SYLLABUS

for

MASTER OF SCIENCE

IN

HUMAN PHYSIOLOGY

under

CHOICE BASED CREDIT SYSTEM

VIDYASAGAR UNIVERSITY
MIDNAPORE – 721102
WEST BENGAL

EFFECTIVE FROM 2018 - 19 ACADEMIC SESSION

Preamble

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

Eligibility Criteria:

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

General Instructions:

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

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

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

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

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

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

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

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

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

Programme Outcomes

Upon completion of the course students will be able to:

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

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

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

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

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

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

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

Syllabus of Human Physiology

Semester I: 300 Marks

Theory / Practical	Paper	Unit	Name	Marks	Credits
Theory	PHY 101	101.1	Physiological Chemistry and Metabolism	25	02
		101.2	Molecular Biology	25	02
	PHY 102	102.1	Biophysical Principles in Physiology	25	02
		102.2	Biomedical Instrumentation	25	02
	PHY 103	103.1	Biostatistics and Research Methodologies	25	02
		103.2	Computer Application in Biology and Bioinformatics	25	02
Practical	PHY 194	194.1	Growth Monitoring and Nutritional Assessment	25	02
		194.2	Assessment of Environmental Status	25	02
	PHY 195	195.1	Biochemical Techniques	25	02
		195.2	Bio-Analytical Techniques and Microbiological Studies	25	02
	PHY 196	196.1	Statistical Treatment of Biological Data	25	02
		196.2	Computer Application in Biological Problems	25	02

Semester II: 300 Marks

Theory / Practical	Paper	Unit	Title	Marks	Credits4
Theory	PHY201	201.1	Community Health: Health, Disease and Nutrition	25	02
		201.2	Community Health: Environmental Pollution, Toxicology and Management	25	02
	PHY202	202.1	Community Health: Exercise Physiology and Mass Fitness	25	02
		202.2	Community Health: Ergonomics and Occupational Health	25	02
	PHY 203	203.1	Physiology of Excitable Cells and Higher Functions of Brain	25	02
		203.2	Integrated Physiology: Homeostasis	25	02
	C-PHY 204 (CBCS)	204.1	Lifestyle and Health	25	02
		204.2	Lifestyle Management and Health Promotion	25	02
Practical	PHY 295	295.1	Anthropometry and Community Health Survey	25	02

		295.2	Human Experiments	25	02
	PHY 296	296.1	Studies with Cardiac Muscle	25	02
		296.2	Studies with Skeletal & Smooth Muscles and Bioassay	25	02

Semester III: 300 Marks

Theory / Practical	Paper	Unit	Title	Marks	Credits
Theory	PHY 301	301.1	Electrophysiology and Sensory System	25	02
		301.2	Systems Physiology	25	02
	PHY 302	302.1	Microbes-Human Interaction	25	02
		302.2	Human Immune System	25	02
	Special Paper				
	PHY 303A: Microbiology and Immunology	303.1A	Advanced Studies in Microbiology	25	02
		303.2A	Cellular and Molecular Immunology	25	02
	PHY303B: Ergonomics and Sports Physiology	303.1B	General Sports Physiology	25	02
		303.2B	Applied Sports Physiology	25	02
	PHY 303C: Biochemistry, Molecular Endocrinology and Reproductive Physiology	303.1C	Advanced Studies in Biochemistry	25	02
		303.2C	Molecular Endocrinology and Reproductive Physiology	25	02
	PHY 303D: Neurophysiology	303.1D	Physiology of Neuron and Evolution of Brain	25	02
		303.2D	Development of Brain and Molecular Neurobiology	25	02
	PHY 303E: Biophysics and Electrophysiology with Structural Biology	303.1E	Biophysical Principles and Advanced Methods in Biology	25	02
		303.2E	Advanced Cellular and Membrane Biophysics	25	02
	C-PHY 304 (CBCS)	304.1	Environment and Health	25	02
		304.2	Human Reproductive Health and Related Issues	25	02
Practical	PHY-395	395.1	Histological and Cytological Techniques	25	02
		395.1	Histochemical and Histometric Techniques	25	02
	Special Paper(Practical)				
	PHY 396A: Microbiology and Immunology	396.1A	Microbiological Techniques	25	02
		396.2A	Experimental Immunology Practical	25	02
	PHY 396B: Ergonomics and	396.1B	Experiments on Work and Sports Physiology - I	25	02

	Sports Physiology	396.2B	Experiments on Work and Sports Physiology - II	25	02
	PHY 396 *C:* Biochemistry, Molecular Endocrinology and Reproductive Physiology	396.1C	Biochemical Techniques	25	02
		396.2C	Experiments on Endocrinology and Reproductive Physiology of Model Animals	25	02
	PHY 396 *D:* Neurophysiology	396.1D	Experiments on Neurophysiology - I	25	02
		396.2D	Experiments on Neurophysiology - II	25	02
	PHY 396*E:* Biophysics and Electrophysiology with Structural Biology	396.1E	Advanced Methods in Biophysics	25	02
		396.2E	Advanced Cell and Membrane Biophysics	25	02

Semester IV: 300 Marks

Theory / Practical	Paper	Unit	Name	Marks	Credits
Theory	PHY 401	401.1	Endocrinology	25	02
		401.2	Reproductive Physiology	25	02
	PHY402	402.1	Cell and Inheritance Biology	25	02
		402.2	Biotechnology	25	02
	Special Paper				
	PHY 403*A:* Microbiology and Immunology	403.1A	Microbial Genetics: Advanced Studies	25	02
		403.2A	Clinical Immunology	25	02
	PHY 403*B:* Ergonomics and Sports Physiology	403.1B	General Ergonomics	25	02
		403.2B	Applied Ergonomics	25	02
	PHY 403*C:* Biochemistry, Molecular Endocrinology and Reproductive Physiology	403.1C	Advanced and Applied Biochemistry	25	02
		403.2C	Applied Molecular Endocrinology and Reproductive Physiology	25	02
	PHY 403*D:* Neurophysiology	403.1D	Neurophysiology of Brain	25	02
		403.2D	Applied and Clinical Neurophysiology	25	02
	PHY 403*E:* Biophysics and Electrophysiology with Structural Biology	403.1E	Biophysics and Electrophysiology with Structural Biology	25	02
		403.2E	Photophysics and Experimental Methods in Structure Elucidation	25	02
		494.1	Advanced Physiological Studies- I	25	02

Practical	**PHY 494**	**494.2**	**Advanced Physiological Studies- II**	**25**	**02**
	Special Paper(Practical)				
	PHY 495*A:* Microbiology and Immunology	**495.1A**	**Advanced Techniques in Microbiology**	**25**	**02**
		495.2A	**Clinical Immunology**	**25**	**02**
	PHY 495*B:* Ergonomics and Sports Physiology	**495.1B**	**Experiments on General Ergonomics and Environmental Ergonomics**	**25**	**02**
		495.2B	**Experiments on Ergonomic Design and Group Projects**	**25**	**02**
	PHY 495*C:* Biochemistry, Molecular Endocrinology and Reproductive Physiology	**495.1C**	**Advanced Experiments on Biochemistry**	**25**	**02**
		495.2C	**Advanced Experiments on Endocrinology and Reproduction**	**25**	**02**
	PHY 495*D:* Neurophysiology	**495.1D**	**Advanced Neurophysiological Studies- I**	**25**	**02**
		495.2D	**Advanced Neurophysiological Studies- II**	**25**	**02**
	PHY495*E:* Biophysics and Electrophysiology with Structural Biology	**495.1E**	**Advanced Medical Biophysics**	**25**	**02**
		495.2E	**Advanced Separation Techniques and Photophysics**	**25**	**02**
	PHY 496	**496.1**	**Project**	**25**	**02**
		496.2	**Project**	**25**	**02**

Semester- I

(Theory: 150 + Practical: 150)

Theory

(Total Marks: 150, 12 Credits)

Paper: PHY 101:

PHY 101.1: Physiological Chemistry and Metabolism

F.M. = 25 Credits = 02

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

Module I

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

Module II

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

Module III

Three dimensional structures of proteins: primary, secondary, tertiary and quaternary structures of proteins, bonds and interactions stabilizing the structure, Ramachandran plot, common fibrous and globular proteins, protein aggregation and protein folding, role of molecular chaperones in protein folding; misfolding of proteins, protein ligand binding.

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

Module IV

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

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

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

PHY 101.2: Molecular Biology F.M. = 25 Credits = 02

Course Outcome: The objective of this unit is to enable the students to learn regarding molecular nature and way of functioning of key structural elements of cell and genetic materials and thus to develop gross understandings towards molecular explanation of physiological interplays.

Module I

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

Module II

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

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

Module III

RNA synthesis and their processing: RNA polymerases, eukaryotic and prokaryotic transcription, organization of transcriptional units, induction, repression and attenuation; exons, introns, post transcriptional modification (RNA processing) – cleavage and splicing, RNA editing, capping, polyadenylation, different forms of RNA in gene expression, regulation of gene

expression in prokaryotic and eukaryotic system.

Module IV

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

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

Paper: PHY 102:

PHY 102.1: Biophysical Principles in Physiology F.M. = 25 Credits = 02

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

Module I

Introduction to biophysics: Historical overview, connections with physics, biology and medicine.

Viscosity of liquids and gases: use of viscometry, viscoelasticity, laminar and turbulent flow, Viscosity coefficient; Newtonian and Non-Newtonian fluids, significance of Reynolds' number in hemodynamics, measurement of viscosity by Oswald's viscometer; models for flows of liquids: Bernoulli and Poiseuille's equations and their applications.

Dynamics of the cardiovascular system: fluid mechanics - blood flow, blood pressure, hydraulic system and resistances to flow in different regions of the circulation; effects of gravity and external acceleration on circulation, haemodynamics in different phases of the cardiac cycle, heart sounds, mechanical power of heart.

Module II

Mechanics in breathing: elastic properties of lung and chest wall, static, dynamic and total lung compliance, Physical basis of lung compliance, physics of alveoli, surface tension, airway resistance, pulmonary vascular resistance, work of breathing, Dalton and Henry's laws of partial pressures in gas mixtures, gas exchange: Fick's law of diffusion, ventilation, perfusion.

Production of speech: phonation (types, mechanism and physiology).

Physics of vision: light and field of view, illumination of retina, eyes as an optical instrument, reduced eye, Critical fusion frequency (CFF).

Module III

Thermodynamics: laws of thermodynamics and living organism, enthalpy, entropy, efficiency and free energy in thermodynamic system, adiabatic process, concept of energy in biological system in the light of thermodynamics, living body as a thermodynamics system, Carnot's cycle.

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

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

Module IV

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

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

PHY 102.2: Biomedical Instrumentation F.M. = 25 Credits = 02

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

Module I

Bioelectric electrodes: ECG, EEG, EMG, microelectrodes.

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

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

Module II

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

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

Module III

Ultrasonic imaging system: Echocardiogram, A, B, M scans and real-time B scanner. PET, MRI, fMRI, CAT. **Biomedical telemetry:** Wireless telemetry, single and multi-channel telemetry, transmission of physiological signal over telephone lines.

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

Module IV

Audiometers: basic audiometer, Speech audiometers.

Haemodialysis machine: dialyzers, artificial kidney.

Physiological transducers: body temperature, pulse sensors, respiration sensors.

Basic idea about physiotherapy and electrotherapy instruments: brief description of generation, circuit diagrams and testing. Demonstration of electrotherapy instruments, principles of their functioning, usage, and safety implications for human beings.

Paper: PHY 103:

PHY 103.1: Biostatistics and Research Methodologies

F.M. = 25 Credits = 02

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

Module I

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

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

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

Module II

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

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

Module III

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

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

Module IV

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

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

PHY 103.2: Computer Application in Biology and Bioinformatics

F.M. = 25 Credits = 02

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

Module I

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

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

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

Module II

Number system and data representation –binary, octal, hexadecimal; simple binary arithmetic; representation of characters; ASCII code.

Problem solving and flow charts –symbols, structure, methods of drawing of flowcharts, application in biological problems.

Principle of programming in BASIC or C: simple programs for solving biological problems

and statistical analysis of biological data.

Module III

Simulation and modeling of different physiological parameters - cardiovascular functioning, Neuralcircuitry, immunological system; biochemical pathways; drug design etc.

Word processor- basic operation and its application in biological sciences; Ms excel–basic operation and its application in biological sciences; Ms. PowerPoint – steps of PowerPoint presentation, slide preparation for biological items. Basic concept of email, Internet- components of Internet, www, searching biological information from Internet, library-searching technique, LAN.

Module IV

Concept of bioinformatics- field of application, common biological databases.

Database management: idea about database management in bioinformatics, structure of database- PDB, NDB, PubChem, Chem Bank, basic concept of derived databases, sources of primary data and basic principles of the method for deriving the secondary data, organization of data, contents and formats of database entries.

Major Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB and knowledge of various databases and bioinformatics tools available at these resources, organization of databases: data contents and formats, purpose and utility in Life Sciences, open access bibliographic resources and literature databases**:** open access bibliographic resources related to life sciences viz., PubMed, BioMed Central, Public Library of Sciences (PloS).

Practical (**Total Marks: 150, 12 Credits**):

Paper: PHY 194

PHY 194.1: Growth Monitoring and Nutritional Assessment

F.M. = 25 Credits = 02

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

1. Assessment of nutritional status of infant (birth to 36 month) from the standard growth curve and determination of stage of malnutrition.

2. Growth monitoring and nutritional assessment: assessment of nutritional status of boys and girls of different ages of a community (2 to 20 years) from standard stature for age, and weight for age curves.

3. Assessment of nutritional status from MUAC, head circumference, skin fold (triceps and

sub scapular) in infancy, pre–school and school children.

4. Determination of outset of puberty from the velocity growth curve of stature of school children.

5. Assessment of nutritional status of boys and girls from the standard body mass index-for age curves.

6. Determination of grades of malnutrition of children by Gomez classification and waterloos classification.

7. Determination of grades of malnutrition by percentile value and Z – score of height, weight of children using standard data.

8. Assessment of nutritional status from height–vs–weight of adult male and female.
9. Assessment of nutritional status of adult male and female from triceps and sub scapular skin folds.

10. Assessment of nutritional status from measurement of food intake by 24 – hour recall method and food frequency questionnaire method.

11. Assessment of nutritional status from anthropometric measures and anthropometric indices such as BMI, Body surface area, ponderal index, Dugdel nutritional index, Waist-Hip ratio, obesity index.

PHY 194.2: Assessment of Environmental Status F.M. = 25 Credits = 02

Course Outcome: This unit will cover the quantitative estimation of different environmental pollutants and it also emphasizes the assessment of lethality of toxicants and parameters of oxidative stress. This course encompasses different factors for environment and its pollution.

A. Environmental study

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

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

B. Measurement of' chemical environment

a. Estimation of total hardness of water. .

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

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

d. Estimation of silica in water sample.

e. Measurement of BOD and COD in water sample.

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

C. Effect of pollutants /toxicants on biological systems

a. Determination of LD_{50}

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

Paper: PHY 195

PHY 195.1: Biochemical Techniques F.M. = 25 Credits = 02

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

1. Preparations of buffers, physiological solutions, molecular solutions, determination of pH,' preparation of tissue homogenate.

2. Blood analysis: estimation of blood glucose: Nelson-Somogyi method, Hagedorn-Jensen method.

3. Protein estimation by Lowry method UV spectroscopy.

4. Blood calcium and blood lactate estimation.

5. Estimation of total cholesterol content of blood.

6. Estimation of triglyceride content of blood.

7. Total non-protein nitrogen estimation.

8. Estimation of urea, uric acid, creatine and creatinine.

9. Enzyme activity: effect of pH and temperature on enzyme activity.

10. Determination of Km.

11. Acid and alkaline phosphatase, bilirubin, free fatty acids, SGOT and SGPT (transaminases) for liver function test

PHY 195.2: Bio-Analytical Techniques and Microbiological Studies

F.M. = 25 Credits = 02

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

A. Bio-Analytical Techniques

1. Separation and identification of amino acids by paper chromatography

2. Separation and identification of amino acids by thin-layer chromatography

3. Identification of sugars by thin-layer chromatography.

4. Electrophoresis of serum proteins.

5. Separation of protein by polyacrylamide gel electrophoresis (PAGE).

6. Separation of DNA by gel electrophoresis.

B. Microbiological Studies

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

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

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

Paper: PHY 196:

PHY 196.1: Statistical Treatment of Biological Data

F.M. = 25 Credits = 02

Course Outcome: To train the students to employ bio-statistical methods to biological problems and draw proper interpretation for any given issue.

1. Computation and significance of product- moment r between two continuous measurement variables.

2. Computation and significance of Kendall ' s rank correlation coefficient between two ordinal variables.

3. Computation and significance of partial correlation coefficient between two variables.

4. Computation and significance of multiple correlation coefficient between a continuous measurement variable and two others continuous measurement variables.

5. Computation and significance of point biserial r between a continuous measurement variable and a genuinely dichotomous qualitative variable.

6. Computation and significance of biserial r between a continuous measurement variable and an artificially dichotomized variables.

7. Computation and significance of phi coefficient between two genuinely dichotomous variables

8. Computation and significance of tetrachoric r by cosine pie formula between two artificially dichotomized variables.

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

10. Computation of percentile values from grouped data.

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

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

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

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

PHY 196.2: Computer Application in Biological Problems

F.M. = 25 Credits = 02

Course Outcome: The learner will be able to get hands on training on operating system and standard software packages for solving problems in biology. The course will help the learners to acquire skill of computer programming to computer different biological data.

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

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

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

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

value.

c. Tabulation of biological data.

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

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

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

g. Operation of Ms Excel – tabulation of biological data, computation of different groups of data, making charts with Ms Excel - bar diagram, line diagram, pie diagram for representing biological data.

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

i. Making table with MSWord.

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

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

Semester- II:

(Theory: 200 + Practical: 100)

Theory (Total Marks: 200, 16 Credits):

Paper: PHY 201:

PHY 201.1: Community Health: Health, Disease and Nutrition

F.M. = 25 Credits = 02

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

Module I

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

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

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

Module II

Population genetics: basic concept of population genetics- allele and genotype frequencies, gene pool, Hardy-Weinberg law in trait inheritance, eugenics, genetic counselling: prospective and reproductive study.

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

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

Module III:

Nutrition in infancy, childhood and adolescence: Nutritional requirement in adults, nutritional requirements of nutrients during infancy, breast feeding – nutritional and others factors, advantages, breast feeding and human immunodeficiency virus transmission, infant milk substitute (IMS) act 1992, formula feeding, supplementary foods of milk, cow's milk, goat's milk, vegetarian beverages, fruit juice, nutritional requirement of pre- term babies.

Nutrients, gene and health: Different food groups and nutrients, dietary fibres, food additives and artificial sweeteners, food processing, foodborne illnesss, food protection-thermal treatment, pasteurization, chemical methods, dehydration methods, vaccum and modified atmosphere packaging, irradiation technology; food toxicity and safety**,** classes of nutraceuticals, nutraceuticals to age, sex, physiological status (pregnancy), probiotics and prebiotics, functional foods and its prospects; transgenic foods and its importance; drug-nutrient interaction, nutritional epigenomics, nutrient sensing - role of sensing transcription factors and dietary signaling routes, genomics and transcriptomics.

Module IV

Feeding problems – Food allergies, cow's milk protein allergy, lactose intolerance, diarrhea, constipations vegetarianism, nutritional requirement of pre-school and school children, monitoring growth and development, nutrition related problems of children- childhood obesity, dental caries, allergies, nutritional requirement and problem of adolescents- anorexia nervosa (AXN), bulimia nervosa (BMN) and binge eating disorder (BED).

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

PHY 201.2: Community Health: Environmental Pollution, Toxicology and Management

F.M. = 25 Credits = 02

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

Module I

Man and environment: concept and types of environment, biotic environment; biotic and abiotic interactions. Ecosystem – structure, function and types, food chains, food webs and

energy flow and mineral cycling in ecosystems; primary production and decomposition; biogeochemical cycle.

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

Air Pollution: air pollutants – Sulfur oxides, nitrogen oxides, carbon monoxide, particulate matter, volatile carbon compounds (PAH etc.)- their effects, their control and prevention. Air quality criteria and standards.

Module II

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

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

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

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

Module III

Environmental toxicology I: toxic kinetics and toxic dynamics–toxic kinetic factors as basic mechanisms of toxicity, toxic dynamic factors as basic mechanism of toxicity, design of toxicity study, biotransformation and bio-activation / bio-inactivation of xenobiotics, Factor affecting xenobiotic action.

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

Module IV

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

Endangered species management and conservation of biodiversity: biodiversity: status, monitoring and documentation; Ecosystem restoration; sustainable forestry; Major drivers of

biodiversity change; biodiversity management approaches. Principles of conservation; major approaches towards conservation; Indian case studies on conservation; Endangered Species Act, IUCN Red list, Importance of biosphere reserves, wildlife sanctuaries and National parks.

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

Waste disposal: human excreta disposal; solid waste disposal-hazards & protection; Municipal solid wastes(MSW) management; Waste to energy conversion(WTE); Concepts of PAYT and EPR; Regional recycling options-material recycling facility(MRF), hospital and biomedical wastes – hazardous waste disposal, radioactive waste, electronic waste & techno trash hazards and protection.

Paper: PHY 202:

PHY 202.1: Community Health: Exercise Physiology and Mass Fitness

F.M. = 25 Credits = 02

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

Module I

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

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

Module II

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

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

Module III

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

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

Module IV

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

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

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

PHY 202.2: Metabolic Disorder and Lifestyle Management

F.M. = 25 Credits = 02

Course Outcome: This course provides the concept of lifestyle modifications for effective treatment of metabolic disorder. It also addresses various aspects of lifestyle modification using dietary modifications, exercise and nutrition promotion in community for geriatric and general people.

Module I

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

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

Module II

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

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

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

Module III

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

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

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

Module IV

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

Paper: PHY 203:

PHY 203.1: Physiology of Excitable Cells and Higher Functions of Brain

F.M. = 25 Credits = 02

Course Outcome: This unit highlights the structural and functional properties of excitable cells This unit also emphasizes on the higher brain functions and understanding of the fascinating processes driving human thought, cognition and behavior and the disorders related to nervous system malfunction.

Module I

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

Skeletal and cardiac muscle: muscle proteins, properties and locations, muscular contraction–

interaction of filaments in vitro and in vivo, coupling of mechanical and chemicals events at the cross bridge, muscle energetic, muscle mechanics – mechanical transients, patho-physiology of muscle contraction – muscular dystrophy, Mc-Addis diseases

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

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

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

Module II

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

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

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

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

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

Module III

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

Memory –short term and long-term memory, declarative and non-declarative memory,

neuroanatomy of memory, cellular and molecular basis of memory, amnesia, Korsakoff's syndrome.

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

Module IV

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

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

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

PHY 203.2: Integrated Physiology: Homeostasis F.M. = 25 Credits = 02

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

Module I

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

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

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

Module II

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

Gastrointestinal systems: neural control gastrointestinal functions–bile secretion and cholesterol homeostasis., immune function of GI tract, physiology of gastrointestinal disorders, assessment of gastric, pancreatic and intestinal functions in different patho-physiological

conditions.

Module III

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

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

Module IV

Homeostasis in extreme environments: hypobaric and hyperbaric environment, extreme hot and coldenvironment, Altered G – force on human body, artificial gravity, zero gravity, space travel on human body.

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

Paper: C-PHY- 204 (CBCS)

C-PHY 204.1: Lifestyle and Health(CBCS) F.M. = 25 Credits = 02

Course Outcome: This unit highlights the relationship of lifestyle and health and its associated problems. Provide understanding on concepts of physical activity and fitness, healthy habits and fitness related nutrition as well as about communicable and non-communicable diseases and food toxicity in the community.

Module I

Concept of lifestyle: Definition, components of lifestyle, factors influencing, importance of lifestyle on health, lifestyle and environment.

Concept of health and disease: definition of health (WHO), dimension and determinants of health, physical health, mental health, psycho-social health. **Disease** - definition, causal factors.

Module II

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

Health concepts of physical education: Concept of physical education, need and importance of physical education, physical activity and health benefits, types of physical activity, recreational physical activity and its importance. Role of physical education programme on community health promotion.

Module III

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

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

Module IV

Communicable diseases: definition, mortality, causative agents, transmission vehicles, transmission modes, its relation with lifestyle; concept of infection and infectious agents; virulence & virulence factors; concept of vectors - common vector borne diseases; sexually transmitted diseases; lifestyle, personal hygiene and communicable diseases; antibiotics and drug resistance. Some common communicable diseases in India: diarrhoea, AIDS, malaria, kala-azar, influenza, hepatitis, tuberculosis, typhoid, skin infections.

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

PHY 204.2: Importance of Health education and its promotion

F.M. = 25 Credits = 02

Course Outcome: This unit will give idea about the different aspects of health education, especially in the workplace. The learner can acquire knowledge about the safety in daily life as well as work place. The relationship between physical fitness and life style and health promotion can be known. The effect of life style modification on health can be well understood.

Module I

Safety education in health promotion: Health and safety in daily life, health and safety at work and their management, principles of accident prevention, first aid and emergency care.
Repetitive motion injury: Definition, causes, and prevention.

Module II

Physical fitness and health promotion: Physical fitness components, activities for developing physical fitness components, types and components of fitness, cosmetic fitness, assessment of physical fitness physiological effects of exercise. Cardio-respiratory endurance, muscular strength and endurance, body composition and weight control: body mass index and skin fold measurement, body types and posture, anthropometry and it types of measurement. Blood pressure, Heart rate and pulse rate: Definition and measurement.

Sports, lifestyle and recreation: yoga, meditation and relaxation, sports and mechanics, sports and socialization, yoga and stress management.

Module III

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

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

Module IV

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

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

Practical (Total Marks: 100, 08 Credits):

Paper: PHY 295:

PHY 295.1: Anthropometry and Community Health Survey

F.M. = 25 Credits = 02

Course Outcome: To provide training to the students for anthropometric measurements, their importance and applications. Field based training will also be offered on health, diseases through community-based health survey to make them understand the actual forms of physiological problems in population in various socio-demographic backgrounds beyond classroom teaching.

- **Anthropometric measurements:**

1. Body weight.
2. **Measurement of height** –stature, eye height, sub-nasal height, gnathion height, suprasternal height,porion height , acromion height , naval height, iliac crest height, knee height, ankle height, infrascapular height, elbow height.
3. **Measurement of diameter**– bi-acromion diameter, bi-cristal diameter, transverse diameter of the chest, antero-posterior diameter of the chest, hip breadth.
4. **Measurement of girth**- neck, upper arm, forearm, chest, waist, hip, thigh, calf, upper body, lower body.
5. **Measurement of sitting height**- vertex height, eye height, shoulder height, stomion height, elbow rest height, popliteal height, knee height, thigh clearance height.
6. **Measurement of head** –head length, head breadth, head circumference.
7. **Measurement of hand**- hand length, hand breadth, maximum hand breadth, fist girth.
8. **Measurement of foot**- foot length, foot breadth, ankle diameter.

- **Community health survey**

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

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

PHY 295.2: Human Experiments F.M. = 25 Credits = 02

Course Outcome: In this practical unit the students will be able to learn the different techniques of assessing physiological parameters related to work and exercise. There is enough scope for the learners to develop skills for measuring different health related parameters of human.

1. Study of pulse rate and breathing rate with the change of postures.
2. Determination of diurnal variations of pulse rate, blood pressure, respiratory rate.
3. Study of blood pressure with the change of postures.
4. Study of pulse rate as an effect of breath-holding.
5. Study of pulse rate with the variation of static work load.
6. Study of blood pressure with the variation of static work load.
7. Study of pulse rate as an effect of dynamic exercise.
8. Study of blood pressure as an effect of dynamic exercise.
8. Determination of Galvanic skin response (GSR).
9. Determination of visual acuity.
10. Determination of visual field by the perimeter.
11. Brightness discrimination test

Paper: PHY 296

PHY 296.1: Studies with Cardiac Muscle F.M. = 25 Credits = 02

Course Outcome: To demonstrate the students the kymographic record on -induced changes in cardiac contractility and function to explain their nature of functions and the effect of agonist and antagonist drugs and electrolytes and other physical parameters on perfused amphibian heart.

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

PHY 296.2: Studies with Skeletal & Smooth Muscle and Bioassay

F.M. = 25 Credits = 02

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

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

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

3. Experiments on isolated intestine of rat:

   a) Normal movement of isolated intestine, b) Effect of hypoxia,

   c) Effect of drugs like substances: i) Acetylcholine ii) Adrenaline iii) 5, hydroxy-tryptamine.

4. Experiments on isolated uterus of rat: effects of drugs like Oxytocin.
5. Bioassay: Preparation of standard curves for acetylcholine through bioassay.
6. Estimation of nature and potency of unknown drug by using reference standard and blocker.
7. Bioassay of catecholamine.
8. Estimation of the potency of the unknown sample (Oxytocin) on rat uterus muscle by using reference standard.

Semester III

(Theory: 200 + Practical: 100)

Theory (Total Marks: 200, 16 Credits):

Paper: PHY 301:

PHY 301.1: Electrophysiology and Sensory System F.M. = 25 Credits = 02

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

Module I

Electrophysiology of heart, electrocardiogram (ECG), ECG lead configuration, source of ECG voltage - dipole theory, vector analysis of ECG , changes of ECG potential in different cardiac abnormalities- myocardial ischemia and infraction, hypertrophy, different types of arrhythmias; vectorcardiogram.

Module II

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

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

Module III

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

Module IV

The auditory system: Ultra-structure of cochlea, Organ of Corti, central auditory pathway, descending auditory pathway, the primary and secondary auditory cortical areas, resting and stimulus related potentials – endocochlear potential, cochlear microphone potential, summating

potential, auditory nerve potential sound transmission in auditory system; functions of auditory system – frequency analysis of sound by cochlea and central auditory pathway, intensity coding of auditory system, perception of sound in space.

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

PHY 301.2: Systems Physiology F.M. = 25 Credits = 02

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

Module I

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

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

Module II

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

Module III

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

Module IV

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

Paper: PHY-302

PHY 302.1: Microbes-Human Interaction F.M. = 25 Credits = 02

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

Module I

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

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

Module II

Growth and nutritional requirements of bacteria: growth curve, environmental influences on growth, nutritional requirements of bacteria, culture media, sterilization, identification of bacteria, recent laboratory innovations, counting of bacterial cells.

Study of some important genus of bacteria of medical importance: staphylococci, streptococci, clostridia, neisseria, mycobacteria, salmonella, vibrio, shigella.

Module III

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

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

Module IV

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

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

PHY 302.2: Human Immune System F.M. = 25 Credits = 02

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

Module I

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

Module II

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

Module III

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

Module IV

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

Paper: PHY 303 (Special Papers)

PHY 303 A: Microbiology and Immunology

PHY 303.1A: Advanced Studies in Microbiology F.M. = 25 Credits = 02

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

Module I

Microbial Ecology: microorganisms in nature, methods in microbial ecology, the carbon, nitrogen, sulphur and iron cycles, leaching of ore, bio-hydrometallurgy, heavy metal transformation, biodegradation of petroleum and xenobiotics, microbial interaction in nature: biofilm, bioremediation.

Module II

Host-microorganism interactions: host parasite relationship, normal microbial flora of humans, germ-free animals and its importance, transmission of microorganisms, infection, infection mechanisms, microbial pathogenecity and virulence, determining etiology and host factors.

Module III

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

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

Module IV

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

PHY 303.2A: Cellular and Molecular Immunology F.M. = 25 Credits = 02

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

Module I

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

structure, coreceptor-CD3, accessory membrane molecules-CD4 & CD8, T-cell development and maturation, immunological synapse, T-cell activation / signal transduction, the co-stimulatory signals.

Module II

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

Module III

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

Module IV

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

PHY 303 B: Ergonomics and Sports Physiology

PHY 303.1B: General Sports Physiology F.M. = 25 Credits = 02

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

Module I

Historical development of sports science- International and Indian context, role of neuromuscular system in exercise, mechanics of muscle contraction, relationship of different types of muscle fibers with different sports activities, fuel for exercising muscle: metabolism and hormonal control.

Muscle strength and endurance – their role in sports activities.

Bioenergetics of exercise- source and supply of energy for different types of sports.

Module II

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

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

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

Module III

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

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

Module IV

Endocrine system and exercise: importance of hormones in exercise and sports, endocrine effects on performance, pituitary- adrenocortical axis and stress theory, oxidative stress and its management, hormonal regulation of cellular hydration, endocrine regulation of plasma volume, exercise influence on the biological clock mechanism.

Immunological system and exercise: exercise and innate and humoral immunity, exercise induced change in Ig and antibody, exercise and cytokines.

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

PHY 303.2B: Applied Sports Physiology F.M. = 25 Credits = 02

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

Module I

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

Physical conditioning: importance, principle and methods of physical conditioning, aerobic and anaerobic training, adaptation to aerobic and anaerobic training, resistance training, strength, stability training, and high-intensity interval training (HIT), strength training, farklet training, periodization of conditioning program, over training.

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

Module II

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

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

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

Module III

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

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

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

Module IV

Exercise and sports biomechanics: basic concepts of kinematics and kinetics – vectors, motion, degrees of freedom, force, moment of force, equilibrium, biomechanical considerations in reducing sporting injury rates, joints and its movements.

Center of gravity and its importance in sports.

Posture: static and dynamic posture, posture assessment, desirable postures for high level sport performance, modifying posture and technique to improve performance.

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

PHY 303C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

PHY 303.1C: Advanced Studies in Biochemistry F.M. = 25 Credits = 02

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

Module-I

Biomembrane and Cell Biology: The molecular assembly and organization of biomembranes; Lipid-protein and protein-protein interactions; Role of cholesterol and fatty acid composition in membrane fluidity. Supramolecular membrane structure. Membrane permeability. Metabolite transport in normal and cancer cells. Membrane transport; Structure-function interplay of some typical membrane receptors like ASGP-R, LDL, Ferritin etc. Membrane biology of receptor-mediated endocytosis; clathrin-independent and -dependent endocytosis. Membrane asymmetry and its implications in health and disease.

Sub-Cellular organelles-structure and function. Cytoskeleton- Role in motility, intracellular transport, mitosis; Microtubular structure and dynamics. Extracellular Matrix- assembly; their role in integrating cells into tissues and cell-cell interactions. Cell cycles- Characteristics of each phase; Restriction point of cell cycle and Quiescent cells; CDK complexes in the transition of various check point of cell cycle; Role of ubiquitin-protein ligase –SCF and APC/C in the control of cell cycle. Cell differentiation and transformation. Cell and tissue culture-concepts and techniques; Clone and hybridization of mammalian cells and its application. Apoptosis and its mechanism.

Module-II

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

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

Module-III

Enzymology, Advanced Nutritional and Clinical biochemistry: Methods for isolation, purification and characterization of enzymes. Acid-base catalysis, covalent catalysis. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, DNA polymerase, aspartic proteases. Reversible covalent modification of glutamine synthase and phosphorylase and irreversible covalent modification of proteases. Allosteric behaviour of aspartate transcarbamoylase and phosphofructokinase. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthase complex. Isoenzymes of lactate dehydrogenase.

Antioxidant enzymes and their role. The mechanistic role of nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B12 in enzyme catalyzed reactions.
Molecular mechanism of vitamins, trace elements and minerals. Sucrose consumption and intolerance; lactose intolerance; Special role of the non-starch polysaccharides. Nutritive value of proteins and the methods for its determination; Amino acid imbalance. Nutritional aspects of the vitamins and minerals Protein calorie deficiency status.
Disorders of carbohydrate, amino acid and lipid metabolism, Disorders related to the nutrition- Protein energy malnutrition, Starvation, Obesity. Food borne diseases and their prevention, Porphyrins and Gout, Obesity, Diabetes Mellitus, and Atherosclerosis, Functional tests of kidney and liver.
Naturally occurring Anti-nutrients. Food borne toxicants- Protease inhibitors; Hemagglutinin; Oxalates, Phytates. Food allergens. Analytical techniques in nutritional biochemistry.

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

Module-IV

Analytical Biochemistry: Buffers and buffering mechanism; Dissociation of amino acids and determination of pKa. Chromatography. Molecular weight determination of macromolecules by gel filtration chromatography, gel electrophoresis and ultracentrifugation. HPLC and FPLC. Isotopic tracer techniques and autoradiography. Spectrophotometry. Principles of optical rotatory dispersion and circular dichroism and X-ray diffraction and their applications in structure determination. Principle and application of NMR spectroscopy in Biology. Differential and density gradient centrifugation; analytical ultra-centrifugation; Electron microscopy – Transmission and scanning. Freeze fracture techniques. Fluorography. Phosphor-imaging applications. FACS.AFM. Confocal Microscopy. Mass (MALDI and LC). Live cell microscopy. FRAP.
Developmental, Stem Cell and Cancer Biology: Gametogenesis (Meiosis, Oogenesis, Spermatogenesis); Morphogenesis- Cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation and cell migration. Molecular events of embryogenesis. Cell-cell communication and molecular signaling in development - Concepts of induction and competence, epithelial-mesenchymal interactions, role of FGF-RTK pathway, JAK-STAT, Hedgehog family, Wnt family, TGF-β superfamily, Notch pathway and developmental signals from extracellular matrix. Development of model organisms -Drosophila, Xenopus, Zebra fish, Chick, Mouse, *C. elegans*, Human.
Cultivation of stem cells; Adult stem cells; Cancer stem cells; Stem cell markers; Applications of stem cells. Carcinogenesis mechanism; Characteristics of cancerous cells; Genetics of cancer - Mutation and cancer; Viral and cellular oncogenes; Activation of oncogenes and dominant negative effect; Molecular nature of oncogenes; Oncogenes as transcriptional activators. Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Suppression of tumor suppressor genes. Apoptosis and oxidative stress in cancer. Immune mechanism of tumor cell killing. Immunodiagnostics (methods). Different Therapeutic approaches to cancer.

PHY 303.2C: Molecular Endocrinology and Reproductive Physiology

F.M. = 25 Credits = 02

Course Outcome: This special course encompasses a detail understanding of advanced endocrinology and reproductive physiology at cellular and molecular levels as well as about the disorders of endocrine system and reproduction.

Module-I

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

Module-II

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

Hormonal role in apoptosis and cancer: Hormonal aspect of apoptosis in physiological system including germ cell apoptosis, lymphoid apoptosis. Molecular endocrine tumor biology, multiple endocrine neoplasia, molecular pathogenesis in pancreatic and gut endocrine tumors, endocrine-responsive cancer, hormonal approach in the treatment of cancer.

Module-III

Molecular aspect of Sex Differentiation
Location of SRY-gene and its critical period of expression, specific cell type engaged in SRY-gene expression, downstream genes regulation by SRY - gene like AMH gene, aromatase gene. AR-gene, 5a-reductase gene, Sox-9 gene and Z-gene.
Gametogenesis and Gonadal Steroidogenesis: Spermatogenesis: cycle and its hormonal control, Folliculogenesis and hormonal control- endocrine and paracrine regulation, first and second meiotic arrest and its withdrawal mechanism for oocyte development, leuteinization and leuteolysis.
Autocrine, paracrine and endocrine regulation of gonadal steroidogenesis, regulation of expression of genes encoding steroidogenic enzymes
Assessment Makers for Reproductive system: Gonadal cholesterols, gonadal ascorbic acid, gonadal acid and alkaline phosphates activities, gonadal steroidogenic key enzymes activities, sperm motility

Module-IV

Stress and Reproduction: Stress and pituitary gonadotropin, stress and cytokines, oxidative stress and reproductive activities
Reproductive Immunology: in male and in female
Assisted Reproduction Technology (ART): Difference between infertility and sterility, infertility assessment in male and female, role of ART in infertility management, intrauterine insemination (IUI), intracytoplasmic sperm injection (ICSI), in vitro fertilization (IVF), super ovulation technique, subzonal insemination, gamete intra-fallopian transfer (GIFT), Oocyte and embryo culture, oocyte and pre-embryo classification, micro manipulation of human gametes, zygote and embryo.

PHY 303 D: Neurophysiology

PHY 303.1D: Physiology of Neuron and Evolution of Brain

F.M. = 25 Credits = 02

Course Outcome: The present section addresses the advanced physiology of nerve cell and the evolution of human brain and its development and mechanistic basis. It will provide idea on neuro modulation, brain plasticity and electrophysiological techniques for brain function study.

Module I

Neuroscience: past, present and future; history and development of neuroscience, perspective of neuroscience – scope boundaries and present trends.
Evolution of human brain and its development: phylogenetic development of nervous system from invertebrate to mammals.
Development of human brain: embryological development of human brain, genesis of cerebral cortex.

Module II

Neuron: morphological and organization of neuron, axonal transport, myelin and myelinogenesis, evolution of human brain.
Neuroglial cells: type, structure and physiological properties of neuroglial cell membranes, function of neuroglial cells, effect of neuronal activity of glial cells.
Excitation and electrical properties of nerve fibers: origin of membrane potential, electronic potential, action potential- voltage clamp and patch clamp analysis, voltage gated channels, conduction of impulses.

Module III

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

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

Module IV

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

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

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

PHY 303.2D: Development of Brain and Molecular Neurobiology

F.M. = 25 Credits = 02

Course Outcome: The present unit will give an understanding on sensory transduction by different neuro-receptors, genetics and epigenetics of brain as well as autonomic nervous system with its abnomality and molecular neurobiology techniques to study neuronal system.

Module I

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

Module II

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

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

Module III

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

Circulation of brain and Blood brain barrier.

Module IV

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

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

PHY 303E: Biophysics and Electrophysiology with Structural Biology

PHY 303.1E: Biophysical Principles and Advanced Methods in Biology

F.M. = 25 Credits = 02

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

Module I

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

Structure & Bonding: Quantum mechanics: Pauli Exclusion Principle, Ionization energy, electron affinity and chemical binding, Electronegativity and strong bonds, secondary bonds. The electronics structure of atoms, Molecular orbital and Covalent bonds. Molecular interaction: strong and weak interactions. Stereochemistry and Chirality.

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

Module II

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

Kinetics of Molecules & Reactions: 0th, 1st,2nd & 3rd order reactions, Diffusion, Osmosis, Osmotic pressure, osmoregulation, surface tension: Definition, angle of contact, interfacial tension, capillary rise, determination of surface tension, temperature effect, dialysis, adsorption, viscosity: Determination of viscosity coefficient of liquids, diffusion of gases and solute in solution, Fick's law, viscometric measurement, Viscometers- Ostwald capillary, Ubbelonde capillary, Measurement of Viscoelasticity.

Module III

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

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

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

Module IV

Molecular Biophysics: Unusual amino acids, peptides, polypeptides, structural levels of proteins & stabilizing forces, conformational properties of polypeptides, Ramchandran plot, Helical parameters & conformation, organization & interaction angles. Binding small molecule by polymer, identical and independent site model, cooperative binding, anti-cooperative binding and excluded site binding. The random walk, Helix coil transition in protein. Compositions of nucleic acid, Chargaff's rule in DNA, RNA base compositions, Covalent chain structure, secondary structure inferences from RNA sequence comparisons.

Redox potential : Oxidation–Reduction , Equivalence of electrical & chemical energy, Electrochemical cell, contact potentials, galvanic cell, potential of half-cell, redox potentials & its calculations by Nernst equation, standard electrode potentials & its determination , its relationship with e.m.f.

PHY 303.2E: Advanced Cellular and Membrane Biophysics

F.M. = 25 Credits = 02

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

Module I

Physics of hydrodynamics: Molecular structure, Association of water through H- bonding, Nature of hydrophobic interactions, physicochemical properties of water, State of water in bio-structures & its significance, Water as a Liquid and Solvent: Water Structure, Small-Molecule Solutes: Hydrophiles, Small-Molecule Solutes: Hydrophobes, Large Hydrophobic Solutes and Surfaces. The Influence of Ions: Structure-Making and Structure-Breaking, Long-Range Hydrophobic Interactions and the Role of Bubbles, Hydrophilic Surfaces, Aqueous Environment of the Cell.

Bioenergetics, electron transport chain & oxidative phosphorylation: Energy requirements in cell metabolism, role and structure of mitochondria, high energy phosphate bond. Reduction potentials and free energy changes in redox reaction, organization of electron transport chain, chemiosmosis coupling, proton gradient drive and synthesis of ATP, P/O ratio for oxidative phosphorylation, Cytosolic NADH electron feeding into electron transfer.

Module II

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

Membrane transport: Transport system with non-electrolytes and electrolytes. Active Transport: Nature, Selective permeability of bio-membrane, Selectivity & ion specificity of bio-membrane, Ion channel structure and gating function, Ion channel types and characterization, Role of carriers in ion transport (ex: -Valinomycin & gramicidin), Transporting ATPase-Na-K ATPase, Calcium ion transporting ATPase of sarcoplasmic reticulum. Transport by phosphotransferase system, Transport by vesicle formation**.** Transport and communication between cells and organelles: mechanisms of micro- and nano-vesiculation, influence of electrical properties of membranes and solvents on the vesiculation of membranes, endocytosis, exocytosis, fusion of vesicles, encapsulation of nano-particles and DNA.

Membrane potentials & lipid membrane technology: Nature & magnitude of cell surface charge, Electric properties of membranes: electric double layer, Poisson-Boltzmann theory of electric double layer, Gouy-Chapman model of electric double layer, free energy of electric double layer. Cell surface charge, Resting membrane potential, Action potential, properties of action potential, Hodgkin-Huxely equation, Helmholtz-Smoluchowski equation; it's correction by Debye-Huckle theory. Membrane impedance and capacitance, Transmembrane potential, Zeta, stern and total electrochemical potential. Liposomes: small and large unilamellar and multilamellar vesicles, planner lipid bilayer. Applications of liposome in biology and medicine.

Module III

Cellular biophysics: Cell growth and Division: Cell cycle, events in cell cycle – G1, S1, G2 phase, Control of cell cycle, Cell division, Cell transportation and malignant tumor growth. Cell aging and death. Cell differentiation: Primary and secondary induction, Differentiation of cultured cells, Cellular apoptosis. Cell recognition: Cell adhesion, cell signaling, Heat Shock Proteins, G-Protein structure and role in signalling, Intracellular Cyclic AMP, Role Ca^{+2} in cell signalling, CAM Kinases, (Calmodulin/Ca^{+2} dependent protein kinases), Interaction between cyclic AMP & Ca^{+2}.

Module IV

Basic principles of chemical kinetics: Arrhenious equation, Activation energy & its estimation, Collision & transition state theories of reaction rate, Catalysts, Mode of action of catalysts. Kinetics of single substrate reaction, Michaelies equation, steady state kinetics, transient phases of enzyme reactions, Lineweaver-Burk, Eddie-Hofstee plot, Woolf plot.

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

Paper: C- PHY-304 (CBCS)

PHY 304.1: Environment and Health F.M. = 25 Credits = 02

Course Outcome: This unit will help to acquire knowledge in the area of environmental health, including climate change and effects, different environmental pollutants and their toxicity, epidemiological perspectives of environmental health and environmental management policies.

Module I

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

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

Module II

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

Module III

Perspectives and interventions in public health: epidemiological perspectives of environmental health - disease burden and surveillance, alternative systems of medicine, universal immunization programme (uip), occupational health hazards; occupational diseases -

prevention and control; assessment of health risks associated with exposures to environmental hazards.

Module IV

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

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

C-PHY 304.2: Human Reproductive Health and Related Issues

F.M. = 25 Credits = 02

Course Outcome: This unit will enlighten the idea about male and female reproductive physiology including adolescent and maternal health and different related disorders.

Module I

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

Module II

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

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

Module III

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

STIs/RTIs and HIV/AIDS - diagnosis, treatment, prevention: Concept of RTI, STI, causes and precautions in RTI and STI, Impact of RTI & STI on women; problems of RTI and STI suffering women, HIV/AIDS, transmission of HIV/AIDS, HIV/AIDS counselling, HIV/AIDS

suffering adolescent, role of national and international organizations, role of governmental and non-governmental organizations.

Module IV:

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

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

Practical (Total Marks: 100, 08 Credits):

Paper: PHY395

PHY 395.1: Histological and Cytological Techniques F.M. = 25 Credits = 02

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

Histological experiments: fixation, dehydration, embedding and preparation of sections (paraffin, collodion or cold): micrometry, photometry; staining.

1. **Staining of smear for cytological evaluation**: papanicolaou staining, cresyl violet staining.
2. **Study of estrous cycle by different staining techniques**: special and differential staining.
3. **Vital and supravital staining**: platelet count, erythrocyte count, must cell.
5. **Histipathology:** effect of toxicity on the different organ histology.

PHY 395.2: Histochemical and Histometric Techniques

F.M. = 25 Credits = 02

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

1. **Histochemistry of carbohydrates:**

a. Detection of glycogen in liver by Best Carmine method

b. Detection of glycogen using PAS method of Hotchkkin.

c. Detection of glycogen using Lugol's iodine test

2. Histochemistry of proteins:

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

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

c. Histochemistry of liplds.

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

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

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

4. Histochemistry of nucleic acids:

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

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

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

5. Histochemistry of enzymes:

a. Detection of alkaline phosphatase.

b. Detection of ATPase.

c. Detection of cholinesterase.

6. Histometry (demonstration):

a. Measurement of testicular Leydig cells.

b. Measurement of liver cells

c. Measurement of thyroid follicular cells etc.

7. Histopathology:

Effect of toxicity on the different organ histology

8. Immunohistochemistry (demonstration)

Paper: PHY-396 (Practical Special Papers)

PHY 396A: Microbiology and Immunology

PHY 396.1A: Microbiological Techniques F.M. = 25 Credits = 02

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

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

PHY 396.2A: Experimental Immunology Practical F.M. = 25 Credits = 02

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

1. **Separation of different types of blood cells by Histopaque (gradients)**, identification of (a) B-cells by rosetting (b) T-cells by rosetting (c) Macrophages, isolations of macrophages, B-cells, T-cells, polymorphonuclear cells
2. Isolation and culture of peritoneal cells from experimental animal
3. Preparation of antigen and development of antibody: Development of antibody in rabbits by injecting complete-incomplete Freund's adjuvant with BSA, Ouchterlony Double Diffusion

(ODD), Single Radial Immune Diffusion (SRID), agglutination test, Haemolytic Plaque Assay.

4. Subcellular fractionation (a) mitochondria, nuclei etc. (b) centrifugation - differential and density gradient (sucrose, percoll, CsCl).
5. Endonuclease digestion of nuclei and analysis of DNA by Agarose Gel Electrophoresis, thermal melting of DNA.
6. Isolation of plasmid DNA: mini preparation, large-scale isolation.
7. Glassware decontamination, washing-sterilization, packing and sterile handling for animal cell tissue culture.
8. Media and reagent preparation, sterility checks, CO_2 incubator.
9. Maintenance of cell cultures.
10. Preparation of primary cell cultures (CEC).
11. Peripheral blood lymphocytes culture, demonstration of other tissue culture experiments.
12. Chick embryo fibroblast primary cell cultures and mouse choronic villus cells.
13. Induced ovulation in mouse, collection of oviducal eggs and in-vitro fertilization, culture in-vitro of mouse embryos to the blastocyst state.
14. Transferring foreign gene (e.g. chicken globin gene) into mouse fertilized eggs and transplantation to foster mother.
15. Microinjection or electroporation of ES cells with foreign DNA and transplantation to foster mother.

PHY 396B: Ergonomics and Sports Physiology

PHY 396.1B: Experiments on Work and Sports Physiology - I

F.M. = 25 Credits = 02

Course Outcome: The course will provide support to develop the practical skill for measuring different physiological parameters related to the physical efficiency of sports persons and the learners will be able to assess the level of physical fitness of a person for general and specific sports event.

1. Measurements of heart rate at rest and different working conditions.
2. Classification of workload, continuous recording of heart rate by heart rate monitor.
3. Determination of maximal heart rate, cardiac cost and cardiac efficiency by step test method, bicycle ergometer and treadmill.
4. Determination of steady state.
5. Determination of endurance time.
6. Measurement of body temperature, (oral, axial, skin) at rest and different working condition.

7. Recording and interpretation of ECG at rest and working condition, effects of posture on ECG.
8. Recording and interpretation of EMG at rest and working condition.
9. Determination of pulmonary ventilation, static and dynamic lung function tests.
10. Static and dynamic balance test.

PHY 396.2B: Experiments on Work and Sports Physiology - II

F.M. = 25 Credits = 02

Course Outcome: This course will help the students to evaluate the performance of sports persons by means of biochemical, physiological and biomechnical parameters. This training will enhance the employability of the students in the sports field.

1. Determination of VO_2 max by direct method; determination of VO_2 max by indirect method : Queen's college test, 12 min-run test, non-exercise test, Astrand rhyming nomogram method
2. Determination of lactic acid and pyruvic acid in blood before and after exercise.
3. Determination of Haemoglobin level before and after exercise.
4. Anaerobic power test (modified Margaria method).
5. Measurement of flexibility, agility, power and maximal work capacity.
6. Measurement of reaction time (hand, foot) and movement time, determination of simple and choice reaction time.
7. Measurement of blood pressure, sweat rate during exercise.
8. Determination of muscle strength by dynamometer - hand grip strength, pinch strength, leg and back strength.
9. Measurements of body fat in human by (a) skinfold method , (b) anthropometric method densitometric method, determination of body composition.
10. Determination of somatotypes.
11. Gait analysis.

PHY 396C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

PHY 396.1C: Biochemical Techniques F.M. = 25 Credits = 02

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

Methods of Protein Estimation:

1) Folin-Lowry's Method

2) Bradford Method

3) Ultraviolet Absorbance Method

Determination of Albumin-Globulin ratio.

B. Studies on General Enzymology

1) Effects of pH and temperature 2) Determination of Q_{10}

3) Effects of substrate concentration, 4) Determination of Km, Vmax ,5) Determination of Vmax

C. Studies on Clinical Enzymology

1) Determination of SGOT and SGPT.

2) Determination of serum ALP

3) Determination serum creatine phosphokinase

D. Microscopy

1) Fluorescence and phase contrast microscopy.

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

3) DNA damage by Gel electrophoresis

PHY 396.2C: Experiments on Endocrinology and Reproductive Physiology of Animals Model

F.M. = 25 Credits = 02

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

A. Experiments on Model Animals

1. Study of drugs (elicit hypo and hyper condition) on functional activities of thyroid, testis and ovary
2. Experiments on thyroidectomy, adrenalectomy on gonadal functions- cholesterol, acid and alkaline phosphatase, ascorbic acid in gonads.
3. Study of experimental diabetes induced by alloxan, streptozotocin in experimental model animals - Assay of SGOT, SGPT, amylase, and glycogen, Glucose-6-phosphate dehydrogenase, bloodsugar.
4. Experiment on thymectomy - T lymphocyte and macrophage isolation.

B. Experiment on male reproduction

1. Study of the effect of cryptorchydism on markers of male reproduction.
2. Study of sperm count, sperm motility, sperm morphology, sperm viability, Hypo-osmotic swelling, and effect of someanti-fertility drugs.
3. Study of castration (unilateral) on cholesterol in intact testis- acid and alkaline phosphatase activities in accessory sex glands.

4. Assay of the activities of oxidative stress sensitive enzymes and free radicals quantification in male sex glands.
5. Quantitative study of spermatogenesis measurement of semniferous tubular diameter and Leydig cell nuclear area.

PHY 396D: Neurophysiology

PHY 396.1 D: Experiments on Neurophysiology - I F.M. = 25 Credits = 02

Course Outcome: In the present section students will get a hands on training and will be able to identify different regions of a dissected human brain. This section will also enable students to be acquainted with different methods like stereotaxic technique and experimental animal preparation.

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

PHY 396.2D: Experiments on Neurophysiology - II

F.M. = 25 Credits = 02

Course Outcome: Students will be get hands on training and study the effect of electrical stimulation of different portions of the brain, highlights different behavioral along with studies on chemical stimulation of brain. The unit will provide experiments on experimental recording of EEG, EOG and sensory evoked potential in rats and experiments on locomotor activities.

1. Experimental electrical stimulation in animals (rat/cat): Study of electrical stimulation of different portion of brain, by electrical stimulation and observation of changes in muscle

tone, behaviour, heart rate, respiration, blood pressure, evaluation of electrolytic lesion.

2. Experimental chemical stimulation of brain: Microinjection of acetyl choline, epinephrine, nor- epinephrine, serotonin, histamine, kainic acid in different regions of brain and cerebral ventricles and study of changes in physiological parameters.

3. EEG and ECoG in experimental animals: recording of spontaneous electrical activity of surface and deeper parts of brain of experimental animals in acute and chronic condition. effect of stimulant and depressive drugs on ECoG.

4. Evoked potential study in experimental animals , recording of auditory and visual evoked potential in rats.

5. Study of experimental epilepsy rat.

6. Behavioural study in experimental animals:

   a. Exploratory behaviour in open field.

   b. Exploratory behaviour in hole board

   c. Light dark transition test.

   d. Active social interaction test.

   e. Pento barbital sleeping time.

   f. Maze tests.

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

8. Study of neuroendocrine functions:

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

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

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

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

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

PHY 396E: Biophysics and Electrophysiology with Structural Biology

PHY 396.1E: Advanced Methods in Biophysics F.M. = 25 Credits = 02

Course Outcome: Throughout this practical students try to learn the process of different biochemical estimation, knowledge of acidic and basic solution. Knowledge of different separation techniques help the students for the application and development of drugs and medicine.

1. Acid – Base titration using pH meter and Determine the pK values: - Strong acid Vs Strong base, Weak acid Vs Strong base, Mixture of Strong and Weak acid Vs Strong base.
2. To determine the titration curve of protein and amino acids & calculate the pKa values
3. Estimation of Protein by Lowery/Biuret/ Bradford methods

4. To isolate the Proteins- Casein from milk, Hb from RBC.
5. Separation techniques: Electrokinetics methods: electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, Polyacryl amide Gel Electrophoresis (PAGE), SDS PAGE, Capillary, Iso-Electric focusing, applications in biology and medicine.
6. To estimate quantitatively the Amino acids using the ninhydrin reaction.
7. Protein tryptophan fluorescent measurement.
8. Effect of hypertonic/ hypotonic/isotonic on RBC membrane.
9. Osmolarity: Determination of osmotic pressure of salts
10. To study of conformational changes in biomolecules using Ostwald viscometer. Measurement of viscosity of biological and non-biological samples.
11. Refractometry: study of sugars/proteins/amino acids
12. Study of UV absorption spectra of Proteins and nucleic acids.
13. To verify the Lambert Beer's law and Fick's law.
14. Measurement of viscosity of biological and non-biological samples.
15. To study the protein-ligand interactions by Scatchard plot.

PHY 396.2E: Advanced Cell and Membrane Biophysics

F.M. = 25 Credits = 02

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

1. Pressure-flow relationship in rigid system and biological system with different drug activities.
2. To study of membrane potential using fluorescence spectroscopy
3. To observe the stained & unstained Prokaryotes & Eukaryotes
4. To characterize the subcellular fractions and Preparation of Liposome
5. To demonstrate the cell fusion using high DC (Direct current) field.
6. To study the characteristics of different catalytic reactions (Nuecleophilic, Electrophilic & Acid-Base).
7. To study the effect of temperature, pH, metal ions on enzyme activity & kinetics
8. To isolate and purify the enzymes- isolation of muraminidase from egg white
9. To study the histochemical localization of Alkaline & Acid Phosphatase, Glycogen & Lipids in the tissue.
10. To study the Permeability of model membrane (Liposome) anions.
11. To study the effect of cholesterol on the anion permeability of a Phospholipid membrane.
12. To measure the Membrane potential using Fluorescence techniques.
13. To study the phase transition in lipid bilayer membrane.
14. Enzyme Assays (LKH, beta galacotsidase, acid phophotase, arginase, Succinic De – hydrogenase): Time, Temp, Protein concentration, cofactors. LKH: Km & Vmax

Semester IV

(Theory: 150 + Practical: 150)

Theory (Total Marks: 150, 12 Credits):

Paper: PHY 401

PHY 401.1: Endocrinology F.M. = 25 Credits = 02

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

Module I

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

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

Module II

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

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

Module III

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

In vivo action of corticoids and catecholamines: roles in metabolic, vascular, physical and emotional stress , anti-inflammatory role; mineralocorticoids in sodium and potassium

metabolism, general idea about cushing syndrome, pheochromocytoma – diagnosis and management.

Module IV

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

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

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

PHY 401.2: Reproductive Physiology F.M. = 25 Credits = 02

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

Module I

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

Module II

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

Module III

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

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

Module IV

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

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

Paper: PHY 402

PHY 402.1: Cell and Inheritance Biology F.M. = 25 Credits = 02

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

Module I

Cells: Evoloution of cells, basic properties and classification.

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

Module II

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

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

Module III

Cell signaling and signal transduction: Basic ideas about cell signaling, extracellular messengers and their receptors, G protein–coupled receptors and their second messengers, calcium as intracellular messenger, protein-tyrosine phosphorylation, interrelationship among

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

Module IV

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

PHY 402.2: Biotechnology F.M. = 25 Credits = 02

Course Outcome: To develop in-depth knowledge about basic principles, tools and techniques employed in biotechnology. Also the target is conceptual developments regarding major achievements in biotechnology.

Module I

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

Module II

Genetic engineering and biotechnology: restriction endonucleases, recombinant dna technology; transformation, transfection, microinjection and shot gun method; genetic mapping; transposons and their uses in genetic manipulation, site directed mutagenesis; genomic library, c-DNA cloning. transgenic animal, gene targeting, mobile genetic element, general recombination, restriction mapping; RFLP, RAPD, AFLP techniques.

Module III

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

Module IV

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

Paper: PHY 403 (Special Papers)

PHY 403A: Microbiology and Immunology

PHY 403.1A: Microbial Genetics: Advanced Studies

F.M. = 25 Credits = 02

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

Module I

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

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

Module II

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

Module III

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

Module IV

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

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

PHY 403.2A: Clinical Immunology F.M. = 25 Credits = 02

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

Module I

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

Module II

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

Module III

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

Module IV

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

PHY 403B: Ergonomics and Sports Physiology

PHY 403.1B: General Ergonomics F.M. = 25 Credits = 02

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

Module I

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

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

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

Ergonomics standards: ISO standard, OSHA standard.

Module II

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

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

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

Module III

Environmental ergonomics: illumination- effect of illumination on visual performance, factors related to illumination and visual performance, standards of illumination for working and living aspects: other aspects of visual environment, glare, flicker, colour etc, principles of lighting in VDT work station. Illumination and reading performance

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

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

Module IV

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

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

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

PHY 403.2B: Applied Ergonomics F.M. = 25 Credits = 02

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

Module I

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

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

Module II

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

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

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

Module III

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

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

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

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

Module IV

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

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

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

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

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

PHY 403C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

PHY 403.1C: Advanced and Applied Biochemistry F.M. = 25 Credits = 02

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

Module-I

Molecular Biology, Genetics and Population Biology: Regulation of DNA Replication in prokaryote and eukaryotic systems. DNA synthesis in vitro. Mechanism of replication in bacteria and viruses, Reverse transcriptase, Mitochondrial DNA replication. DNA Repair. RNA synthesis-The enzymes of transcription in prokaryotes and eukaryotes, mechanism of transcription in bacteria, post transcriptional processing of RNA, role of ribozymes. Translation-Translation in prokaryotes and eukaryotes; post translational processing of proteins. Regulation of gene expression in prokaryotes, structure and mechanism of different operons. Gene Silencing-Mechanism of action of RNAi and micro-RNA. Recent advances and applications of gene silencing.

Mendelism. Non Mendelian inheritance. Sex linked inheritance. Gene Mapping. Chromosomal anomalies. Mutation. Human cytogenetics-Karyotyping; chromosomal banding; Genetic diseases. Genomics-functional and structural genomics; Concept of physical, cytological and genetic map; Chromosome walking; Chromosome jumping; Brief outline of human genome project, Epigenomics. Genetic analysis in microbes- mechanisms of DNA transfer; Mapping by recombination; Genetic map of *E. coli*.

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

Module-II

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

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

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

Module-III

Proteomics, genomics and metabolomics: Concept of Proteomics. Purification, separation and identification of proteins. Protein identification by 2D gel electrophoresis, mass spectrometry, MALDI TOF (peptide mass fingerprinting), Protein microarrays, proximity ligation. Peptide sequence analysis by tandem mass spectrometry. Applications of proteomics.
Concept of genomics. Genome annotation- Methods for annotating genomes, characterizing functional genes, Gene Expression, Comparative Genomics, Population Genomics. DNA microarray and its application in disease investigation. Micro/si RNA technology and applications in studying gene functions.
Introduction to metabolomics world.Metabolite identification, pathway identification and pathway integration.Application of metabolomics.
Biotechnology and nano-biology: Concepts of Biotechnology. Recombinant DNA technology. Restriction mapping- Restriction fragment length polymorphism (RFLP).Genomic and cDNA library. Analysis of genomic DNA by Southern hybridization.
Gene knock out; gene therapy. Transgenic animal. Site directed mutagenesis. Gene targeting. DNA finger printing. Dot-blot; Nucleic acid sequencing; Polymerase chain reaction. RT-PCR, nested PCR, FISH, GISH, microarray technology.

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

Module-IV

Biochemistry of xenobiotic toxicity
Biochemical basis of detoxification-phase I and phase II reactions and their interrelationships. Inducers and inhibitors of microsomal metabolic transformation. Extra microsomal enzymes and their role in detoxification. Effect of toxicants on structure, biosynthesis and catabolism of proteins, lipids, carbohydrates and nucleic acids, Mutation tests. Toxicological evaluation of recombinant DNA-derived proteins. Cytotoxicity, methods to test toxico gens. Metal toxicity– Arsenic and lead. Nonmetal–oxygen and ozone.
Applied and industrial biochemistry
Biochemical effects of food, toxins, edible oils and environmental pollutants on human health.

Application of enzymes in industry, diagnostics and medicine, agriculture, research; Immobilized enzymes immobilization of enzymes by chemical and physical methods; its application in industry.Large scale production of enzymes, enzyme reactors.

PHY 403.2C: Applied Molecular Endocrinology and Reproductive Physiology

F.M. = 25 Credits = 02

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

Module I

Hormonal basics of hypertension: Hypertension and its classification, hormones involved in hypertension with special reference to role of aldosterone, physiological disorders in endocrine system related to hypertension, management of hypertension.

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

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

Module II

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

Alcohol addiction: Physiological **e**ffect and management of alcohol addiction,

Aging: Effects of aging endocrine and reproductive system.

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

Module III

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

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

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

Module IV

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

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

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

PHY 403D: Neurophysiology

PHY 403.1D: Neurophysiology of Brain F.M. = 25 Credits = 02

Course Outcome: The present unit provide knowledge about the mechanism of sensory coding, transduction and adaptation of olfaction and gustation. It will provide understanding about the role of basal ganglia and cerebellum in regulation of motor movements and regulation of posture and cellular and molecular mechanism of learning, conditioning and memory as well as the mechanism of sleep and the emotional processing by limbic systems.

Module I

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

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

Module II

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

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

Module III

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

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

Module IV

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

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

PHY 403.2D: Applied and Clinical Neurophysiology

F.M. = 25 Credits = 02

Course Outcome: This section highlights the fundamentals of cognitive development, plasticity of brain, neuro-immunology and regulation of biorhythms. The students will also come to know about age related dysfunctions of brain and different updated techniques for neurobiology.

Module I

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

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

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

Module II

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

Neural regulation of biorhythm: characteristics of circadian clock- free running clock, entrainment, Zeitgebars, phase relation to zeitgebers; Biorhythm: sleep- wake cycle, feeding, thermoregulation, endocrine and reproductive rhythms, neural basis of circadian rhythmicity -

pacemakers, suprachiasmatic nucleus, alteration in environmental times- jet lag, shift work.

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

Module III

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

Neurobiology of drug abuse: long term effects of drug of abuse on CNS; tolerance, dependence and withdrawal.

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

Module IV

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

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

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

PHY 403E: Biophysics and Electrophysiology with Structural Biology

PHY 403.1E: Electrophysiology of Cells and Radiation Biophysics

F.M. = 25 Credits = 02

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

Module I

Mathematical methods and their applications in biological systems: Ordinary differential equations of the first degree and first order (variable separable method, linear equation of Bernoullis), linear differential equations of the second order with constant coefficients. Vectors: Vector algebra, coordinate systems, Basic vectors and components, Scalar and vector multiplications, Reciprocal vectors, coordinate transformations.

Basic biomechanics: General concept and biological application of biomechanics, Kinematic concepts of analysing human motion, the biomechanics of human muscle, spine, bone growth and development. Modelling and Remodelling of bones (Wolfe's law of bone remodelling). Analyse the forces at a skeletal joint for various static and dynamic human activities. Calculate

the energy expenditure and power required to perform an activity. Lever system of human architecture.

Module II

Advanced electrophysiology: Different electrical signals in human body. Receptor potential-general transduction mechanism, stimulus–receptor relationship, adaptation of receptors. Modern techniques in voltage clamp, current clamp, patch clamp and Single fibre. Computational electrophysiology. Bioelectric recognition Assay (BERA). Skin contact impedance of Electrodes. Biological Transducers and Measurement of Physiological event, Transducers: properties, principle and biomedical application of Transducers.

Electrophysiology of heart, brain & muscle: Electrocardiogram (ECG), source of ECG voltage – dipole theory, vector analysis of ECG , changes of ECG potential in different cardiac abnormalities myocardial ischemia and infraction, hypertrophy, different types of arrhythmias; Brain Potentials, Electroencephalogram (EEG), source and mechanism of formation of rhythmic pattern of EEG, characteristics of EEG waves. EEG pattern changes in sleep. Abnormalities of EEG. Electromyogram (EMG) – Motor unit potential, physiological significance and analysis of EMG.

Advanced electrophysiology of sensory system: Photoreceptor potential – genesis of potential in light and dark phase, recording of potential. Molecular mechanism of photo transduction process. Electroretinogram (ERG) – characteristics, physiological and clinical significance. Molecular mechanism of cochlear stimulus related potentials and its transduction. Olfactory receptor potential – characteristics and molecular mechanism of transduction. Ultrastructure taste receptors – taste receptor potential – molecular mechanism of transduction.

Module III

Advanced radiation physics : Introduction, Classification of radiation – ionizing and non-ionizing, Nuclearstructure, Nuclear reactions, Radioactivity, Modes of radioactive decay-alpha decay, beta decay, gamma decay, Activation of nuclides, Accelerators, Cyclotron, LINAC, reactors. Cathode Ray Oscilloscope (CRO) and its use in biology. Photon interactions, types of indirectly ionizing radiation, Photon beam attenuation, HVT & TVT, Types of photon interaction, Photoelectric effect, Coherent scattering, Electron interactions: Electron-orbital electron interactions, Electron-nucleus interactions.

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

Radiation protection & radiotherapy: Principles of radiation protection – time, distance, shielding, quantities and units used in radiation protection, physical quantities, radiation protection quantities, organ dose, equivalent dose, effective dose, committed dose, collective dose, justification of medical exposure, optimization of exposure and protection, dose limits, ALARA, ICRP and AERB regulations. Radiotherapy: principles, dosage data for clinical

applications, Gamma Camera, Positron Emission Tomography (PET), Single Photon Emission Tomography (SPECT), Cobalt-60 machine, Therapeutic application of radio isotopes, application of UV radiation for treatments, biological effects of radiation and ultrasound, different telemetry systems, telemedicine applications, concepts, telemedicine technology

Module IV

Fundamentals of biomedical microscopic imaging: Specialized microscopy techniques- differential interference contrast (DIC), time lapse fluorescence, and fluorescence resonance energy transfer (FRET), labeling biomolecules for fluorescence microscopy, atomic force microscopy (AFM).

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

PHY 403.2E: Photophysics and Experimental Methods in Structure Elucidation

F.M. = 25 Credits = 02

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

Module I

Physicochemical fractionation & electro-analytical techniques: **Chromatography**-Basic Concepts of Adsorption & Partition Chromatography, Principle, Experimental set-up, Methodology & Applications of all types of Adsorption & Partition Chromatography methods- chromatography using paper, thin layer, HPTLC column (gel filtration, ion exchange, affinity), gas (GC,GLC) and HPLC: types of HPLC**,** Mobile phase elution , normal phase and reverse-phase HPLC, column packing material, efficiency of column ,types of HPLC – principles of methodologies ; HPLC pumps -efficiency and suitability, Different injectors and Detectors; Ion Chromatography.

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

Module II

Photophysics & photochemistry: Nature and measurement of light, Light sources, Physical properties of excited molecules; Photophysical processes, fluorescence, Photophosphorescence, Action spectra, Optical activity, Basic principles and laws of photochemistry, Quantum

photochemical principles, Photochemical primary processes, Types of photochemical reaction, Photochemistry of amino acids and proteins, Photochemistry of DNA & RNA and its constitutes, Recovery from photochemical damage, Chemiluminisence.

Photo-medicine: Optical properties of skin, Acute and chronic effect of sunlight on skin, Photosensitivity, Phototoxicity, Photo allergy and clinical implication, Beneficial effects of sun and artificial light energy, Photoprotection, Photoimmunology. Mediphotonics: Lasers in dermatology and cell biology, Application of ultra-fast pulsed lasers in medicine and biology, Fibre optics in medicine.

Module III

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

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

Crystallography: Crystals, molecular crystal symmetry, miller indices, reciprocal lattice, Scattering factor, structure factor expression, reciprocal lattice, Ewald's sphere, Ewalds construction, electron density equation, phase problem, Patterson function, molecular replacement method, Crystallization of proteins, structure factors of Centro-symmetric and non-Centro symmetric crystals. Application in Biomolecular structural studies.

Module IV

Non-ionizing radiation physics: Different sources of non ionizing radiation-their physical; properties, various types of optical radiations-UV, visible & IR sources, Lasers-theory and mechanism, optical properties of tissues, theory and experimental techniques, interaction of laser radiation with tissues, photothermal, photochemical, photo ablation electromechanical effect, radiofrequency microwave radiation, production and properties, interaction mechanism of rf and microwaves with biological systems, thermal and non-thermal effects on whole body, lens and cardiovascular systems, tissue characterization and hyperthermia and other applications. Biomagnetism: effects, applications. Electrical impedance and biological impedance, principle and theory of thermography, applications in biology & medicine.

Practical (Total Marks: 150, 12 Credits):

Paper: PHY 494

PHY 494.1: Advanced Physiological Studies – I F.M. = 25 Credits = 02

Course Outcome: The students will get hands on advanced training on different parameters of electrophysiology , physical efficiency and neuro-physiological parameters

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

PHY: 494.2 Advanced Physiological Studies – II F.M. = 25 Credits = 02

Course Outcome: Students from different specializations will get hand-on trainings on certain specialized advanced techniques in Microbiology, Immunology, Biochemistry and Endocrinology.

1. Identification of urease activity for supplied bacteria.
2. Identification of catalase activity for supplied bacteria.
3. Amplification of a target DNA by polymerase chain reaction and identification of amplified DNA by agarose gel electrophoresis.
4. Tissue processing and staining by automatic tissue processor and stainner.
5. Determination of Abs by Ouchterlony double diffusion test. (Demonstration).
6. Delayed type of hypersensitivity response (DTH) (Demonstration).
7. Study of the effect of cryptorchidism on testicular and adrenal cholesterol.
8. Study of estrous cycle after administration of synthetic estrogen or hCG.
9. Measurement of hormone by ELISA techniques.

10. Determination of acid phosphatase activity in the supplied tissue sample.
11. To study bioluminescence of live fire flies by correlating light intensity with time.
12. To isolate cellular fraction by centrifugation methods.
13. To determine the molecular weight of biomolecules using ultracentrifuge

Paper: PHY 495 (Special Papers):

PHY 495A: Microbiology and Immunology

PHY 495.1A: Advanced Techniques in Microbiology F.M. = 25 Credits = 02

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

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

(demonstration).

14. DNA, RNA and Protein Sequencing (Demonstration).

PHY 495.2A: Clinical Immunology F.M. = 25 Credits = 02

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

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

PHY 495B: Ergonomics and Sports Physiology

PHY 495.1B: Experiments on General Ergonomics and Environmental Ergonomics

F.M. = 25 Credits = 02

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

1. Evaluation of occupational stress- development of questionnaire, quantitative evaluation technique, pain mapping.
2. Measurement of different heat stress indices: WBGT, ET, CET, P_4SR; measurement of relative humidity.
3. Determination of hearing loss of different groups of workers by audiometric method.
4. Measurement of illumination level by lux meter in different working areas.
5. Measurements of noise level in different working stations.
6. Measurement of vibration level.
7. Determination of environmental conditions surrounding the workers determination of concentration of dust and particulates in air.

8. Product analysis - Pair comparison test.
9. Determination of center of gravity of human body under resting and working conditions.
10. Biochemical study of work posture, joint angle study, determination of spinal curvature, analysis of posture by video graphic method – OWAS, REBA, RULA, OCRA etc.
11. Time and motion study, job analysis.
12. Peg board test.

PHY 495.2B: Experiments on Ergonomic Design and Group Projects

F.M. = 25 Credits = 02

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

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

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

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

PHY 495C: Biochemistry, Molecular Endocrinology and Reproductive Physiology

PHY 495.1C: Advanced Experiments on Biochemistry

F.M. = 25 Credits = 02

Course Outcome: The objective of this unit will provide hands on training for bioanalytical techniques used for the isolation, purification, and characterization of biomolecules, differential centrifugation techniques as well as immune-biochemical techniques for the utilize of the

biochemical methods for research purpose.

A. Analytical Techniques in Biochemistry

1. Separation of amino acids and sugars by paper chromatography
2. Separation of amino acids and lipid fractions by thin layer chromatography.
3. Purification of proteins by salt precipitations and column chromatography.
4. Separation of mixtures of proteins by Sephadex Gel Filtration (column).
5. Separation of proteins by Polyacrylamide Gel Electrophoresis (PAGE).
6. Agarose gel electrophoresis of chromosomal & plasmid DNA.
7. Assay of mitotic indices.
8. Isolation of Goat RBC membrane and estimation of Na+/K+ ATPase

B. Determination of Isoelectric pH of proteins

C. Assay of vitamins

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

E. Differential centrifugation Techniques

Isolation of subcellular fractions.

F. Immunobiochemical Techniques

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

PHY 495.2C: Advanced Experiments on Endocrinology and Reproduction

F.M. = 25 Credits = 02

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

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

1. Bio-assay of oxytocin and epinephrine
2. Hormone assay-ELISA. RIA
3. Measurement of hormones by spectroflurometer
4. Study of localization steroidogenic enzymes in testis, ovary and uterus by histochemical methods
5. DNA and chromosomal studies in endocrine and reproductive disorder

6. Karyotypic study
7. Pedigree analysis-Autosome and sex chromosome related pedigree

A. Techniques in Reproductive Physiology

➢ **Experiments on female reproduction**

1. Study on estrous cycle-effect of synthetic estrogen and hCG injection.
2. Study on ovariectomy (unilateral and bilateral) – effects on ovarian and adrenal cholesterol
3. Study of acid and alkaline phosphatase activities in uterus of ovariectomized animal.
4. Study of immunological methods for pregnancy detection.
5. Basic experiment on superovulation study in mice and rat
6. **Optional Training Programme / Laboratory Visit::** Training in higher research institute are to be arranged for the students to learn some advance techniques in reproductive physiology and they are also to be taken for visiting different national laboratories. The student shall submit a report during practical examination for special paper.

PHY 495D: Neurophysiology

PHY 495.1D: Advanced Neurophysiological Studies – I

F.M. = 25 Credits = 02

Course Outcome: This section helps the students to learn different staining techniques in neurophysiology. The electroencephalographic studies in different stages of sleep and wakefulness, electrocardiographic changes in resting and stress condition along with measurement of neurotransmitters with spectroflurometric method and HPLC methods.

1. Study of the nerve cell: staining of neurons by crestyl violet and Nissl fast violet stain in the paraffin section of the spinal cord and cerebellum.
2. Study of central nervous system architecture by hematoxylin van Giessen method and Mallory's phosphotungstic acid hematoxylin method.
3. Experimental neuroanatomical studies:
    a) Nauta – Laidlaw method / Marchi's method
    b) Fink – heimer procedure.
    c) Cupric silver method.
    d) Rapid Golgi cox method / Bulchawosky method.
4. Tracing nerve tract horseradish peroxidase techniques.
5. Vital staining of nerve fibre by Methylene blue method.
6. Measurement of neurotransmitters:

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

b) HPLC method for measuring neurotransmitter.

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

PHY 495.2D: Advanced Neurophysiological Studies – II

F.M. = 25 Credits = 02

Course Outcome: This section describes different physiological techniques like perimetry, audiometry, studies of blood pressure (in different conditions) and neuroimmunological studies. The students will also have to submit a report on an Institute visit to some advanced national laboratories.

1. Studies of blood pressure in humans:
    a) Effect of posture changes on blood pressure and heart rate.
    b) Effect of vestibular stimulation on blood pressure and heart rate
    c) Valsalva maneuver.
2. Perimetry: visual field determination with different colours in perimeter in resting and stressfull condition.
3. Audiometry: study of frequency threshold curve in humans.
4. Biofeedback: EMG biofeedback studies.
5. Study of galvanic skin response (GSR): measurement of GSR in resting and different stressful condition.
6. Experimental of Chronobiology:
7. Recording of 24 hours body temperature to study circadian rthythm of body temperature
    a) Recording of heart rate to study circadian rthythm of resting heart rate
8. Neuroimmnological studies: PMN assay, cytotoxic assay, PLN assay, phagocytotic assay in experimental animals in resting condition and after stress
9. Training programme / Laboratory Visit: Students will submit a report on the basis of their visit training in some advanced national laboratories such as NBRC, New Delhi: NIMHAN, Bangalore; NCBS, Pune; AIIMS, New Delhi etc as a part of their practical syllabus.

PHY 495E: Biophysics and Electrophysiology with Structural Biology

PHY 495.1E: Advanced Medical Biophysics

F.M. = 25 Credits = 02

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

1. Five Mathematical assignment based on Module-I
2. Recording of simple muscle twitch (SMT). Effect of increasing frequency of stimulus on SMT
3. Determination of strength-duration curve, measurement of contraction kinetics of excitable tissues, measurement of conduction velocity of nerve fibre. Genesis of fatigue
4. Determination of isometric twitch-tetanus of toad with different drugs. Calculation of work done by muscle.
5. Effect of Vago-sympathetic Trunk and White Crescentic Line on heart muscle. Effect of Vagal stimulation showing Vagal Escape.
6. To study the effect of drugs – Nicotine and Atropine.
7. Perfusion of mammalian heart by Langendorff's Method and effect of drugs and ions.
8. Study of reflexes in Spinal and Decerebrate frog.
9. Modern techniques in voltage clamp, current clamp, patch clamp and Single fibre.
10. Conformation of Nucleic acid by Spectral study.
11. Methods of sample preparation for microscopy
12. Electrophysiological recording setup (EEG, ECG, EMG, EOG, Heart rate, respiration, pulse rate, heart sound, etc.),cardiac observation by electrocardiography and blood flow measurement.
13. CRO and its biomedical application. Experiments using electrophysiological techniques: Skin receptors and demonstration of dermatomes in frog. Muscle spindle, Golgi tendon organ activity demonstration in toad/frog.
14. To demonstrate the effect of UV and Gamma rays on cell division, Enzymes, Proteins and DNA, cell membrane.

PHY 495.2E: Advanced Separation Techniques and Photophysics

F.M. = 25 Credits = 02

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

1. Column Chromatography for Proteins, Pigments, amino acids.

2. One and two dimensional Ascending & Descending TLC and Paper chromatography of Amino acids & sugars
3. Fractionation of protein, Sugars from fruit juice using TLC/HPTLC
4. To perform the separation of Proteins using HPLC
5. To determine the molecular weight of biomolecules using ultracentrifuge
6. To isolate cellular fraction by centrifugation methods.
7. To study the Action Spectrum for Bacterial killing.
8. To study the Photo Inactivation of Enzymes.
9. To study the survival of E. Coli. as a function of fluence of UV radiation (254 nm) at different temperature.
10. To study bioluminescence of live fire flies by correlating light intensity with time.
11. To isolate and characterize photosynthetic pigments by Chromatography and Spectrophotometry.
12. To demonstrate Hill reaction using Oxygen Electrode.
13. To obtain relation between concentration and Refractive Index (RI) using Refractometry.
14. Training Program/Laboratory visit (Optional): Students will submit a report on the basis of their visit training in some advanced National laboratories such as IICB, Bose Institute, NICED-Kolkata, IIT- Kharagpur, NBRC, AIIMS, NIH-New Delhi, NIMHAN- Bangalore, and NCBS-Pune etc. as a part of their practical syllabus.

Paper: PHY-496

PHY 496.1: Project F.M. = 25 Credits = 02

Course Outcome: This practical paper will help students to execute a research project under the guidance of a teacher (laboratory based or field based) for a period of 6 months which can specialise in a more advanced area as part of their community heath and infection, specific disease, pharmacology or industry related research project.

PHY 496.2: Project F.M. = 25 Credits = 02

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

Note:

1. **For semester examination four questions each of 5 marks are to be set in each unit of theory papers, taking one question from every module, with one alternative to each question from the same module.**
2. **Each student has to take one special paper among the choices declared in each session from the five special papers included in syllabus. Special papers will be taught in Semester III and IV.**
3. **For the project paper of Semester IV 10 marks (05 marks in each unit) will kept for internal assessment and the remaining 40 (20+20) marks will be evaluated during semester examination.**