the menstrual cycle phases on substrate metabolism; pregnancy and the "Fit Mother" hypothesis. Aging & Sarcopenia: Physiological mechanisms of muscle loss and the role of high-intensity resistance training in the elderly.

### **Clinical & Work Physiology**

Metabolic Disorders: Pathophysiology of insulin sensitivity through exercise in Type 2 Diabetes; exercise as medicine for metabolic syndrome. Work Physiology: Physiological cost of industrial tasks; Assessment of physical work capacity (PWC) and heat stress management in occupational settings. Cardiac Rehabilitation: Adaptations to exercise training in patients with chronic heart failure (CHF) and coronary artery disease.

### **Research Methodologies in Sports Science**

Measurement of Human Performance: Precision and reliability of metabolic carts; critical power testing and anaerobic threshold determination. Data Analytics: Application of Principal Component Analysis (PCA) and internal consistency measures in sport-specific psychometric scales. Ethics in Sports Research: Institutional Review Board (IRB) protocols for high-intensity human testing.

### **Course Outcomes:**

*Upon completion, students will be able to: Analyse the molecular signalling pathways responsible for muscle hypertrophy and aerobic adaptation; Evaluate the impact of biological rhythms and environmental extremes on elite athletic performance; Design evidence-based*

*exercise interventions for special populations and clinical cohorts; Critically assess the biochemical mechanisms of ergogenic aids and metabolic recovery strategies.*

### **PHY2PCOR17T (4 Credits)**

#### **Pathophysiology & Pharmacology**

Symptoms and syndromes, Pathophysiology, pharmacology and toxicology (if any) of different communicable and non-communicable diseases. Pathophysiology and pharmacological management of common diseases in community – herpes, encephalitis, common fever, diarrhea, amoebiasis, malaria, filarial, leishmaniasis. Antibacterial drug against gram positive and gram negative bacteria. Gastritis, cholitis, ulceration, pancreatitis and cirrhosis of liver. Lifestyle disease: Coronary heart disease, obesity, hypertension, diabetes mellitus, hypertension, osteoporosis, back pain, hypokinetic diseases. Drug abuse and addiction.

Hormonal and metabolic diseases - Hypo- and hyperthyroidism, diabetes, hypertension, osteoporosis, constipation, fatty liver, kidney stones, gall stones, polycystic ovarian syndrome.

Macular degeneration, glaucoma, cataract. Cancer and autoimmunity. Types of pain, pathophysiology of pain and its management. Pathophysiology of hemophilia, thalassemia, Alzheimer's disease, Huntington's disease. Pharmacogenetics. Stages of drug development – up to clinical trials, Principles of toxicology Effective dose of drug, therapeutic dose. Drug receptor interaction and drug resistance. Toxicity assessment of drug – acute and long term.

Effects of toxicants on different organisms; xenobiotic-induced oxidative stress, hepatotoxicity, reproductive toxicity, nephrotoxicity, neurotoxicity, genotoxicity, immunotoxicity, endocrine disruption.

*CO: This unit disseminates knowledge on molecular basis of pathological manifestation and thereby the pharmacological principles of its management. Understanding pathophysiological shift in disease and pharmacological principles in the management of different diseases opens up avenues to pharmaceutical industries.*

### **PHY2PDSE02T (4 credits)**

#### **A. CAM & Yoga:**

**4 credits      50 marks**

Applications of Complementary Alternative Medicine (CAM) – Homeopathy, Ayurveda, Siddha, Traditional Chinese Medicine, Concept of Integrative Medicine.

Yoga and Ancient Indian Tradition: An Introduction to Yoga in different ancient texts; Sports vs yoga, meditation and relaxation, Yoga and Holistic Health, Conceptions and Misconceptions about yoga; Relevance of yoga in modern age. Yoga as a method of improving

personal-efficiency.

Applied Yoga: Different Perspectives: Sports-person, Geriatrics, Specially-abled and Corporates.

*CO: This unit equip for diseases prevention through the application of knowledge of physiology, thereby to act as independent professional in the field. Course contents expose students towards disease prevention and management at pre-clinical level.*

**OR**

## **B. Medical Analytics**

Medical Analytics - Definition & Objectives. Data driven Health, Digital Healthcare. Types of Data – Biochemical and Molecular, electrical, histopathological, radiological. Clinical observations – Importance, Address towards hierarchy, Electronic Health Record and Blockchain Technology, LAN Database and Global Database, Community Database – Importance and implementation. Public Domain Data Resources - Kaggle, Github, TCIA, JSRT, Immunoinformatics database – HMGT. Analytical Platforms – MatLab, FreeMat, Octave, R, Python; Different IDEs, Open-source platforms.

Multivariate Statistics –Data visualization and presentation, Classification Algorithm - PCA, LDA. Machine Learning - Supervised and Unsupervised Learning; Big Data Analytics; High-throughput data, Automation and Batch processing.

Biochemical data analysis: Biochemical basis of network, Metabolic Network, Gene expression network, Information theory (IT), Mutual Information, Multivariate Information Entropy. Reverse Sequencing – Single cell and whole tissue gene expression, RefSeq data.

Electrical data analysis: EEG, FFT - Frequency and Time Domain, Cobweb, wavelet, Phase transform, Power-spectral density.

Image data analysis - Image formats, use of bits, pixel intensity; DICOM Image – Resolution, Monochromaticity versus gray scaling, Level & Window visualization; Image Filtering – importance and methods, Noise reduction; Spatial and Frequency Domain Conversion.

Tissue Analysis – Tools for tissue studies – whole slide imaging, Fluorescence-based tissue analysis, Real time data acquisition, Integration of optics and electronics in Flow-based morphology; Mathematical Morphology (MM); Radon and FFT. Healthcare Analytics – Multidimensional and Multi-scaling, Chaotic Dynamics, Personalized Medicine and Quality of Life (QoL).

*CO: This course gives exposure to the resource, tools and analytical methods of Medical Analytics.*

## **PHY2PDSE02P (4 credits)**

### **A. CAM & Yoga:**

Applications of Complementary Alternative Medicine (CAM) – Homeopathy, Ayurveda, Siddha, Traditional Chinese Medicine, Concept of Integrative Medicine.

Yoga and Ancient Indian Tradition: An Introduction to Yoga in different ancient texts; Sports vs yoga, meditation and relaxation, Yoga and Holistic Health, Conceptions and Misconceptions about yoga; Relevance of yoga in modern age. Yoga as a method of improving personal-efficiency.

Applied Yoga: Different Perspectives: Sports-person, Geriatrics, Specially-abled and Corporates.

*CO: This unit equip for diseases prevention through the application of knowledge of physiology, thereby to act as independent professional in the field. Course contents expose students towards disease prevention and management at pre-clinical level.*

## **B. Medical Analytics**

Denosing by Filter. Features Identification - Use of Open-source Tools. Automation. Quantitative features of Tissue. Simulation Studies – Randomness and Chaotic Dynamics. Population Data Analysis - PCA, LDA. High Dimensional DICOM Image Visualization. Simulation studies for Therapeutic Assessment. Personalized Vaccine Prediction – Use of Open-source Tools. Single cell (RefSeq) gene expression analysis

*CO: This course gives exposure to the applications and hands-on training to the resources, tools and analytical methods of Medical Analytics.*

### **PHYP2COR19M** (4 credits)

**Project.** Project shall be carried out under the guidance of a teacher for a period of minimum four months. Students will have to prepare the project report in a standard format and submit the same in duplicate well before the examination. The report should not be less than 20 A4 size typed pages.

*CO: Objective of the course is to prepare students for research. This will provide practical training on data collection and analysis for further research work or survey compilation.*

### **PHYP2COR20M** (4 credits)

**Project Seminar & Grand Viva.** The project work will be evaluated on the basis of the internal assessment, seminar delivered by the student as well as viva-voce on the project report before the external examiners.

*CO: This would help students realize the vitality of proper presentation of a work. Besides recollecting the entire Physiology, this would help prepare students for interview.*

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