COOCH BEHAR PANCHANAN BARMA UNIVERSITY

POSTGRADUATE PROGRAMME
PHYSIOLOGY

A Four Semesters Course under NCCF

(Courses effective from Academic Year 2026-27)

Effective for M.Sc. 2 years (1st to 4th Sem)
&
M.Sc. 1 year (3rd & 4th Sem)

Both M.Sc. Courses for 3rd & 4th Sem will be similar for candidates pursuing (1) one year & (2) Year PG.

* The 3rd Sem & 4th Courses for M.Sc. 2 years will be treated as 1st Sem & 2nd Sem for PG 1 year course

There will be four semesters. The entire curriculum consists of 6 Core Courses (Core: 1-6), 1 Discipline Centric Elective (DCE) Course, 1 Generic Elective (GE) Course, 3 Course Work papers (CWP: 1-3), 4 Research papers (RP: 1-4) and 1 Dissertation paper. Each course paper is of 100 marks i.e., 5 credits.

07/08/25

(Dr. Suvendu Ghosh)
Chairman, PGBoS

SEMESTERWISE COURSE STRUCTURE AND MARKS DISTRIBUTION FOR 1ST, 2ND, 3RD AND 4TH SEMESTERS OF PG NCCF COURSE IN PHYSIOLOGY

SEM	PAPER CODE	PAPER NAME	THEORY	CE	ATTENDANCE	TOTAL	PRAC / FIELD TOUR	VIVA/ SEMINAR/ SURVEY/ REPORT/ REVIEW	TOTAL MARKS
SEM I	CORE-1	RESEARCH METHODOLOGY AND RESEARCH ETHICS	50	20	05	75	25		100
	CORE-2	BIOPHYSICS, BIOPHYSICAL CHEMISTRY, ENZYMES, BIOCHEMSTRY AND METABOLISM	50	20	05	75	25		100
	CORE-3	GENERAL AND SYSTEMIC PHYSIOLOGY	50	20	05	75	25		100
	DCE	1A. SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS &YOGA 1B. BIOCHEMISTRY OF CELL 1C. ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY 1D. ENVIRONMENTAL PHYSIOLOGY 1E. NUTRITION &DIETATICS 1F. IMMUNOLOGY & MICROBIOLOGY	50	20	05	75	25		100
SEM II	CORE-4	MICROBIOLOGY, IMMUNOLOGY, MOLECULAR BIOLOGY AND GENETICS	50	20	05	75	25		100
	CORE-5	ENDOCRINOLOGY, REPRODUCTION DEVELOPMENTAL BIOLOGY AND CHRONOBIOLOGY	50	20	05	75	25		100
	CORE-6	NERVOUS SYSTEM, SPECIAL SENSES AND BIOSTATISTICS	50	20	05	75	25		100
	GE	INTERDISCIPLINARY ASPECTS OF PHYSIOLOGY	50	20	05	75	25		100
SEM III	COURSEWORK PAPER-I	ADVANCED CELLULAR AND MOLECULAR PHYSIOLOGY	50	20	05	75	25		100
	COURSEWORK PAPER-II	CLINICAL AND TRANSLATIONAL PHYSIOLOGY	50	20	05	75	25		100
	COURSEWORK PAPER-III	BIOMEDICAL INSTRUMENTATION AND ADVANCED PHYSIOLOGICAL TECHNIQUES	50	20	05	75	25		100
	RESEARCH PAPER-I	REVIEW WRITING AND SEMINAR PRESENTATION	REVIEW ARTICLE SUBMISSION & EVALUATION 50	20	5	75		SEMINAR PRESENTATION OF REVIEW WORK 25	100

SEMESTERWISE COURSE STRUCTURE AND MARKS DISTRIBUTION FOR 1ST, 2ND 3RD AND 4TH SEMESTERS OF PG NCCF COURSE IN PHYSIOLOGY

SEM	PAPER CODE	PAPER NAME	THEORY	CE	ATTENDANCE	TOTAL	PRAC / FIELD TOUR	VIVA/ SEMINAR/ SURVEY/ REPORT/ REVIEW	TOTAL MARKS
SEM IV	RESEARCH PAPER-2 (OPTIONAL) ANY ONE OPTION TO BE TAKEN	2A. SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS &YOGA	50	20	05	75		FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION 25	100
		2B. BIOCHEMISTRY OF CELL	50	20	05	75			100
		2C. ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY	50	20	05	75			100
		2D. ENVIRONMENTAL PHYSIOLOGY	50	20	05	75			100
		2E. NUTRITION &DIETATICS	50	20	05	75			100
		2F. IMMUNOLOGY & MICROBIOLOGY	50	20	05	75			100
	RESEARCH PAPER-3 (OPTIONAL) ANY ONE OPTION TO BE TAKEN	3A. SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS &YOGA		20	5	25	50	LABORATORY/ INSTITUTE VISIT AND REPORT SUBMISSION- 25	100
		3B. BIOCHEMISTRY OF CELL		20	5	25	50		100
		3C. ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY		20	5	25	50		100
		3D. ENVIRONMENTAL PHYSIOLOGY		20	5	25	50		100
		3E. NUTRITION &DIETATICS		20	5	25	50		100
		3F. IMMUNOLOGY & MICROBIOLOGY		20	5	25	50		100
	RESEARCH PAPER-4	SCIENTIFIC COMMUNICATION, COMPUTER APPLICATION AND DATA ANALYTICS	50	20	05	75	25		100
	FINAL SUBMISSION OF RESEARCH WORK	DISSERTATION PAPER	Dissertation Writing and Report Submission & Assessment- 50	20	05	75		SEMINAR ON DISSERTATION 25	100

SEMESTER I

SUMMARY SHET

SEM	PAPER CODE	PAPER NAME	THEORY	CE	ATTENDANCE	TOTAL	PRAC / FIELD TOUR	VIVA/ SEMINAR/ SURVEY/ REPORT/ REVIEW	TOTAL MARKS	TOTAL CREDIT
SEM I	CORE-1	RESEARCH METHODOLOGY AND RESEARCH ETHICS	50	20	05	75	25		100	5
	CORE-2	BIOPHYSICS, BIOPHYSICAL CHEMISTRY, ENZYMES, BIOCHEMSTRY AND METABOLISM	50	20	05	75	25		100	5
	CORE-3	GENERAL AND SYSTEMIC PHYSIOLOGY	50	20	05	75	25		100	5
	DCE	1A. SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS &YOGA	50	20	05	75	25		100	5
		1B. BIOCHEMISTRY OF CELL								
		1C. ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY								
		1D. ENVIRONMENTAL PHYSIOLOGY								
		1E. NUTRITION &DIETATICS								
		1F. IMMUNOLOGY & MICROBIOLOGY								

SEMESTER I

CORE T 1 | **Theory** | **Full Marks = 50**

RESEARCH METHODOLOGY AND RESEARCH ETHICS

Group A

Full Marks =25

RESEARCH DESIGN AND EXPERIMENTAL PLANNING

1. Scientific Knowledge and Research: Nature and characteristics of scientific knowledge, Evolution of scientific thought, Science, pseudoscience and evidence-based inquiry Logic in scientific investigation: inductive and deductive reasoning, Research as a tool for knowledge generation
2. Fundamental aspects of Research: Nature and scope of scientific research, Basic and applied research, Quantitative and qualitative research, Fundamental and applied research, Exploratory, descriptive and analytical research, Experimental and observational research, Action research and participatory research, Clinical and community-based research
3. Research Design: Principles of Research Design - Purpose and significance of research design Internal and external validity, Reliability and reproducibility, Bias and confounding variables.
4. Research Planning: Identification of research problems, Hypothesis formulation, Variables and controls, Experimental and observational studies, Sampling methods, Pilot studies, Research proposal preparation, Literature survey and gap analysis,
5. Experimental design and protocol development: Completely randomized design, Randomized block design, Factorial design, Repeated-measure design, Cross-over design
6. Observational Designs: Cross-sectional studies, Cohort studies, Case-control studies, Cross sectional studies, Longitudinal studies
7. Translational and Interdisciplinary Research: Bench-to-bedside research, One Health approach, Precision medicine, Integrative biomedical research
8. Research Questions and Hypotheses: Characteristics of good research questions, Hypothesis formulation, Null and alternative hypotheses, Directional and non-directional hypotheses, Variables and operational definitions
9. Sampling techniques: Census and sampling, Probability sampling- Simple random, Stratified, Cluster, Systematic, Non-probability sampling – Convenience, Purposive, Snowball, Quota
10. Sample Size Determination: Concepts of statistical power, Effect size, Sampling error, Practical considerations
11. Data Collection Methods: Observation techniques, Structured and semi-structured interviews, Questionnaires and surveys, Focus group discussions, Laboratory investigations, Field-based studies
12. Scientific Literature: Primary, secondary and tertiary literature, Scholarly journals and impact metrics, Peer-review process, Predatory journals and publishers
13. Literature Search Strategies: Database searching- PubMed, Scopus, Web of Science, Embase, Google Scholar, Citation tracking and bibliometric analysis
14. Literature Review: Narrative review, Systematic review, Scoping review, Meta-analysis: principles and applications

Group B

Full Marks =25

RESEARCH OUTCOME, RESEARCH REPORTING, RSEARCH CONDUCT AND ETHICS

1. Outcome Assessment: Primary and secondary outcomes, Surrogate endpoints, Composite outcomes, Clinical versus statistical significance, Translational relevance of findings
2. Risk and Association Analysis: Relative risk, Attributable risk, Odds ratio, Number needed to treat, Number needed to harm

3. Meta-analysis and Evidence Synthesis: Systematic review methodology, Forest plots Heterogeneity analysis, Publication bias, Funnel plots
4. Advanced Data Visualization and Reporting: Advanced graphical presentation, regression plots, Survival curves, Heat maps, Confidence interval plots
5. Interpretation and Reporting: Presentation of statistical findings, Interpretation of software outputs, Writing statistical sections of dissertations and publications
6. Reporting standards: CONSORT, STROBE, PRISMA, ARRIVE guidelines
7. Research Ethics: Historical development of research ethics, Principles and theories of biomedical ethics, Responsible conduct of research, Human participant research, Animal experimentation guidelines, Importance of ethical consideration in biomedical and translational research
8. Ethical Aspects of Research Planning and Implementation: Ethical principles in designing and conducting research studies, evaluating risks, benefits, and practical feasibility of research, Choosing appropriate study populations and participant recruitment methods, Ensuring data quality, management, and integrity in translational research
9. Informed Consent and Safeguarding Research Participants: Fundamental components of the informed consent process, assessing decision-making ability and capacity to provide consent, Special consent considerations for vulnerable and high-risk populations
10. Ethics in Preclinical Research: Animal welfare concerns and ethical responsibilities in laboratory studies, Application of the Three Rs: Reduction, Refinement, and Replacement, Ethical considerations in moving from preclinical findings to human research
11. Ethical Considerations in Clinical Trial Research: The role of randomization and the principle of clinical equipoise, Ethical issues surrounding placebo use and established standards of care, Procedures for monitoring, documenting, and reporting adverse events
12. Ethical Implications of Emerging Technologies: Gene editing and genetic modification, Stem cell research and regenerative medicine, The impact of artificial intelligence and large-scale data use in translational research
13. Ethical Regulations: Institutional Ethics Committee, Institutional Animal Ethics Committee, Good Laboratory Practices (GLP) , Good Clinical Practices (GCP)
14. Publication Ethics: Authorship criteria, Duplicate publication, Fabrication, falsification and plagiarism, Retraction and correction, Conflict of interest
15. Intellectual Property Rights: Patents; Copyright, Trademark, Geographical indication, Technology transfer and commercialization
16. Research Management: Research funding agencies, Project management, Research audit

LABORATORY COURSES

Core-P1 **Practical** **Full Marks = 25**

1. Data analysis using software
2. Graphical representation of data
3. Error bar computation in graphs
4. Framing of questionnaire
5. Calculation of sample size
6. Interpreting a scientific article

CORE T 2 **Theory** **Full Marks = 50**

BIOPHYSICS, BIOPHYSICAL CHEMISTRY, ENZYMES, BIOCHEMSTRY AND METABOLISM

Group A

Full Marks = 25

BIOPHYSICS, BIOPHYSICAL CHEMISTRY

1. Acids and Bases: Molarity and normality, Henderson-Hasselbalch equation, pKa, pH.
2. Buffers in Biological systems, buffer capacity, titration curve.
3. Viscosity, factors affecting viscosity, Ostwald viscometer, concept of fluidity and micro viscosity. Surface tension and its role in lung compliance, airway resistance and other physiological processes
4. Membrane structure and functions: Molecular organization of plasma membrane, Membrane fluidity and lipid rafts, Membrane proteins and membrane dynamics, Diffusion and Osmosis.
5. Thermodynamics: Laws of thermodynamics, enthalpy, entropy, efficiency and free energy in thermodynamic system, living body as a thermodynamic system.
6. Hemodynamics: Shear stress, viscoelasticity, Newtonian and Non-Newtonian fluids. Flow and Pressure – Laminar and streamline flow; Reynolds' number; Poiseuille-Hagen Formula; Laws of Laplace; blood flow, blood pressure, hydraulic system and resistances to flow.

BIOCHEMSTRY

1. Carbohydrates: Monosaccharides, Disaccharides, Polysaccharides – Classification, structure, Physiological importance. Different types of Isomerism. Fischer & Haworth projections and Formation of cyclic structures - Pyranose and furanose isomerism, anomerism.

   Mutarotation and its mechanism. Properties and Chemical reactions. Derivatives of monosaccharides. Glycosaminoglycans, Proteoglycans, Glycoproteins.

2. Lipids: Fatty acids – Classification and structure. Isomerism of fatty acids. Properties and chemical reactions. Chemical characterization of fats. Eicosanoids. Structure and physiological importance of phospholipids and plasmalogens, glycolipids, sphingolipids, cholesterol. Lipoproteins – Structure and classification.

3. Proteins: Classification and structure of amino acids. Isomerism, properties and chemical reactions. Protonic equilibria and acid-base behaviour of amino acids. Titration curve of glycine. Structural features and bio-physical properties of peptide bonds, Torsion angles (Phi & Psi). Ramachandran Plot. Three-dimensional structure of proteins – primary, secondary (α-helix; β pleated sheet, reverse turns, triple helix supercoil), tertiary (super secondary motifs, domains, folds) and quaternary structures. Chemical bonding forces and stabilizing interactions.

4. Nucleic Acids: Purines and pyrimidines, nucleosides and nucleotides. DNA double helix -Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. Denaturation and annealing of DNA, hyperchromicity. Structures of mRNA, tRNA, rRNA. Different types of non-coding RNAs.

Group B

Full Marks = 25

ENZYMES

1. Structural and molecular basis of enzyme actions and kinetics: ES complex, Transition State, Models.

2. Chemical mechanisms in enzymatic catalysis. Derivation of the rate-equation of a single-substrate enzyme-catalysed reaction (Michaelis–Menten equation). Substrate concentration, initial rate, maximum velocity, Michaelis constant, significance of Km and Vmax. Linear transformation plots of enzyme kinetics.

3. Enzyme Inhibitions: Competitive, Non-competitive, Uncompetitive and mixed inhibition kinetics. Factors influencing enzyme catalysed reactions. Modulation of enzyme activities: Allosteric enzymes, Feedback regulation, Covalent modifications. Rate limiting enzymes, Isozymes, Proenzymes, Ribozymes, Abzymes, Antizymes, Synzymes. Regulation of enzyme activity: Induction and Repression. Clinical enzymology: Diagnostic and therapeutic uses of enzymes.

METABOLISM

1.Carbohydrate Metabolism: Biochemical Pathways and Their Regulations: Glycolysis, TCA Cycle, Neoglucogenesis, HMP shunt. Biosynthesis and degradation of polysaccharides (Homoglycans and Heteroglycans / Glycosaminoglycans). Cataplerosis and anaplerosis. Inborn errors of glycogen metabolism (Glycogenosis).

2. Lipid Metabolism: Mitochondrial Beta-oxidation of saturated & unsaturated Fatty Acids. Peroxisomal Beta-oxidation. alpha- and omega-oxidations. Ketone body biosynthesis and breakdown, Cytoplasmic de novo biosynthesis of palmitate. Microsomal fatty acid elongase system. Biosynthesis of mono- and polyunsaturated fatty acids. Microsomal desaturase system. Biosynthesis of eicosanoids: arachidonate, prostanoids and prostaglandins, leukotrienes, lipoxins. Biosynthesis of Cholesterol. Biosynthesis of phospholipids (phosphoglycerides) and their metabolism. Biosynthesis of triacylglycerol. Biosynthesis and breakdown of sphingolipids and glycolipids. Metabolism of lipoproteins.

3. Protein Metabolism: Deamination, Transamination, Transmethylation, Urea-Ornithine cycle. Biosynthesis of specialized products and informational biomolecules from amino acids, Biosynthetic pathways of non-essential amino acids. Metabolic fates of essential and non-essential amino acids. Mechanism of glycosylation in glycoproteins.

4. Nucleotide Metabolism: Biosynthesis of purine & pyrimidine nucleotides (de novo and salvage pathways). Regulation of synthesis. Catabolism of free bases-nucleosides-nucleotides. Purine Salvage Cycle.

5. Other Essential Metabolisms: Metabolism (sources, biosynthesis, fates) of one carbon compounds; two carbon compounds; Three Carbon Compounds. Biochemical actions of vitamins as coenzymes in metabolic reactions. Integrations of carbohydrate, fat and protein metabolism.

6. Biological Oxidation, Electron Transport Chain, Oxidative Phosphorylation: Oxidoreductases; Redox potential and redox couples; Respiratory chain complexes; Mechanism and pathway of electron transfer; Cytochrome oxidase and terminal respiration. Structure of ATP synthase complex; Molecular mechanism of ATP synthesis; Chemiosmotic theory; Proton-motive force and mechanism of proton translocation.

LABORATORY COURSES

CORE P 2 — **Practical** — **Full Marks = 25**

1. Estimation of total cholesterol by Zak's method
2. Estimation of total protein
3. Estimation of A/G ratio
4. Estimation of blood glucose by colorimetric method
5. Estimation serum urea
6. Estimation serum creatinine
7. Estimation serum amylase activity

CORE T 3 **Theory** **Full Marks = 50**

GENERAL AND SYSTEMIC PHYSIOLOGY

Group A
Full Marks = 25

BLOOD

1. Composition and functions of blood, plasma protein, plasmapheresis, bone marrow

2. RBC- Erythropoiesis, characteristics, and fate.

3. Haemoglobin- Chemistry, biosynthesis, fate, types and derivatives, functions, haemoglobinopathies.

4. Platelets: Blood coagulation- mechanisms, factors, anticoagulants, coagulation-hastening factors, prothrombin time, coagulation disorders.

5. WBC- types, leukopoiesis, fate.

6. Blood Group: General concept, inheritance, hazards, and precautions.

7. Different diagnostic techniques and parameters and their physiological significances (Special emphasis on ESR, Haematocrit, PCV, MCV, MCH, MCHC), Anaemias.

CARDIOVASCULAR PHYSIOLOGY

1. Electrical activity of heart- ionic basis of action potential, conduction of action potential, role of neurohormones; conduction blocks, re-entry phenomenon, fibrillation, defibrillators.

2. Electrocardiogram (ECG)- Laws, recording principle, generation of EGC waves, electrical axis, normal and abnormal ECG. Vectorcardiography.

3. Mechanical events of heart- Cardiac cycle, pressure volume changes during cardiac cycle; Cardiac output, blood pressure and cardiovascular regulatory mechanism.

4. Regional Circulations-Coronary Circulation, Cerebral Circulation and Pulmonary Circulation.

5. Heart as an endocrine organ.

RESPIRATORY PHYSIOLOGY

1. Mechanics of Breathing: Principles of respiratory mechanisms and regulations: Elastic forces, lung volumes, Pressure/volume relationship. Respiratory system resistance: Physical principles of gas flow and resistance; compliance, Lung function tests.

2. Gas transport between the lungs and the tissues: Oxygen transport– mechanism, dissociation curve and factor regulating it; Carbon dioxide transport – mechanism, dissociation curve and factor regulating it.

3. Regulation of Respiration: Neural and chemical control of breathing.

4. Non respiratory functions of the lung: Filtration, defence against inhaled substances; Endocrine fun

Group B

Full Marks = 25

GASTROINTESTINAL PHYSIOLOGY

1. Histomorphology of gastrointestinal tract.
2. Gastro-intestinal motility: Deglutition, movements of alimentary canal and their regulation, physiology of vomiting- vomiting reflex.
3. Regulation of gastrointestinal functions: GI hormones, paracrine mediators in the GI tract, innervation of GI tract- sympathetic, parasympathetic, enteric nervous system, reflex control, neural control of GI functions. Mechanism and regulation of GI secretion: salivary secretion, gastric acid secretion & H-ATPase pump, bicarbonate secretion and pancreatic secretion. GI hormones and functions.
4. Digestion and absorption of carbohydrate, protein and lipid and nucleic acids. Absorption of water, electrolytes and vitamins.
5. Role of hepato-biliary systems in gastrointestinal functions, Physiology of constipation;
6. Gastrointestinal immunity. Pathophysiology of GI tract: Secretary diarrhoea, ulceration, Peptic ulcer, Jaundice, Gallstones. irritable bowel syndrome and Crohn's diseases.

EXCRETORY SYSTEM

1. Functional anatomy of kidney: gross anatomy; ultrastructure of nephron, renal corpuscle, and Juxtaglomerular apparatus; innervations of kidney, peculiarities of glomerular circulation.
2. Mechanism of formation of urine: GFR, reabsorption and secretion in renal tubules, Counter-current-exchanger and multiplier system, Diuresis.
3. Non excretory functions of kidney. Role of kidney in the regulation of ionic, osmotic, acid and base balance of the body fluid, control of extracellular fluid volume. Renal function tests.
4. Kidney perfusion techniques, peritoneal dialysis. Urine formation, micturition and its reflex.
5. Kidney as an endocrine organ.

LABORATORY COURSES

CORE P 3 — **Practical** — **Full Marks = 25**

1. Blood film preparation and Leishman's staining; assessment of RBC morphology; and DC
2. Platelet count, Reticulocyte count, Bleeding time and Clotting time,
3. Blood group determination, Hemoglobin estimation.
4. Determination of heart rate in supine, sitting and standing posture.
5. Experiments on smooth muscle contraction (Dale's Experiment): Kymographic recording of:
   (a) Effect of acetylcholine on the movements of intestinal movements of albino rat with and without application of atropine.
   (b) Effects of oxytocin on uterine contractions of albino rat.
6. Testing of normal constituents of urine (Biochemical Test)
7. Identification of abnormal constituent of urine (Biochemical Test)

DISCIPLINE CENTRIC ELECTIVE

Students have to choose any one paper from the set

1A. SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS &YOGA

1B. BIOCHEMISTRY OF CELL

1C. ENDOCRINOLOGY &.REPRODUCTIVE PHYSIOLOGY

1D. ENVIRONMENTAL PHYSIOLOGY

1E. NUTRITION &DIETATICS

1F. IMMUNOLOGY & MICROBIOLOGY

DCE 1A-T THEORY Full Marks=50

SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS AND YOGA

1. **Fundamentals of kinesiology and biomechanics of human movement**
   Fundamental Principles and Laws for Application of Biomechanics, Vectors, units of measurement, coordinate systems, statics, forces and moments, inertial forces, newton's laws, kinematics - rotational and translational motion displacement, velocity, and acceleration, kinetics- linear and angular, work, energy, and power, friction, projectile and body levers, mechanical efficiency, center of gravity, stability, stress, strain, fracture mechanics, viscoelastic models, fatigue, bending, torsion, biomechanics of bone, biomechanics of ligaments, muscle tendon unit, muscle forces, muscle moments, three mechanical characteristics of muscles- Active and Passive Tension of Muscle , Hill Muscle Model-force–velocity relationship. stretch- shortening cycle, force–time principle, Sports Ergonomics
2. **Bioenergetics, exercise metabolism**
   Fuel utilization during rest and exercise, Concept of energy continuum, Anaerobic Energy Production, Alactic Anaerobic PC Production, Lactic Acid/Lactate Levels, lactate threshold, Accumulation of Lactate, Metabolism Time Frame for Lactate Removal Postexercise, The Anaerobic Exercise Response, Oxygen Deficit and Excess Postexercise Oxygen consumption, Measurement of Anaerobic metabolism, The Availability and Utilization of ATP-PC, Mechanical Power and Capacity
   Aerobic Exercise Responses: Oxygen Consumption and Carbon Dioxide Production, The Oxygen Cost of Breathing, Respiratory Quotient/Respiratory Exchange Ratio, Estimation of Caloric Expenditure, VO2 max, Maximum aerobic power, The Metabolic Equivalent, Field Estimates of Energy Expenditure during Exercise, Laboratory Measurement of Aerobic Metabolism Calorimetry, Spirometry
3. **Metabolic Training Principles and Adaptation**
   Application of the Training Principles for Metabolic Enhancement and body composition control: Specificity, overload, Rest/Recovery/Adaptation, Progression, Individualization, Maintenance, Retrogression/Plateau/ Reversibility, Warm-Up and Cooldown, Detraining, Physiological Adaptations to Training, skeletal muscle plasticity, Metabolic Adaptations to Exercise Training, Substrate or Fuel Supply, Enzyme Activity Oxygen Utilization, ATP Production, Storage, and Turnover, The Influence of Age and Sex on Metabolic Training Adaptations, Adaptations in Children and Adolescents, Male-Female Differences in Adaptations, Adaptations in Older Adults, Molecular basis of training adaptations
4. **Nutrition for Fitness and Performance**
   Nutrition for Training: Kilocalories, macronutrients, Vitamins, Minerals, Nutrition for Competition: Carbohydrate Loading (Glycogen Supercompensation), Pre-Event Meal, feeding during Exercise, Fluid Ingestion during and after Exercise, Nutrient Timing Eating Disorders: Criteria, Risk Factors, The Consequences of Eating Disorders, Prevention and Treatment
5. **Body composition and athletic performance**
   Kin anthropometry, somatotype and morphological typologies, assessment techniques for body composition, Definitions and concepts: fat mass, fat-free mass, lean body mass, bone density, body water, Genetic Determinants of physical performance, Sport-specific body composition profiles (endurance vs power athletes), Periodization of training and composition changes, Optimal body composition for performance: myths vs evidence, Weight management strategies: making weight, rapid weight loss/gain, Body composition and injury risk, The Effects of Diet, Exercise Training, and Diet Plus Exercise Training on Body Composition and Weight
6. **Physiologic system responses to exercise, limitations and training adaptations**
   Response of the Respiratory System to Exercise: Short-Term, Light to Moderate Submaximal Aerobic Exercise Long-Term, Moderate to Heavy Submaximal Aerobic Exercise Incremental Aerobic Exercise to Maximum Static Exercise, Locomotor-Respiratory Coupling (Entrainment) during

Exercise; Respiratory Limitations to Exercise: Exercise-Induced Arterial Hypoxemia, Respiratory Muscle Fatigue, Excessive Fluctuations in Intrathoracic Pressures, Respiratory Muscle Training Principles and Adaptations: Controlled- Frequency Breathing Training, Whole Body Respiratory Training Principles and Adaptations: Lung Volumes and Capacities Pulmonary Ventilation External and Internal Respiration, Gender and age specific responses Cardiovascular Responses to Aerobic Exercise: Short-Term, Light to Moderate Submaximal Aerobic Exercise, Long-Term, Moderate to Heavy Submaximal Aerobic Exercise, Incremental Aerobic Exercise to Maximum.High-Intensity, Interval, Exercise Upper-Body versus Lower- Body Aerobic Exercise, Cardiovascular Responses to Static Exercise: Intensity of Muscle Contraction, Blood Flow during Static Contractions, Comparison of Aerobic and Static Exercise, Cardiovascular Responses to Dynamic Resistance Exercise: Varying Load/Constant Repetitions, Varying Load/Repetitions to Failure, Constant Load/Repetitions to Failure, Cardiovascular Adaptations to Aerobic Endurance Training , Cardiovascular Adaptations to HIIT, Maximal Oxygen Consumption and Vascular Function adaptations, Cardiovascular Adaptations to Dynamic Resistance Training: Cardiac Structure Stroke Volume and Heart Rate Blood Pressure Maximal Oxygen Consumption, Gender and age specific Responses

7. **Neuro endocrine system and exercise**

Overview of Neuroendocrine Integration: Communication between the nervous and endocrine systems, Feedback loops and homeostatic regulation, Role of the autonomic nervous system in exercise, Hormonal Responses to Acute and Chronic Exercise: Endocrine responses to acute exercise: intensity and duration effects, Chronic adaptations of hormones with training, Training type- specific hormonal profiles: endurance vs resistance, Hypothalamic-Pituitary Axes and Exercise: Cortisol dynamics, stress response, circadian rhythm, Thyroid hormones in metabolism and performance, Reproductive hormones, exercise-induced amenorrhea, Prolactin and exercise, Neuroendocrine adaptations to overreaching and overtraining, Autonomic and Adrenal Response in Exercise: Role of catecholamines: epinephrine and norepinephrine, Sympathetic and parasympathetic balance (HRV in training assessment), Adrenal medulla and cortex function, Interaction of psychological stress and exercise responses, Metabolic and Growth Hormones in Exercise: Growth hormone: exercise-induced secretion and recovery roles, Insulin and glucagon: glucose homeostasis and exercise, IGF-1 and muscle remodeling, Adipokines and myokines: leptin, adiponectin, irisin; Neuroendocrine Regulation of Hydration, Appetite, and Recovery: Vasopressin and aldosterone: fluid balance and thermoregulation, Ghrelin and leptin: appetite regulation with exercise, Role of melatonin and sleep hormones in recovery, Inflammatory cytokines and neuroendocrine interactions (e.g., IL-6), The Brain and Fatigue

8. **Immune system and Exercise**

Overview of exercise immunology and historical development. innate and adaptive immunity, Immune cells, cytokines, and signaling pathways, Interaction of the neuroendocrine and immune systems, Acute Exercise and Immune Response: Immediate immune changes post-exercise; Leukocyte trafficking, NK cell activity, and cytokine response, Influence of exercise duration and intensity on immune markers, The "open window" hypothesis and infection susceptibility, Chronic Exercise and Immune Modulation: Immune adaptation to endurance and resistance training, Dose- response curve: J-shaped and S-shaped models, Effects of overtraining and excessive load on immune suppression, Anti-inflammatory effects of moderate regular physical activity, Immune Surveillance and Athletic Health: exercise-induced changes in mucosal immunity (e.g., salivary IgA), Susceptibility to upper respiratory tract infections (URTI), Role of oxidative stress and inflammation in immune function, Monitoring immune health in athletes (biomarkers, symptoms), Special Populations and Clinical Implications: Immunosenescence and exercise in aging populations, Exercise immunology in children and adolescents, Immune function in autoimmune and inflammatory disorders, Cancer, HIV, and chronic fatigue: exercise as adjunct therapy

LABORATORY COURSES

DCE 1A-P Practical Full Marks = 25

1. Introduction to practical experiments on human subjects and Standardization of different.
2. techniques for recording different parameters on human subjects
3. Study of structural anthropometry on human subjects.
4. Study of body composition, i.e. Lean Body Mass (LBM), FM, target weight, somatotype etc.
5. Determination of Physical Fitness Index with step test.
6. Determination of Physical Fitness Index with Astride Jump Test.
7. Determinations of VO2 max with Queen College Step Test.
8. Determination of VO2 max with Astrand Nomogram by Bicycle ergometer
9. Determinations of VO2 max with Margaria Nomogram by Step Test.
10. Determination of Cardio-respiratory fitness with Point slope Method by Step Test.
11. Determination of distance of 12 min run (Cooper test).
12. Estimation of Blood Glucose (fasting, post-exercise) – Glucometer/Colorimetric method before and after exercise
13. Estimation of total protein in serum (Biuret or Lowry Method)
14. Assessment of Heart Rate variability
15. Determination of lung volumes by expirograph
16. Determination of static and dynamic lung functions.
17. Determination of steady state heart rate at different work load on a bicycle ergometer.
18. Determination of ventilation volume of lungs at steady state heart rate.
19. Educational tour to study physiological parameters and fitness strategies in different athletic and sedentary populations.

DCE 1B-T THEORY Full Marks=50

BIOCHEMISTRY OF CELL

1. Cell Biology:

Membrane proteins and cellular diversity, Membrane carbohydrates and their roles in cell-cell recognition; Role of membrane asymmetry in cellular functions, exocytosis and endocytosis, Extracellular matrix, Sub-cellular fractionation, Translocation of secretory proteins across the ER membrane; protein modifications, folding and quality control in the ER; export and sorting of proteins to mitochondria and peroxisomes, Cytoskeleton: Types of cytoskeletal filaments, Molecular mechanisms involved in self-assembly and dynamic structure of cytoskeletal filaments, Polymerization and depolymerization of cytoskeletal filaments coupled to cellular functions, Molecular motors and their significance in intracellular transport, Cell cycle: Regulation of cell cycle control system in each phase of cell cycle, Molecular mechanisms underlying cell cycle regulation, Cell and Tissue culture-concepts and techniques.

2. Molecular Biology and Genetics:

Chromatin Remodeling and Histone Modification, Regulation of Transcription: Transcription Activation/Co-Activators/Co-Repressors, RNA Processing and Splicing, Translation and post-

translational modification, DNA Methylation & Epigenetic Regulation, Gene Regulation by UTRs, RNAi & Micro RNA, DNA damage and repair,
Gene Silencing, Exon shuffling, Frame shifting, Gene knock out, Genetic drift- its clinical significance, Microbial genetics- Lytic cascade and lysogenic repression in lambda bacteriophage.

3. **Proteomics:**

Concept of Proteomics: Techniques in proteomic research- Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy, Protein microarrays, Advantages and disadvantages of protein microarrays, Structural Proteomics-Protein dynamics. Applications of Proteomics: protein expression profiling, identifying protein-protein interactions and protein complexes, mapping protein modifications. Concept of protein data bank.

4. **Functional Genomics:**

Physical structure and genetic content of Human genome, Nature of genetic variations: Single nucleotide polymorphism, Large scale variations, conserved and variable domains, Methods for studying variation: RFLPs, VNTR and minisatellites, SSCP and direct Sequencing. DNA microarrays, Advantages and Disadvantages of DNA microarrays. Genetic and physical maps of human genome: chromosome maps and markers, genetic footprinting, Concept of gene library; GENE Bank.

5. **Integration of Metabolic Pathway**: Bioenergetics: significance in Biological Systems, Reciprocal regulation of Glycolysis and gluconeogenesis, Regulation of TCA cycle, Reverse Cholesterol Transport and Lipoproteniemias, regulation and disorders of β-oxidation, Regulation and associated disorders of Urea cycle, Heme Metabolism, Hyperbilirubinemia and Jaundice, Inborn errors of metabolism.

6. **Enzymes and Metabolism:**

Types of Enzyme assays - discontinuous, continuous, coupled assays; Features of enzyme catalysis, factors affecting the rate of enzymatic reactions, activation energy and transition state theory. Catalytic power. Enzyme kinetics: Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics, Derivation of Michaelis-Menten equation; other enzyme plots like Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Determination of Km Vmax and Kcat, specificity constant. Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Structural analogs (allopurinol, methotrexate). Mechanism based inhibitors (β-lactam antibiotics). Coenzymes (TPP, NAD, pyridoxal phosphate) in enzyme catalyzed reactions. Enzymes in clinical diagnosis: Serum alkaline phosphatase, Serum lactate dehydrogenase, Serum alpha hydroxybutyrate dehydrogenase, Serum creatine phosphokinase, serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, serum and erythrocyte cholinesterases, serum isocitrate dehydrogenase, serum amylase, serum aldolase, serum glucose-6-phosphate dehydrogenase.

LABORATORY COURSES

DCE 1B-P **PRACTICAL** **Full Marks=25**

1. Serum total protein estimation
2. Blood glucose estimation
3. Estimation of total cholesterol of serum
4. Estimation of serum amylase activity

5. Study on the effect of temperature and determination of Q10
6. Study on the effect of pH on enzyme activity
7. Effects of substrate concentration on enzyme activity; Michaelis- Menten Plot, Lineweavor-Burk Plot, Determination of Km, Vmax.
8. Studies on the effect of competitive and non-competitive inhibitors on enzyme activity.
9. Studies on the determination of activity of some clinically relevant enzymes: SGOT, SGPT, LDH, Creatinine Kinase
10. Educational tour to assess the clinical / biochemical disorders in population

DCE 1C-T THEORY Full Marks=50

ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY

ENDOCRINOLOGY

1: Hormones and Receptors

a. Biosynthesis, processing, and metabolism of peptide, steroid, and amine hormones; **Peptide Hormones**: Gene transcription, translation, post-translational modifications (e.g., prohormone cleavage, glycosylation), storage, and secretion mechanisms including insulin, glucagon, somatostatin, pancreatic polypeptide and gonadotropins; **Steroid Hormones**: Cholesterol uptake, steroidogenesis pathways (enzymes: CYPs, 3β-HSD, aromatase), organ-specific biosynthesis (adrenals, gonads); **Amine Hormones**: Biosynthesis from tyrosine and tryptophan (e.g., catecholamines, melatonin); rate-limiting steps and enzymatic control; **Hormone Inactivation**: Degradation, conjugation, and excretion pathways (hepatic, renal)

b. **Hormone Transport and Half-Life Transport Mechanisms** - Free vs bound hormone fractions in plasma; Specific binding proteins (e.g., SHBG, CBG, TBG, albumin); **Biological Half-Life**: Factors affecting hormone stability and clearance; Clinical relevance in hormone replacement and pharmacokinetics

c. **Hormone Receptors: Structure, Classification, and Regulation**-Cell surface receptors (e.g., GPCRs, RTKs, cytokine receptors); Intracellular (nuclear) receptors; Domain organization (ligand-binding domain, DNA-binding domain, transactivation domain); Receptor synthesis, desensitization, internalization, recycling, and degradation; Genetic mutations and receptor isoforms

d. **Intracellular Signalling Pathways:** Autocrine and paracrine signalling; ***G-Protein Coupled Receptors (GPCRs)***- Signal initiation, second messengers (cAMP, IP3, DAG, Ca^{2+}), and PKA/PKC activation; ***Receptor Tyrosine Kinases (RTKs)*** - Ligand-induced dimerization and autophosphorylation; Downstream activation of Ras/MAPK and PI3K-Akt pathways; ***JAK-STAT pathway***- Cytokine and prolactin signalling, STAT phosphorylation and nuclear translocation; ***MAPK Pathway***- Hormonal activation of ERK, JNK, p38 cascades; impact on gene expression; ***PI3K-Akt Pathway***- Role in insulin signalling, cell survival, metabolism

e. **Nuclear Receptor Superfamily**- *Structure and Types*: ***Steroid receptors*** -(ER, AR, PR, GR, MR); ***Non-steroid receptors*** - (TR, VDR, RAR, PPAR, LXR, FXR); ***Mechanisms of Action*** - Ligand binding, receptor dimerization, binding to Hormone Response Elements (HREs); ***Co-activator and co-repressor interactions*** (SRC, NCoR, SMRT); ***Transcriptional Regulation***- Chromatin remodeling, histone modifications, gene expression regulation; Crosstalk with signaling pathways (e.g., MAPK phosphorylation of nuclear receptors)

2: Hypothalamic-Pituitary Axis (HPA) and Endocrinology of key glands

a. Molecular neuroendocrinology of hypothalamic peptides (GnRH, CRH, TRH, TRH, GHRH, somatostatin, dopamine (as prolactin-inhibiting hormone): Mechanisms of anterior and posterior pituitary hormone release; Pulse frequency and amplitude in hormone secretion (e.g., GnRH pulsatility, CRH secretion and regulation, kisspeptin, neurokinin B, dynorphin (KNDy neurons); Feedback regulation (short loop, long loop, ultrashort loop)

b. Neuropeptide processing and secretion: Preprohormone synthesis, enzymatic cleavage, and vesicular transport; ***Neurovascular and neuroendocrine integration***- Hypothalamo-hypophyseal portal system, tanycyte and glial neural cell communication; Synthesis transport and trafficking of oxytocin and vasopressin; Receptor and signaling pathway; Regulation of secretion and physiological role

c. Thyroid axis: Iodine metabolism in thyroid, Mechanisms of Wolff–Chaikoff and Plummer effects thyroglobulin genes and synthesis; biosynthesis, release, peripheral conversion, deiodinases and roles, **Feedback and decompensation**: Central vs peripheral regulation, subclinical vs overt imbalance.

d. Endocrine pancreas: ***Regulation of insulin secretion*** (GLUTs, incretins), ***Beta-cell dysfunction*** and diabetes mechanisms, ***classification of diabetes*** - T1DM, T2DM, MODY, secondary forms; definition and diagnostic cut-offs; glucagon physiology, role of pancreatic hormones on nutrient metabolism

e. Adrenal axis: zonation and differential steroidogenesis, cortical and medullary hormones physiology and physiological actions.

f.Growth hormone: synthesis; Receptors; Signaling; mechanism of action - direct and indirect; physiological roles and regulation

3: Other Hormonal Systems

Pineal gland and melatonin; Role of circadian clocks in endocrine regulation; clock genes; Gastrointestinal hormones; kidney as an endocrine gland, ANP; endocrine regulation of sodium and electrolyte homeostasis; Local hormones: prostaglandins, nitric oxide, cytokines

REPRODUCTIVE PHYSIOLOGY

4: Molecular Control of Gametogenesis, sex determination and puberty

Stem cell regulation of spermatogenesis and oogenesis; Meiosis-specific genes and checkpoints; Sertoli and granulosa cell signaling pathways; Epigenetic regulation in germ cells; non-coding RNAs in gamete development; Neuroendocrine regulation of puberty - Genetic and epigenetic influences; Disorders of puberty: precocious and delayed; Sex differentiation and determination

5: Endocrinology of Reproductive Cycles

a. Spermatogenesis: stages, hormonal control; Sertoli and Leydig cell functions; seminiferous epithelium and spermatogenic cycles; Sertoli cells and Leydig cell roles; Epididymal maturation of sperm; Testicular function and endocrine control; Seminal plasma composition and function; Erectile physiology and ejaculation; blood testis barrier and immune privilege;

b. Oogenesis: folliculogenesis, hormonal control, granulosa and theca cell interactions;

c. Estrous/menstrual cycle: hormone feedback loops and ovarian dynamics; Folliculogenesis and luteal physiology; Endometrial remodelling and angiogenesis; Cervical and vaginal physiology; Role of prostaglandins and endometrial immune cells; Role of FSH, LH, inhibin, activin, and AMH;

d. Gonadal steroidogenesis and enzyme pathways

e. Neuroendocrine regulation of reproduction: Hypothalamic-pituitary-gonadal (HPG) axis; Pulsatile hormone release and feedback mechanisms; role of kisspeptin, GnRH, neurokinin B, and dynorphin; Integration with stress, metabolic, and circadian signals; Hypothalamic amenorrhea and functional reproductive disorders; Neuroendocrine regulation of sexual behaviour and libido

6: **Fertilization to Implantation**: Capacitation, acrosome reaction, and sperm-egg interaction; Molecular basis of fertilization and cross-talk; Zygote transport and early embryonic development; Uterine receptivity and implantation signaling - Decidualization and immune tolerance in implantation; Placentation and placental endocrine functions; Hormonal changes during pregnancy (hCG, hPL, progesterone, estrogens); Immunological aspects of pregnancy; Fetoplacental-maternal axis; Parturition: hormonal triggers, uterine contractility and reflex; Physiology of lactation: prolactin, oxytocin, milk production and ejection

LABORATORY COURSES

DCE 1C-P — **PRACTICAL** — **Full Marks=25**

1. Identification of endocrine glands using histological slides.
2. Routine HE staining of thyroid, adrenal and pancreas
3. Study of endocrine gland models and charts.
4. Interpretation of normal hormone laboratory reports (TSH, T3, T4, insulin and cortisol).
5. Blood glucose estimation.
6. Interpretation of endocrine case studies.
7. Separation of amino acids by paper chromatography.
8. Estimation of total protein serum
9. Studies on the determination of activity of some clinically relevant enzymes in serum: SGOT, SGPT, ALP
10. Acquiring knowledge on short-term culture of eukaryotic cells.
11. Demonstration: ELISA, RIA, Western Blotting for hormone receptors,
12. Determination of activities of steroidogenic enzymes.
13. Seminar on a common endocrine disorder.
14. Visit to a clinical biochemistry/endocrinology laboratory (optional).
15. Educational tour to assess to endocrine disorders in specific population.

DCE 1D-T — **THEORY** — **Full Marks=50**

ENVIRONMENTAL PHYSIOLOGY

1. Environmental biophysics

Environmental systems: atmosphere, hydrosphere, lithosphere, biosphere, Energy balance of Earth and environment, Solar radiation spectrum and intensity, Radiative transfer in atmosphere and Earth's surface, Albedo, greenhouse effect, and global energy balance.

Laws of thermodynamics in environmental systems, Heat transfer: conduction, convection, radiation in air, water, soil and biota , Thermal properties of natural systems, Microclimates and energy budgets of organisms, Water vapor in the atmosphere: absolute, relative, and specific humidity, Dew point, vapor pressure, and saturation concepts, Psychrometric principles and psychrometric chart, Measurement of

humidity: hygrometers, wet-and-dry bulb thermometers, Phase transitions: evaporation, condensation, sublimation, Latent heat of vaporization and its environmental role, Heat and mass transfer in humid air.

Humidity and Animal Physiology: Heat index and its physiological implications, Evaporative cooling and thermoregulation in animals, Respiratory water loss and adaptations in desert vs aquatic animals, Humidity effects on skin, hydration, and body electrolytes, Humidity effects on respiratory physiology and health (e.g., asthma, infections), Human thermoregulation under different humidity conditions.

Water Relations, Thermal conditions and Biophysics: Physical properties of water relevant to biology, Water potential and osmotic relations, tonicity, Soil–plant–atmosphere continuum (SPAC), Physics of lakes, rivers, and oceans (currents, waves, tides), Water cycle and hydrological processes, Heat capacity, viscosity, and density of water, Biophysical basis of drought resistance, pH and buffers,

Total body water distribution (intracellular, extracellular, plasma, interstitial fluids), Biophysical measurement of water compartments (dilution principle, isotopic tracers), Water dynamics between compartments, Role of plasma proteins in maintaining osmotic balance (oncotic pressure), Starling's forces and capillary exchange, Lymphatic system and fluid return mechanisms, Edema: physical basis and fluid imbalance, biophysical models of microcirculation, Membrane transport: aquaporins, ion channels, and pumps Biophysical control of cell volume, Osmotic fragility of erythrocytes, Sweating, and heat dissipation, Water loss through skin, lungs, and excretion, Dehydration and rehydration dynamics, Dehydration and rehydration at the cellular level in different ambient conditions, Role of kidney in water homeostasis, Body water balance and osmoregulation in different thermal states, Heat gain mechanisms.

Light, luminance and biophysics: Units and measurements, Nature of light: wave–particle duality, visible and invisible spectrum, electromagnetic spectrum, Properties of light: absorption, reflection, refraction, scattering, polarization, Interaction of light with matter (Beer–Lambert Law, fluorescence, phosphorescence, Measurement of light in biological systems (radiometry, photometry, PAR), Chromophores and pigments (chlorophyll, haemoglobin, melanin, rhodopsin), Absorption spectra of biomolecules, Photochemical reactions in biology, Fluorescence and bioluminescence mechanisms.

Light and vision- Physics of optics in the human eye, Biophysics of image formation, focusing, and visual acuity, Photoreceptor physiology (rods, cones, rhodopsin cycle), Colour vision and spectral sensitivity, Disorders of light perception (night blindness, colour blindness, photophobia), Non-visual photoreception (pineal gland, melanopsin-containing cells), Optogenetics and light-controlled cellular processes, Photoperiodism in animals (seasonal reproduction, migration, molting, hibernation), Light as a regulator of animal behavior, Illuminance effects and sleep–wake cycles (melatonin regulation, pineal physiology), Seasonal Affective Disorder (SAD) and light therapy, UV-B effects, photooxidative stress, and photoprotection.

Sound biophysics and acoustics: Nature of sound waves: frequency, wavelength, amplitude, velocity, Decibel scale and sound intensity levels, Resonance, interference, and absorption of sound, Acoustic properties of air, water, and biological tissues.

Sound , Human Hearing and animal acoustics: Structure and biophysics of the ear (outer, middle, inner ear), Mechanics of sound transmission in the ear (tympanic membrane, ossicles), Cochlear physiology: basilar membrane mechanics, hair cells, mechanoelectrical transduction, Frequency discrimination and pitch perception, Disorders of hearing: conductive and sensorineural deafness, Echolocation in bats, dolphins, and whales, Acoustic communication in birds, insects, and amphibians, Adaptations to underwater and ultrasonic communication. Bioacoustics of predator–prey interactions.

Ultrasound -Physics of ultrasound wave, Interaction of ultrasound with biological tissues, UV exposure and physiological markers (pigmentation, antioxidant activity), medical applications: ultrasonography, Doppler imaging, physiotherapy, therapeutic uses and bioeffects of ultrasound

Biophysics of radiation: Nature of radiation: ionizing and non-ionizing radiation, Electromagnetic spectrum and types of radiation (α, β, γ, X-rays, UV, IR, microwaves), Radiation sources: natural, artificial, cosmic,

nuclear, and medical, Units of radiation (Becquerel, Gray, Sievert, Rad, Rem, Curie), Principles of energy absorption and deposition in tissues, Linear energy transfer (LET) and relative biological effectiveness (RBE), Radiation tracks and dose–response relationships, Radiolysis of water and free radical formation, Physical, chemical, and biological dosimeters, Thermoluminescence dosimeters (TLD), film badges, ionization chambers, scintillation counters, Principles of dose distribution in tissues, International radiation safety standards (ICRP, IAEA, WHO) in hospitals, nuclear plants, and laboratories, Regulations for occupational exposure limits

2. Environmental Biochemistry

Biochemical basis of environmental interactions, Biomarkers of exposure, effect, and susceptibility, Ecosystem energetics and biochemical cycling of matter, Biochemistry of global climate change and greenhouse gases, Nutrient biochemistry and eutrophication Biochemical basis of sustainability and green chemistry approaches, Biochemistry of renewable energy sources (biofuels, biogas, hydrogen metabolism), Human impacts on biochemical processes of the environment, Biogeochemical Cycles- Carbon cycle: photosynthesis, respiration, carbon sequestration, Nitrogen cycle:, sulphur, phosphorus, and trace element cycles, Anthropogenic effects on natural biogeochemical cycles,

ATP generation and energy transduction, Role of cofactors and electron carriers (NAD^+, FAD, quinones, cytochromes, Environmental influences on energy metabolism.

Environmental Stress Biochemistry - Glycolysis, gluconeogenesis, and pentose phosphate pathway under aerobic and anaerobic conditions-Anaerobic metabolism in hypoxic environments (fermentation, lactate metabolism), exercise and carbohydrate metabolism, β oxidation and fatty acid synthesis under environmental stress, Membrane lipid remodeling under temperature and salinity stress, Lipid-based energy reserves in migration, hibernation, and starvation, Role of lipids in stress signaling (prostaglandins), Amino acid catabolism and nitrogen excretion (ammoniotelism, ureotelism, uricotelism), Oxidative stress and free radicals in organisms, Role of antioxidant defense systems (enzymatic and non-enzymatic)- enzymatic (SOD, catalase, peroxidases) and non-enzymatic (glutathione, vitamins), Immune system responses to environmental stressors.

Environmental water stress and physiological adjustments: Biochemical and physiological Mechanisms and adaptations

Environmental thermal stress and physiological adjustment: Heat shock proteins, stress proteins, and molecular chaperones, Biochemical responses to temperature, salinity, and UV stress, DNA and protein damage by radiation (strand breaks, crosslinking, mutations), Chromosomal aberrations and genomic instability

3. Environmental Pollution, Monitoring and Remediation

Water Pollution: Water pollutants: arsenic, fluoride, – biochemical and physiological mechanisms; Industrial and occupational hazards (solvents, asbestos, VOCs), Minamata disease, Itai-Itai disease,

Air pollution: Dispersion, transport, particulate dynamics, Effects of air pollutants (SO_2, NOx, CO, ozone, particulates) on respiratory and cardiovascular physiology, Case studies, Bhopal gas tragedy, remediation

Noise Pollution: measurement and analysis, mechanism, physiological effects, remediation

Soil pollution: sources, physiological impacts, remediation

Thermal Pollution: Sources and consequences, remediation

Radiation pollution: Sources, biological effects, nuclear accidents, radiation disasters and remediation, pace radiation and human physiology (cosmic rays, astronaut health risks)

Microbial Pollution: Microbial degradation of hydrocarbons, plastics, and xenobiotics, Heavy metal transformations and resistance, Microbial interactions with pesticides and industrial effluents, Biofilms in polluted environments

Bioremediation: Principles and strategies of bioremediation, Defence and Repair Mechanisms-Enzymes in pollutant degradation (laccase, peroxidases, dehalogenases), Enzyme assays in pollution monitoring (AChE inhibition, catalase, peroxidase activity), DNA repair mechanisms under environmental stress (BER, NER, homologous recombination, non-homologous end joining), DNA and protein damage markers, Molecular tools in environmental biochemistry (PCR, ELISA, omics-based approaches) Microbial metabolism of pollutants (hydrocarbons, plastics, pesticides)Phytoremediation, Microbial consortia in pollutant degradation, Biosurfactants, biofilters, and constructed wetlands, Microbes in waste recycling, composting, and sewage treatment, Waste management technologies and Artificial intelligence, Nanobiotechnology in waste management, Genetically engineered microbes for pollution control

LABORATORY COURSES

DCE 1D-P **PRACTICAL** **Full Marks=25**

1. Estimation of Chloride in natural water by titrimetric method
2. Determination of Dissolved Oxygen (DO) using Azide modification method
3. Estimation of Chemical Oxygen Demand (COD) in natural water by titrimetric method
4. Nitrate Determination in water by PDA method
5. Phosphate Determination in water by colorimetric method
6. Estimation of Arsenic in water by spectrophotometric method
7. Heat Stress Indices: Measurement of WBGT and CET
8. Noise Level Measurement using Sound Level Meter in occupational settings
9. Illumination Level: Determination using Luxmeter
10. Serum Calcium Estimation (Kramer & Tisdall method) in animals exposed to ETS; comparison with human smoker/non-smoker data
11. Blood Glucose Estimation (Nelson-Somogyi method) in tobacco-smoke exposed animals and human subjects
12. Estimation of SGOT and SGPT: Liver function indicators
13. DO and BOD Measurement in water samples
14. Chloride and Nitrate Measurement in water ($AgNO_3$ and PDA methods respectively)
15. Biochemical Identification of Food Additives (e.g., metanil yellow, rhodamine B, TOCP)
16. Educational tour to assess environmental influences on physiological parameters in humans.

DCE 1E **THEORY** **Full Marks=50**

NUTRITION AND DIETETICS

1. **Food Science:** Food groups and classification, *Water and Ice in Foods* - Structure and properties of water, Water activity (aw) and its effect on microbial growth and shelf life, Free water vs. bound water in foods. *Carbohydrates in Foods*-Structure and properties of sugars, starches, cellulose, pectins, gums, Functional roles: sweetness, crystallization, gelatinization, retrogradation, thickening, gelling, Changes during cooking and processing (Maillard reaction, caramelization). *Proteins in Foods* - Structure and classification of food proteins, Functional properties: solubility, denaturation, coagulation, foaming, emulsification, Protein-rich foods: milk, egg, meat, legumes, soy protein. *Fats and Lipids* - Structure and classification, Physical and chemical properties:

melting point, smoke point, rancidity, Role in flavor, texture, and satiety, Fats in food products: spreads, shortenings, emulsions.

Vitamins, Minerals, and Pigments - Effect of cooking and processing on vitamins, Pigments: chlorophyll, carotenoids, anthocyanins, betalains' Flavors and flavor compounds in foods, Food faddism, Adulteration of food and food contaminants, infective agents in food; natural good toxins. Food poisoning – chemical and microbial. Food allergy and hypersensitivity.

2. **Food guide and dietary guidelines:** Food Pyramid and Food Plate: Structure and concept of the Food Pyramid Concept and need for food guides; Dietary diversity and inclusion of all food groups, MyPlate and Indian Food Plate models, Cultural adaptation of food guides.

   Evolution of dietary guidelines, Balanced diet principles (ICMR/NIN), Indian Dietary Guidelines (ICMR-NIN), WHO/FAO food-based dietary guidelines, Comparative analysis of food guides across countries.

3. **Portion Size and Serving Standards:** Concept of portion size vs. serving size, Household measurements vs. standard measurements, Portion control for weight management, Portion estimation tools (cups, spoons, hand measures, food models)

4. **Food processing:** Factors effecting nutritive value in processed food; enrichment of foods; major chemical reactions in the food components. Effect of processing on nutrients – chemical and radiation hazards. Food additives, food colour and preservatives.

5. **Energy needs and energy balance:** Components of energy expenditure – Macronutrients and micronutrients: functions, requirements, and imbalances, Energy metabolism and nutritional energetics, BMR, physical activity, SDA of food etc. daily energy need. Regulation of energy intake – hunger and satiety – role of hypothalamus and limbic system. Positive and negative energy balance. Laws of thermodynamics and their application to nutrition. Weight control programs – dietary management, modification of physical activity and behavior.

6. **Nutritional biochemistry:** Nutrition–biochemistry interface: Essential vs. non-essential amino acids Overview of digestion, absorption, transport, and storage of micro and macronutrients, coenzymes and cofactors, Glycolysis, gluconeogenesis, glycogen metabolism, TCA cycle, oxidative phosphorylation, Blood glucose regulation, insulin and glucagon. Fatty acid metabolism (oxidation, synthesis, ketogenesis), Lipoproteins, cholesterol metabolism, prostaglandins, Protein metabolism and nitrogen balance, Amino acid catabolism and urea cycle. Biochemical roles of water- and fat-soluble vitamins, Coenzymes and co-factors, Deficiency disorders and biochemical manifestations, Mineral metabolism: calcium, iron, zinc, iodine, selenium.

7. **Metabolic disorders:** Diabetes mellitus, lactose intolerance, glycogen storage diseases, obesity, atherosclerosis, fatty liver disease, inborn errors of lipid metabolism, Inborn errors of amino acid metabolism (phenylketonuria, maple syrup urine disease), Deficiency disorders and biochemical manifestation of vitamins and mineral metabolisms, Biochemical markers of nutritional status (blood, urine, enzymes)

8. **Enzymes, hormones and integrated metabolism:** Integration of metabolism (fed state, fasting, starvation, exercise), Hormonal regulation of metabolism, Biochemical basis of malnutrition and metabolic syndrome

9. **Nutrition through Different Stages of Life:** Assessment of nutritional status: anthropometric, clinical, biochemical methods. Nutrition through the life cycle: infancy, childhood, adolescence,

pregnancy, lactation, elderly. Nutritional needs in infancy, childhood, adolescence and adulthood, Nutrition during pregnancy and lactation

10. **Geriatric Nutrition.** Aging and senescence, Demographic trends and the aging population, Physiological changes during aging (digestive system, musculoskeletal, renal, cardiovascular, and neurological), Concepts of successful aging, frailty, and quality of life, Energy, macronutrient, and micronutrient requirements in the elderly, Changes in nutrient metabolism with age, Fluid and electrolyte balance in older adults, Role of dietary fiber and antioxidants, Protein-energy malnutrition, undernutrition, and sarcopenia, Obesity and metabolic syndrome in old age, Micronutrient deficiencies (Vitamin D, Calcium, B12, Iron, Zinc), Osteoporosis and bone health, Cognitive decline, dementia, and nutrition, Oral health, chewing/swallowing difficulties, and implications for diet, Gastrointestinal problems (constipation, GERD, lactose intolerance), Cancer prevention and supportive nutrition, Immune system and role of nutrition in infection resistance, dietary management of diabetes, hypertension, renal dysfunctions in elderlies, Nutritional assessment tools for elderly (MNA, BMI, dietary recall, biochemical markers).

11. **Clinical Nutrition:** Principles of diet therapy: modification of diet in health and diseases, Nutrition and diet in the management of metabolic diseases (diabetes mellitus, gout), systemic diseases (hypertension, coronary heart disease, gastrointestinal diseases, renal disease), iodine deficiency disorder, dental diseases, disorders of pancreas, liver and biliary tract, diseases of the blood, inherited metabolic diseases (phenyl ketonuria, homocystinuria, glycogen, storage disease, galactosaemia, etc.) nutrition for post-operative patients.

12. **Advanced Therapeutic nutrition:** Nutrition in Stress (fever burn survey), Cancer, HIV, Osteoporosis and neurodegenerative diseases

13. **Emerging Trends in Nutrition & Dietetics:** Functional foods and nutraceuticals, Personalized nutrition, Nutrigenomics and nutrigenetics: biochemical perspectives, Probiotics and prebiotics, Nutrition in aging and longevity, Nutrition and climate change (sustainable diets, plant-based nutrition).

LABORATORY COURSES

DCE1E-P **PRACTICAL** **Full Marks=25**

1. Adulteration of food: (i) Metanil yellow in sweets, ice-cream and beverages. (ii) Aluminium foil in sweet. (iii)Margarin in Ghee. (iv) Water in Milk. (v) Chalk powder in sugar. (vi) Khesari flower in, Besan.
2. Estimation of serum constituents: a. protein b. glucose, c. cholesterol.
3. Nutritional assessment and Diet survey
4. Separation of bio molecules: Chromatography – a. Paper, b. thin layer, c. gas liquid chromatography (demonstration) d. High performance liquid chromatography (demonstration).
5. Genomic DNA isolation from blood and tissues.
6. Studies on the determination of activity of some clinically relevant enzymes in serum: SGOT, SGPT, Acid and alkaline phosphatase.

7. Educational tour to assess nutritional status and diseases related to the topic (paper) assessment of any population and report submission

DCE 1F-T THEORY Full Marks=50

IMMUNOLOGY AND MICROBIOLOGY

IMMUNOLOGY

Understanding of basic immunology

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

Components of the immune system and their roles in defense

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

Molecular immunology

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

MICROBIOLOGY

1. Understanding of diversity of the microbial world, Bacterial diversity, bacterial populations relevant to nutrient cycles in environmental systems, microbial evolution and systematic phylogenetic trees.
2. Methods of studying microbial diversity (Conventional and molecular tools).
3. Mechanisms of bacterial resistance to host cellular (phagocytosis) and humoral Defences. Immune escape mechanisms, Molecular basis of bacterial pathogenecity – cytoskeletal modulation of host cell, virulence genes and pathogenecity island, Host- pathogen specificity and genetics of host pathogen interactions
4. Pathogenesis of viral infection: Stages of infection, Patterns of some viral diseases-epidemiology, transmission, infection, symptoms, risk, transformation and oncogenesis, emerging viruses. Antiviral strategies-prevention and control of viral diseases: Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections, Contributions of various host defense mechanisms in viral infections.
5. Microbial physiology and metabolism

   History and major events in the development of microbiology, Structure, Function, Growth and Cell Division

   Regulation of Metabolic pathways, Metabolism of C1, carbohydrates, lipids, nucleotides, amino acids, Regulation and energetics of hexose and pentose m

   Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in some heterotrophic and chemolithotrophic bacteria. Bacterial anaerobic respiration: Electron transport chains in some anaerobic bacteria.

   Response to environmental stress, Catalase, super oxide dismutase, mechanism of oxygen toxicity, Heat-Shock responses, pH homeostasis, osmotic homeostasis.

   Nutrition as indication of physiological complexity: growth requirements, Nutrient requirements, nutrient mutants as physiological probes, Nutrient transport: Transport of solutes across the membrane, Active and Passive transport, Drug export systems, Carrier mediated transport mechanism, thermodynamics of transport process
6. Microbial genetics: horizontal and vertical gene transfer, bacterial genomic mapping, plasmids and genetic elements, lambda phage genetics and site-specific recombination, Phage transduction as a genetic tool, Phage display and applications.

LABORATORY COURSES

DCE 1F-P **PRACTICAL** **Full Marks=25**

1. Demonstration of animal handling for experimental purposes: cervical dislocation, dissection of rat and mice: cardiac puncture, blood sample preparation and its handling.
2. Diagnostic immunologic principles and methods: Demonstration of antigen-antibody reaction by agglutination, hemagglutination and precipitation reaction.

3. Cleanliness, media preparation, sterilization, culturing methods, dilution technique, and isolation of pure culture- techniques Serial dilution, Pour plate method, Spread plate method and streak plate method; Colony morphology, Staining techniques for bacteria and yeast: Gram Staining and Spore staining for bacteria; Methylene blue staining for Yeast
4. Bacterial growth curve: serial dilution plating and turbidity measurement, Enumeration of bacteria – Quantitative estimation of microorganisms – total and viable counts. Growth curves, Bacterial growth measurement, viable count by spread plate method, colony count. Enumeration by dry weight and turbidimetric methods.
5. Educational tour to study microbial and immunological diseases in human and report submission.



SEMESTER II

SUMMARY SHET

SEM	PAPER CODE	PAPER NAME	THEORY	CE	ATTENDANCE	TOTAL	PRAC / FILED TOUR	VIVA/ SEMINAR/ SURVEY/ REPORT/ REVIEW	TOTAL MARKS	TOTAL CREDIT
SEM II	CORE-4	MICROBIOLOGY, IMMUNOLOGY, MOLECULAR BIOLOGY AND GENETICS	50	20	05	75	25		100	5
	CORE-5	ENDOCRINOLOGY, REPRODUCTION, DEVELOPMENTAL BIOLOGY AND CHRONOBIOLOGY	50	20	05	75	25		100	5
	CORE-6	NERVOUS SYSTEM, SPECIAL SENSES AND BIOSTATISTICS	50	20	05	75	25		100	5
	GE	INTERDISCIPLINARY ASPECTS OF PHYSIOLOGY	50	20	05	75	25		100	5

SEMESTER II

CORE T 4 | **Theory** | **Full Marks = 50**

MICROBIOLOGY, IMMUNOLOGY, MOLECULAR BIOLOGY AND GENETICS

Group A

Full Marks =25

MICROBIOLOGY AND IMMUNOLOGY

MICROBIOLOGY

1. Microbiology: Historical developments in microbiology: brief history of infectious diseases, developments preceding the germ theory, the germ theory of disease. Classification of microorganisms: major groups of microorganisms. 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. Microbes in disease control, Probiotics and Prebiotics. Gut microbial flora and its importance in health and disease
2. Bacterial morphology. Growth and nutritional requirements of bacteria: growth curve, environmental influences on growth, nutritional requirements of bacteria, culture media. Sterilization, identification of bacteria, staining. Bacterial genetics: chromosome and plasmids, genes, genetic recombination, conjugation and chromosome mobilization, high frequency transconjugants, transduction: generalized vs specialized, transformation, comparative prokaryotic genomics.
3. Virology: general properties of viruses, nature of virion, virus host, classification, reproduction and multiplication, bacteriophages, single stranded filamentous DNA bacteriophages, lytic phage, temperate bacteriophages - lambda, transposable phage, RNA bacteriophages, animal viruses, viroid and prions, classical bacteriophage T4 and T7 genetics. COVID 19.
4. Fungi: morphology and growth.
5. Control of microbial growth: Chemotherapeutic agents - Classification and mechanism of actions of antibiotics. Bacteriostatic and bactericidal agents.

IMMUNOLOGY

1. Humoral and cell mediate immunity: antigen, epitope, immunoglobulin structure- types, biological properties. Immune response, innate and adaptive immunity; immune complex; antigen presentation, Structure and function of MHC – I and MHC –II, cell cooperation for triggering T and B cells interactions; B cell and T cell receptor signalling pathways; Immunosuppression,
2. Complement system - alternate, classical and lectin pathways. Cytokines and Chemokines; Mechanism of inflammation. Vaccine and development of vaccines.
3. Hypersensitivity and autoimmunity: IgE-mediated (type-I), Ab-mediated cytotoxic (type II), immune complex mediated (type-III), delayed type hypersensitivity (type-IV), anaphylaxis, 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.
4. Tumor & transplantation immunology: tumor immunology, oncogene and cancer induction, tumor antigens, immunotherapy; types, mechanism of transplantation rejection, prevention of graft rejection.
5. Immunological methods: Principle and procedure of antigen-antibody reactions, precipitation and agglutination reaction, titre, Ouchterlony double diffusion (ODD), single radial immune diffusion (SRID), ELISA, immunofluorescence, monoclonal antibody production.

Group B

Full Marks = 25

MOLECULAR BIOLOGY AND GENETICS

MOLECULAR BIOLOGY

1. 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.
2. 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, regulation of gene expression in prokaryotic and eukaryotic system.
3. 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.

GENETICS

1. 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,
2. Pedigree analysis, karyotyping, genetic disorders, structural and numerical alterations of chromosomes.
3. 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.

LABORATORY COURSES

CORE P 4 **Practical** **Full Marks = 25**

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

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

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

4. Haemagglutination test with antibodies of A, B, and D antigen.

5. Ouchterlony double diffusion test in agar-gel by kit for determination of antigen-antibody pattern.

6. Isolation, purification and characterization of bacteria from soil sample.

7. Isolation, purification and characterization of bacteria from water sample.

8. Determination of the concentration of viable bacteria in supplied solution by plate count method.

9. Pedigree analysis of common human dominant/recessive traits (PTC, rolling tongue polydactyly, Red Green colour blindness etc.)

10. Detection of ABO blood groups and determination of gene frequencies in human population.

11. Retrieval of amino acid sequence from mRNA

12. Retrieval of codogen in DNA from codon sequence of mRNA

13. DNA gel electrophoresis (Agarose Gel)

14. Genomic DNA/Plasmid isolation (Demonstration)

15. Separation, visualization and determination of molecular sizes of isolated DNAs by agarose gel electrophoresis.

16. Amplification of a target DNA by polymerase chain reaction and identification of amplified DNA by agarose gel electrophoresis

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

CORE T 5 Theory Full Marks = 50

ENDOCRINOLOGY, REPRODUCTION, DEVELOPMENTAL BIOLOGY AND CHRONOBIOLOGY

Group A
Full Marks =25

ENDOCRINOLOGY

1. Classification of hormones, Mechanism of hormone action.
2. Hypothalamic neurosecretory systems: Regulation of anterior and posterior pituitary hormones; Hypothalamo-hypophysial axis and anterior pituitary hormones.
3. Stress and the HPA Axis: Mechanisms of stress response, effects on metabolism and immune function; Neuropeptides and Hormones role on social–emotional behaviours; Neuroendocrine Regulation of Appetite: Hypothalamic centres, ghrelin, leptin, and the gut-brain axis.
4. Thyroid Hormones: Synthesis, secretion, and physiological actions. Disorders and clinical implications; Adrenal Cortex and Medulla: Hormones (glucocorticoids, mineralocorticoids, catecholamines) and their role in stress physiology; Pancreas and Glucose Regulation: Insulin, glucagon, and somatostatin; diabetes mellitus and metabolic syndrome; Hormones involved in calcium metabolism: role of parathyroid hormones, dihydrocholecalciferol, and calcitonin; osteoporosis - primary and secondary type; phosphorus metabolism.

REPRODUCTION

1.Embryology of the gonads and genital ducts – Origin of primordial germ cells, Sex differentiation and determination, Endocrine function of gonads and its control system.

2.Function of mammalian testis: Spermatogenesis; Sertoli cells – germ cells – Leydig cells interaction; functions of Sertoli cells and Leydig cells, Blood testis barrier. Structure of Sperm: histology, biochemistry and capacitation of spermatozoa.

3.Functions of mammalian ovary: Folliculogenesis, Oogenesis, Ovulation, Luteinization and Luteolysis. Biological action of gonadotropins on gonads. Feedback control of gametogenesis and endocrine functions of gonads. Photoperiods.

4.Fertilization and Implantation: Molecular mechanism of fertilization; acrosomal reaction; Sperm-induced oocyte activation and completion of meiosis at fertilization. Mechanism and control of fertilization. Decidualization, function of placenta and foeto-placental unit, placental hormone (synthesis, control; role in foetal life and bioassay of HCG), Physiology and maintenance of pregnancy.
5.Parturition and Lactation: Mechanism and Regulation of parturition and lactation, Hormonal control of mammary glands during pregnancy and after parturition; significance of breast feeding.
6. Principle and Techniques of fertility regulation in male and female: chemical, mechanical and immunological method of controlling fertility, in vitro fertilization, preservation of gametes and embryo transfer and amniocentesis.

Group B
Full Marks =25

DEVELOPMENTAL BIOLOGY

1.Basic concepts of development: potency, commitment, specification, induction, competence, determination and differentiation. Planar cell polarity (PCP), genomic equivalence and the cytoplasmic determinants.

2.Morphogenesis and organogenesis in animals – cell aggregation and differentiation, limb development and regeneration, differentiation of neurons, environmental regulation of normal development,

3.Stem cells: Molecular basis of genesis and differentiation of stem cells, types and characteristics of stem cells, Placenta as a source of stem cells and its importance in stem cell research, Applications and prospects of stem cells in Modern Biology and Health Sciences.

4.Genetic basis of evolutionary changes in development

5.Ageing and senescence.

6.Teratology: causes of congenital malformities, developmental basis of common birth defects, teratogens.

CHRONOBIOLOGY

1. Introduction to chronobiology: Definitions and scope.
2. Types of rhythms (circadian, ultradian, infradian); Molecular mechanisms of circadian rhythms: Clock genes, feedback loops, and protein interactions; Environmental entrainment: Zeitgebers and their relation to circadian clock;
3. Suprachiasmatic Nucleus (SCN): The central circadian pacemaker; Melatonin and Pineal Gland: Regulation, secretion, and physiological roles;
4. Sleep-wakefulness cycles: Neural and endocrine regulation of sleep; insomnia and narcolepsy; Shift work and jet lag: Mechanisms, physiological effects, and management strategies;
5. Disruption of biological rhythms: Impact of circadian misalignment on metabolic and endocrine disorders.

LABORATORY COURSES

Core P 5 — **PRACTICAL** — Full Marks = 25

1. Identification of endocrine glands using histological slides.
2. Routine HE staining of thyroid, adrenal and pancreas
3. Study of endocrine gland models and charts.
4. Interpretation of normal hormone laboratory reports (TSH, T3, T4, insulin and cortisol).

5. Microscopic study of different stages of embryonic development, placenta and organogenesis.
6. Interpretation of hormone profiles (FSH, LH, estrogen, progesterone, testosterone, hCG).
7. Histological staining of reproductive tissues
8. Monitoring and studying estrous cycle of mammals
9. Sperm count and sperm morphology of mammals

CORE T 6 **Theory** **Full Marks = 50**

NERVOUS SYSTEM, SPECIAL SENSES AND BIOSTATISTICS

Group A
Full Marks = 25

NERVOUS SYSTEM AND SPECIAL SENSES

1.Evolutionary development of central nervous system, with special reference to cerebrum and cerebellum, Neurophysiology of planning, programming & execution of motor tasks, Experimental methods in the study of CNS functions,

2.Neurogenesis & Gliogenesis, Functions of glial cells, Higher order functions of Cerebral Cortex- Blood-Brain-Barrier.

3.Structure-activity relationship of cerebellum, Regulatory function of cerebellum with special reference to autonomic function, Basal nuclei and its involvement in motor movement. Thalamocortical projections and its influence on evoked cortical activity. Verbal and non-verbal communication,

4.Cognition and Emotion control system -role of hypothalamus and limbic system, Neural Plasticity, Dominant Cortex, Amnesia and dementia, depression, schizophrenia. Mood, Anxiety and Stress-Related Disorders, Personality and neurodevelopmental disorders,

5.Modern concepts of sleep & wakefulness, Posture and equilibrium control system – role of vestibular apparatus, cerebellum, basal ganglia and Reticular Formation of brainstem; regulation of muscle tone and neurophysiological basis of decerebrate rigidity, Stretch Reflexes.

6. Taste sense – Taste receptors – distribution, ultramicroscopic structures, innervation, mechanisms of transduction; Sensory processing; Taste pathways, after taste, taste diversity.

7. Olfactory sense – Olfactory epithelium and receptors, turnover and regeneration of olfactory receptor cells; Central olfactory connections; Anosmia and directional smelling.

8. Visual Sense: E.M. structure of retina and Photoreceptors, photo-transduction; Visual pathway, Visual cortex and cortical processing; light and dark adaptation, Modern concept of colour vision- colour coding and colour blobs, binocular and stereoscopic perception, visual acuity, critical fusion frequency, Positive and negative after images.

9. Auditory Senses: ultramicroscopic structure of Organ of Corti, cochlear mechanics, sensory transduction and processing; Auditory pathway, Functions of auditory system – Frequency analysis and its discrimination; pitch; loudness adaptation, masking, auditory fatigue.

Group B

Full Marks = 25

BIOSTATISTICS

1. Basis concepts of - population, sample, sampling methods, Variables, data: parametric and nonparametric statistics; significance of statistical analysis of biological data.

2. Method of data collection, measure of central tendency and dispersion; standard score, degrees of freedom; Probability and distribution: normal distribution, student's t distribution.

3. Design of experiment: Data Presentation- graphical representation.

4. Testing of hypothesis, errors of inference, levels of significance, t-test, z score, Chi-square test.

5. Parametric & non-parametric statistics: Analysis of variance (ANOVA): models and types, one-way & two-way ANOVA, Kruskal Wallis non-parametric ANOVA; Multiple comparison t test, Schiff f test, Mann-Whitney U test; Pearson's product-moment correlation, multiple correlation, partial correlation, Spearman's rank difference correlation; Regressions: linear and non-linear; Logistic regression and multivariate analysis.

LABORATORY COURSES

CORE P 6 Practical Full Marks = 25

1. Audiometry
2. Determination of Visual acuity by Snellen's chart
3. Determination of Colour vision by Ishihara chart
4. Olfactory discrimination and adaptation
5. Neural Perception -stick drop test, two-point discrimination.
6. Practical problems on statistical data analysis

Generic Elective -GE T Theory Full Marks = 50

INTERDISCIPLINARY ASPECTS OF PHYSIOLOGY

Group A

Full Marks = 25

HUMAN HEALTH AND LIFESTYLE DISSORDERS

1. Human Health and Lifestyle Disorders: Concepts of health, disease, and wellness. Physiological determinants of health. Epidemiology and burden of lifestyle diseases. Urbanization, sedentary behaviour, stress, and health outcomes. Physiological basis of non-communicable diseases (NCDs).
2. Nutrition and metabolism: Principles of human nutrition. Macronutrient and micronutrient metabolism. Dietary fibres. Energy balance and metabolic regulation. Food calories, SDA, NPU, PER, BMR, ACU. Nutritional assessment and dietary guidelines. Role of nutrition in disease prevention and health promotion. Food preservation and food adulteration- impact on human health
3. Obesity and diabetes: Physiology of adipose tissue and energy homeostasis. Pathophysiology of obesity. Metabolic syndrome and associated complications. Insulin secretion and action. Mechanisms of insulin

resistance. Physiological basis and complications of Type 1 and Type 2 diabetes mellitus. Prevention and management strategies.

4. Hypertension: Regulation of arterial blood pressure. Neural, hormonal, and renal mechanisms in hypertension. Endothelial dysfunction and vascular remodelling. Risk factors and complications of hypertension. Lifestyle and therapeutic interventions in blood pressure management.
5. Public health awareness: Health education and disease prevention. Community-based approaches to health promotion. Screening and early detection of lifestyle disorders. National and global strategies for control of non-communicable diseases. Physiologist's role in public health initiatives.
6. Lifestyle modification: Scientific basis of lifestyle interventions. Physical activity and exercise prescriptions. Stress management and behavioral modification. Sleep hygiene and circadian health. Evidence-based approaches for prevention and management of lifestyle diseases.
7. Yoga and wellness: Physiological principles of yoga. Yoga as a mind-body intervention. Effects of asanas, pranayama, and meditation on physiological systems. Yoga in stress reduction, metabolic health, and cardiovascular function. Role of yoga in preventive and integrative healthcare. Concepts of holistic wellness and quality of life.

Group B

Full Marks = 25

ENVIRONMENT, SPACE AND OCCUPATIONAL PHYSIOLOGY

1. Introduction to Environmental Physiology: Scope and significance of environmental physiology. Homeostasis and physiological adaptation. Acclimatization, acclimation, adaptation, and tolerance. Environmental stressors and their physiological consequences.
2. Thermal Physiology: Mechanisms of thermoregulation. Heat production and heat loss. Physiological responses to heat stress. Heat exhaustion, heat stroke, and preventive measures. Physiological responses to cold exposure. Hypothermia, frostbite, and cold adaptation.
3. High-Altitude Physiology: Atmospheric pressure and oxygen availability at altitude. Acute physiological responses to hypoxia. Acclimatization to high altitude. High-altitude pulmonary edema (HAPE) and cerebral edema (HACE). Adaptations in high-altitude populations.
4. Diving and Hyperbaric Physiology: Physiological effects of increased pressure. Gas laws and their physiological relevance. Decompression sickness and nitrogen narcosis. Hyperbaric oxygen therapy and its applications.
5. Environmental Pollution and Human Physiology Air pollution and respiratory health. Water and soil contaminants. Heavy metals, pesticides, and endocrine disruptors. Physiological effects of environmental toxins. Oxidative stress and environmental health.
6. Occupational and Industrial Physiology: Physiological responses to occupational stress. Egonomics and workplace health. Shift work and circadian disruption. Occupational hazards and preventive strategies.
7. Climate Change and Human Health: Physiological consequences of global warming. Extreme weather events and human adaptation. Climate-sensitive diseases and public health concerns. Strategies for resilience and adaptation.
8. Space and Extreme Environment Physiology: Physiological effects of microgravity. Musculoskeletal and cardiovascular adaptations in space. Radiation exposure and physiological risks. Human survival in extreme environments.

LABORATORY COURSES

GE P — Practical — Full Marks = 25

1. Dietary food consumption and nutrient analysis study of family and community
2. Nutritional anthropometry.
3. Detection of food adulteration in food samples

4. Biochemical analysis of food macro and micro-nutrient content (protein, carbohydrate, fat and ascorbic acid. Ca, Fe etc.).
5. Determination of dissolve oxygen (DO) in natural water.
6. Determination of Chemical Oxygen Demand (COD) in natural water by titrimetric method.
7. Determination of nitrate in natural water by PDA method.
8. Determination of phosphate in natural water by colorimetric method.
9. Determination of arsenic in natural water by standard analytical method using
10. Community health survey and report submission

SEMESTER III

SUMMARY SHET

SEM	PAPER CODE	PAPER NAME	THEORY	CE	ATTENDANCE	TOTAL	PRAC / FIELD TOUR	VIVA/ SEMINAR/ SURVEY/ REPORT/ REVIEW	TOTAL MARKS	TOTAL CREDIT
SEM III	COURSEWORK PAPER-I	ADVANCED CELLULAR AND MOLECULAR PHYSIOLOGY	50	20	05	75	25		100	5
	COURSEWORK PAPER-II	CLINICAL AND TRANSLATIONAL PHYSIOLOGY	50	20	05	75	25		100	5
	COURSEWORK PAPER-III	BIOMEDICAL INSTRUMENTATION AND ADVANCED PHYSIOLOGICAL TECHNIQUES	50	20	05	75	25		100	5
	RESEARCH PAPER-I	REVIEW WRITING AND SEMINAR PRESENTATION	Review article submission & Evaluation 50	20	5	75		Seminar Presentation of Review Work 25	100	5

SEMESTER III

COURSEWORK -CWP-T 1 | Theory | Full Marks = 50

ADVANCED CELLULAR AND MOLECULAR PHYSIOLOGY

Group A

Full Marks =25

MEMBRANE TRASPORT AND BIOELECTRICITY

1. Biological transporters: ATP-dependent transporters, Na^+/K^+-ATPase, Ca^{2+}-ATPase, H^+/K^+-ATPase, ABC transporters and multidrug resistance proteins., Solute carrier (SLC) transporters, Regulation of transporter expression and trafficking, Transporter dysfunction in disease, Active transport, passive transport, intracellular transport, Nuclear transport, transport across membranes, Carrier-mediated transport, Vesicular transport: endocytosis and exocytosis, Electrophysiological basis of membrane transport.
2. Ion Channels- Structure, Function and Regulation: Classification of ion channels, Voltage-gated channels, Ligand-gated channels, Mechanosensitive channels, TRP channels, Molecular architecture of ion channels, Gating mechanisms, Ion selectivity and conductance, Single-channel properties, Voltage clamp technique, Patch-clamp studies and channel kinetics, Channel modulation by intracellular signaling pathways, Channelopathies.
3. Membrane Potential and Bioelectricity: Biophysical basis of membrane potential, Ionic basis of resting membrane potential, Action Potential, Goldman-Hodgkin-Katz equation, Nernst equilibrium potential, Electrogenic transport mechanisms, Membrane capacitance and resistance, Electrical properties of biological membranes, generator potential, EPP, EPSP, IPSP, LTP, LTD. MEPP – quantal transmitter release, botulism and tetanus, IS spike and SD spike.
4. Muscle and Synaptic Physiology: Threshold and excitability, Generation and propagation of action potentials, Voltage-gated Na^+, K^+ and Ca^{2+} channels, Refractory periods, Conduction velocity and saltatory conduction, Excitation-contraction coupling, Excitation-secretion coupling, Electrical activities in smooth muscle and cardiac muscle and contractile mechanisms, Synaptic integrity, Plasticity, Neurotransmitters and neuromodulators, Co-transmission, Molecular basis of synaptic transmission, Neurophysiology of learning and memory

Group B

Full Marks =25

MOLECULAR MOTORS, CELLULAR DYNAMICS, COMMUNICATION AND HOMEOSTASIS

1. Molecular Motors: Structure and Mechanisms, actin based molecular motors, microtubules based molecular motors, molecular motors in cell division, molecular motors in specialized physiological system
2. Cellular Dynamics: Cytoskeletal system, cytoskeletal remodelling and cellular plasticity, Regulation of cytoskeletal assembly and disassembly, Cell polarity and spatial organization
3. Cell Communication and Cell Signalling: Cell Adhesion Molecules (CAMs), Gap junctions, Desmosomes, Extracellular Matrix (ECM), Integrin signalling, Electrical signalling in neurons, muscle and endocrine cells, Cell Signalling and Principles of Signal Transduction-Autocrine, paracrine, endocrine and juxtracrine signalling, Signal amplification and integration, G protein and G-protein coupled receptors (GPCRs), Enzyme-linked receptors, Cytokine receptors, Intracellular and nuclear receptors, Second Messenger Systems - cAMP and cGMP pathways, Phosphoinositide signalling (IP_3/DAG), Calcium signalling, Nitric oxide signalling, Protein Kinases and Cellular Responses- Protein phosphorylation, MAPK signalling pathways, PI3K-AKT pathway, Cross-talk among signalling pathways
4. Cellular Homeostasis and Cell Fate: Cell Cycle and Growth Regulation-Cell cycle checkpoints, cyclins and cyclin-dependent kinases, Growth factors and cell proliferation, Apoptosis: intrinsic

and extrinsic pathways, Autophagy, Necroptosis and pyro ptosis, Physiological significance of cell death

5. Advanced Cellular Mechanisms: Stem cell biology, Differentiation, Cellular stress response, Stress response genes, Epigenetic regulation of gene expression, cellular adaptation to environmental changes

LABORATORY COURSES

COURSEWORK -CWP-P 1 **Practical** **Full Marks = 25**

1. Isolation and staining of node of Ranvier
2. Isolation and staining of cardiac, skeletal and smooth muscle
3. Study on conduction velocity of nerve.
4. Calculation of latent period of toad sciatic gastrocnemius contraction.
5. Effect of two successive stimuli on contraction of toad sciatic gastrocnemius preparation.
6. Numerical problems on bioelectric potential.
7. Separation and staining of peripheral blood mono-nuclear cells

COURSEWORK -CWP-T 2 **Theory** **Full Marks = 75**

CLINICAL AND TRANSLATIONAL PHYSIOLOGY

Group A

Full Marks =25

DISEASE DEVELOPMENT AND PATHOPHYSIOLOGY

1. Fundamental Concepts: Health, disease and homeostatic imbalance, Aetiology and pathogenesis of disease, Adaptation versus maladaptation in health and disease, Mechanisms of hypertrophy. Atrophy, hyperplasia and metaplasia, Disease susceptibility: genetic, epigenetic and environmental influences, Physiological basis of risk factors and comorbidities, Systems-level integration in disease progression
2. Cellular Stress, Injury and Organ Dysfunction: Cellular stress responses and adaptive mechanisms, Oxidative stress, mitochondrial dysfunction and energy failure, Endoplasmic reticulum stress and unfolded protein response, Apoptosis, necrosis, autophagy and cellular senescence, Transition from cellular dysfunction to organ failure
3. Inflammation and Tissue Injury: Acute and chronic inflammatory responses, Mediators of inflammation, Role of cytokines and growth factors in systemic immune responses, Neuroimmune-endocrine interactions, Immunometabolism and inflammatory diseases, Tissue repair, regeneration and fibrosis
4. Cardiovascular and Renal Pathophysiology: Endothelial dysfunction and atherosclerosis, Heart failure and cardiac remodelling, Ischemic heart disease, Myocardial infarction, Cardiac hypertrophy, Cardiac valve disorder, Fluid-electrolyte imbalance, Acute and chronic kidney

disease, renal diseases and mechanisms of Nephritis, Kidney stone, Renal failure, Diseases of urinary bladder and sphincter, Atonic bladder, Hypoxia, ischemia and reperfusion injury

5. Pulmonary disease pathophysiology: Ventilatory disorders and pathophysiology of respiratory failure, Asthma and COPD, Alveolar fibrosis, pulmonary circulation and hypertension, Pulmonary-cardiovascular interactions, Physiological basis of oxygen therapy, Artificial respiration
6. Gut Pathophysiology: GI tract related diseases like Ulcer, Varices, Irritable Bowel Syndrome, pancreatitis, Malabsorption and Diarrhoea, Gut-brain axis, Gut-liver axis, Microbiome and metabolic disorders, Microbiome-based therapeutics
7. Endocrine, Metabolic and Reproductive Physiology: Hypothalamic-pituitary disorders, Thyroid dysfunction, Adrenal disorder, Disorders of calcium metabolism, Obesity and metabolic syndrome, Metabolic adaptation during fasting and starvation, Energy balance and appetite regulation, Male reproductive dysfunction, Female reproductive disorders
8. Neural Disease Pathophysiology: Alzheimer's Disease: amyloid plaques, tau tangles, Parkinson's Disease: dopamine deficiency, Lewy bodies, Huntington's Disease: trinucleotide repeat expansion, Amyotrophic Lateral Sclerosis: motor neuron degeneration

Group B

Full Marks =25

METHODOLOGIES IN TRANSLATIONAL MEDICINE

1. Preamble of Translational Medicine and Bench to Bedside: Definition and significance, Historical perspective. The Translational Continuum; Basic research, Preclinical studies, Clinical trials, Implementation in clinical practice, Requirement of preclinical validation. Phases of Clinical Trials; Phase I: First-in-Human Studies, Phase II: Proof-of-Concept Studies, Phase III: Efficacy and Safety Trials, Phase IV: Post-Marketing Surveillance.
2. Cell culture: 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
3. Culture Media: Composition of culture media, Natural and synthetic media, Serum and serum-free media, Preparation and sterilization of media
4. Cell Culture Techniques: Isolation of cells, Subculturing (passaging), Cell counting methods, Cryopreservation and revival of cells
5. Maintenance and Monitoring: Growth characteristics of cultured cells, Cell viability assays, Detection and prevention of contamination, Morphological examination of cells
6. Applications of Cell Culture: Vaccine production, Drug screening and toxicity testing , Cancer research, Tissue engineering and regenerative medicine, Production of biological products
7. Transgenic animal and chimera: Production of Transgenic Animals and gene transfer techniques, Applications of Transgenic Animals, Chimeric technology- methods, types, characters and applications
8. Artificial Intelligence and Computational Physiology: Basics of AI, Machine Learning, Deep Learning, Big data and systems physiology, Digital twins in healthcare, AI Applications in Disease diagnosis, Patient monitoring, Predictive modelling
9. Translational Neuroscience: Translational Approaches to Neurological Disorders, Stroke and neurodegenerative diseases, Traumatic brain injury and spinal cord injury, Psychiatric disorders and addiction, Neurogenetics and Genomic Medicine, Genetic basis of neurological and psychiatric disorders, Advances in genomics and personalized medicine, Mechanisms of action of psychoactive drugs, Pharmacotherapy for neurological and psychiatric disorders Gene therapy and gene editing approaches .
10. Translational Oncology: Cancer biology basics, oncogenes and tumour suppressor genes, Cancer signalling pathways, solid tumours and haematological malignancies, cancer diagnostics, staging and grading, Oncology pharmacology, Mechanisms of carcinogenesis and tumour growth, Chemotherapeutic agents and targeted therapies, Personalized medicine approaches in oncology

11. Advanced Pharmacology and toxicology: Fundamentals of pharmacodynamics and pharmacokinetics; receptor theory and drug–receptor interactions; mechanisms of drug action including agonists, antagonists, inverse agonists, partial agonists, and allosteric modulators; signal transduction pathways and pharmacological modulation; drug absorption, distribution, metabolism, and elimination (ADME); drug clearance, biological half-life, pharmacokinetic models, and principles of rational drug dosing; Phase I and Phase II drug metabolism; cytochrome P450 enzymes and drug–drug interactions; pharmacogenomics and pharmacogenetic variability in individualized drug response and precision medicine; principles of toxicokinetics and toxicodynamics; mechanisms of xenobiotic absorption, distribution, biotransformation, bioactivation, bioinactivation, and elimination; factors influencing xenobiotic action; design and interpretation of toxicity studies; cellular and molecular mechanisms of toxicity; xenobiotic-induced oxidative stress; hepatotoxicity, nephrotoxicity, neurotoxicity, reproductive toxicity, genotoxicity, immunotoxicity, endocrine disruption, and developmental toxicity; environmental toxicology, human health risk assessment, environmental risk management, and biomonitoring using biomarkers and biosensors.

LABORATORY COURSES

COURSEWORK -CWP-P 2 **Practical** **Full Marks = 25**

1. Histology of different mammalian tissues: Tissue preparation, histological sectioning and permanent slide preparation; Haematoxylin/ Eosin staining of histological sections.
2. Pathophysiological slide identification.
3. Plates of different pathological condition and disease identification
4. Micronuclei detection in mucosal epithelium
5. Preparation of culture media.
6. Demonstration of sterilizing techniques and autoclaving.
7. Demonstration of effect of drugs on heartbeat of toad.
8. Study (Demonstration) of bioassay of drugs on mammalian intestine.
9. MTT assay
10. Knowledge on drug isolation, purification of drug and biological activity testing in both animal model lines
11. Lethality assessment: MLD, LD50, IC50 of drugs.
12. Hematological investigations: Complete blood count (CBC) and differential leukocyte count.
13. Estimation of ESR and interpretation in inflammatory diseases.
14. Measurement of blood glucose, HbA1c (demonstration) and interpretation in diabetes.
15. Analysis of liver function tests (ALT, AST, bilirubin) and renal function tests (urea, creatinine).
16. Electrolyte estimation and interpretation of acid–base disorders.
17. Clinical interpretation of lipid profile and cardiovascular risk markers.

18. Urinalysis for renal disorders (protein, glucose, ketone bodies, microscopic examination).

19. Isolation of peritoneal macrophage and determination of phagocytic index.

COURSEWORK -CWP-T3 **Theory** **Full Marks = 50**

BIOMEDICAL INSTRUMENTATION AND ADVANCED PHYSIOLOGICAL TECHNIQUES

Group A

Full Marks =25

BIOMEDICAL INSTRUMENTATION

1. Fundamentals of Biomedical Instrumentation: Components, Sensors and transducers, Signal conditioning systems, Amplification and filtering, Analog-to-digital conversion, Sources of biological noise and artifact removal, Data acquisition system, Data interpretation and visualization,
2. Bioelectric signals, their characteristics and clinical significance: Electrocardiography (ECG), Electroencephalography (EEG), Electromyography (EMG), Electrooculography (EOG), Evoked potentials, ERG, Hemodynamic principles and blood pressure measurement
3. Centrifugation: Basic Principles and Applications, Relative centrifugal force (RCF) and sedimentation coefficient Components of a centrifuge, Types of rotors: fixed-angle, swinging-bucket, vertical rotors, Differential centrifugation, Density-gradient centrifugation, Rate-zonal centrifugation, Isopycnic centrifugation, Ultracentrifugation and its applications
4. Physiological Imaging, Functional Assessment, Working Principle and Applications: Ultrasonography, Doppler imaging, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Functional MRI (fMRI), Positron Emission Tomography (PET), cathode ray oscilloscope (CRO). Scintillation counter and principles of radioactivity, Radio isotopic tracer techniques: Process and applied value.
5. Instrument Calibration and Quality Assurance: Calibration procedures, Instrument validation, Safety regulations in biomedical laboratories, Good Laboratory Practice (GLP)

Group B

Full Marks =25

ADVANCED PHYSIOLOGICAL TECHNIQUES

1. Microscopy: Principles, components, techniques and application of - light microscopy, fluroscence microscopy, phase contrast microscopy, Confocal microscopy image analysis, TEM and SEM
2. Chromatography - Principle, technique, applied value of major types (Paper Chromatography, TLC, Gel filtration, Ion-exchange, Immuno-affinity), HPLC (in brief).
3. Spirometry: Spirometry and lung function tests. Work of heart, Pressure volume relations of heart; significance of echocardiography and ECG in the assessment of cardiac function,
4. Spectrophotometry and Colorimetry: Principles. Laws, components, applications, transmittance, absorbance, optical density.
5. Autoradiography - principle and applied value.
6. Molecular Techniques: Polymerase Chain Reaction (PCR) and Real-Time PCR Principle, techniques and applications of - Gel electrophoresis, SDS-PAGE; Immuno-electrophoresis, blotting techniques - Southern blotting, Northern blotting, Western blotting, SDS-PAGE; Immuno-electrophoresis - Principle, techniques and applications, Autoradiography, Principles of ELISA, RIA and immunoassays, DNA and protein Sequencer, Gene expression analysis

7. Spectroscopy: Atomic absorption spectroscopy, Infrared spectroscopy, X-ray diffraction, Microarray technology, Proteomics and Genomics
8. Histochemistry and Immunohistochemistry: Histochemical tissue processing, fixation, applications, Principles of antigen–antibody binding, Antigen retrieval techniques, Primary and secondary antibodies, Direct immunohistochemistry, Indirect immunohistochemistry, Immunofluorescence methods, Detection systems (enzyme-based and fluorescent methods), Principle of fluorescence and fluorochromes, Fluorescent dyes and probes (e.g., FITC, Rhodamine, DAPI), In Situ Hybridization (ISH)- Principle, probes, labelling, applications, FISH
9. Nanoparticles and its applications in Physiology

LABORATORY COURSES

COURSEWORK -CWP -P3 **Practical** **Full Marks = 25**

1. Histochemical staining tissues: PAS staining, Iron Haematoxylin staining, Sudan staining of adipose tissues.
2. Recording of 12-lead electrocardiogram; Computation of HR, PQ interval, QRS complex, PR interval, mean electrical axis from supplied ECG recording graph.
3. Pneumographic experiment.
4. Spirometry- Static and dynamic lung function test.
5. Haemagglutination test with antibodies of A, B, and D antigen.
6. DNA gel electrophoresis (Agarose Gel)
7. Genomic DNA/Plasmid isolation (Demonstration)
8. Separation, visualization and determination of molecular sizes of isolated DNAs by agarose gel electrophoresis.
9. Amplification of a target DNA by polymerase chain reaction and identification of amplified DNA by agarose gel electrophoresis
10. Isolation of cellular organelles (nuclei, mitochondria, lysosomes) from liver by differential centrifugation.
11. Chromatographic separation of biomolecules

RP-1

Full Marks = 75

REVIEW WRITING AND SEMINAR PRESENTATION

REVIEW WRITING

Full Marks = 50

Evaluation to be based on :

Abstract	5
Understanding and Review of Work done on topic	10
Organization and Coherence	5
Critical Analysis and Evaluation	10
Summary of the Work and Future Prospects	5
Bibliography	5
Language, Grammar, and Style	5
Originality and Personal Insight	5

SEMINAR PRESENTATION

Full Marks = 25

SEMESTER IV

SUMMARY SHEET

SEM	PAPER CODE	PAPER NAME	THEORY	CE	ATTENDANCE	TOTAL	PRAC / FILED TOUR	VIVA/ SEMINAR/ SURVEY/ REPORT	TOTAL MARKS.	TOTAL CREDIT
SEM IV	RESEARCH PAPER-2 (OPTIONAL) **ANY ONE OPTION TO BE TAKEN**	2A. SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS &YOGA 2B. BIOCHEMISTRY OF CELL 2C. ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY 2D. ENVIRONMENTAL PHYSIOLOGY 2E. NUTRITION &DIETATICS 2F. IMMUNOLOGY & MICROBIOLOGY	50	20	05	75		FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION 25	100	5
	RESEARCH PAPER-3 (OPTIONAL) **ANY ONE OPTION TO BE TAKEN**	3A. SPORTS, EXERCISE PHYSIOLOGY, ATHLETICS &YOGA 3B. BIOCHEMISTRY OF CELL 3C. ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY 3D. ENVIRONMENTAL PHYSIOLOGY 3E. NUTRITION &DIETATICS 3F. IMMUNOLOGY & MICROBIOLOGY		20	5	25	50	LABORATORY/ INSTITUTE VISIT AND REPORT SUBMISSION-25	100	5
	RESEARCH PAPER-4	SCIENTIFIC COMMUNICATION, COMPUTER APPLICATION AND DATA ANALYTICS	50	20	05	75	25		100	5
	FINAL SUBMISSION OF RESEARCH WORK	**DISSERTATION PAPER**	Dissertation Writing and Report Submission & Assessment-50	20	05	50		SEMINAR ON DISSERTATION 25	100	5

SEMSTER IV

RP-2 T THEORY (Advanced/Applied) **Full Marks = 50**

(Any one topic is to be selected in parity to DCE paper)

RP-2A-T Theory **Full Marks=50**

SPORTS , EXERCISE PHYSIOLOGY, ATHLETICS AND YOGA

1. Sports Medicine

Sports injury: mechanism, types, muscles, tenons, ligaments, joint injuries, eye injuries, neurological injuries, Intrinsic vs extrinsic risk factors for injury, Sports specific injuries, with special emphasis on the specific risk factor, nature of sports, kind of medical intervention anticipated and prevention with respect to individual sports (Individual events: Team events: Contact and Non-contact sports, Water sports specific injuries), Over-use training in Sports,

Principles of prevention and management of sports injury: Phases of tissue healing and rehabilitation stages, psychological aspects of injury and recovery, Acute management- first aid, Cardio pulmonary resuscitation, Pharmacological interventions: NSAIDs, corticosteroids, Surgical vs conservative treatment decisions, Return-to-play criteria and protocols, prehabilitation, sports physical therapy- Massage ,Heat therapy , Hydrotherapy ,Electrotherapy, Functional Bandages and Orthotic aids, Cryotherapy, Manual therapy, taping, bracing, use of equipment for injury management, Rehabilitation and therapeutic exercises, warm-up, Electromyography and Rehabilitation, Nutritional therapy

Sports psychology: Personality assessment and sports personality, Attention and perception in sports, Concentration training in sports, Motivational orientation in sports, pre-competitive anxiety, Relaxation training, Aggression in sports, Role of Psychology in dealing with injuries, Eating disorders, Goal setting (Psychological aspect of doping, stress management, group behaviour and leadership, emotion)

Sports pharmacology: Performance enhancing drugs, ergogenic aids, doping-history, definition, classification and their adverse effects on health and sports performance

2. Athletics, Sports skills, training and coaching:

Sports skills and technique: Skill and Techniques of track events and field events, Methods of teaching and training of skills and techniques of different track events and field, Preparation of training schedule for different events of track and field events like -sprits, middle-distance, long-distance relays and hurdles and steeplechase events, long jump, High jump, Pole vault, Shot put, Discus throw, Javelin throw and Hammer throw, Short term, Long term training plans and periodisation

Sports Training and Coaching: Characteristics of Sports Training, Principles of Sports Training and Coaching Adaptation process- factors affecting recovery, means of faster recovery, Meaning, forms, factors determining and training methods of -strength, speed, endurance, flexibility, co-coordinative abilities. Qualities and qualifications of a successful coach, Nature and scope of coaching profession, Sports Talent Identification and Development, Psychological and sociological factors in training competition, *Technique :* Meaning of technique, skill and style, significance of technique training in different sports, Factors affecting technique training, phases of technique training and their implications, *Tactical Training :* Meaning of strategy and tactics, difference between strategy and tactics, significance of tactics, Technical and tactical skills-passing, receiving, dribbling, shooting, blocking, serving, etc. (sport-specific) *Game tactics:* formations, strategies, offensive and defensive play, Team coordination and communication, *Competitions :* Types and importance of competitions as a methods of training. *Environmental factors and Sports Training :* Training plans and principles, periodization, training schedule and monitoring, *Rules, Officiating, and Scoring:* Team composition and substitution rules, Duties and responsibilities of referees/umpires Scoring systems and signals, Common rule violations and penalties, Use of technology in officiating (VAR, Hawk-

Eye, etc.) *Role of Managers and Coaches:* In controlling the dope and athletic problems, Safety appliances in different sports and their uses, Principles of safety and provisions of safety rules in competitive sports

3. Yoga Science and Meditation:

Concept of Yogic Practices: History, Yoga sutras, Dhyana, Samadhi, Principles of Breathing – Awareness – Relaxation, Sequence – Counter pose – Time – Place – Clothes – Bathing – Emptying the bowels – Stomach – Diet – No Straining – Age – Contra- Indication – Inverted asana – Sunbathing.

Aasanas and Pranayam: Loosening exercise: Techniques and benefits. Asanas: Types- Techniques and Benefits, Surya Namaskar: Methods and benefits. *Pranayama:* Types- Methods and benefits. Nadis: Meaning, methods and benefits, Chakras: Major Chakaras- Benefits of clearing and balancing Chakras.

Kriyas Shat Kriyas: Meaning, Techniques and Benefits of Neti – Dhauti – Kapalapathi- Trataka – Nauli – Basti, Bandhas: Meaning, Techniques and Benefits of Jalendhar Bandha, Jihva Bandha, Uddiyana Bandha, Mula Bandha.

Mudras: Meaning, Techniques and Benefits of Hasta Mudras, Asamyukta hastam, Samyukta hastam , Mana Mudra, Kaya Mudra, Banda Mudra, Adhara Mudra.

Meditation: Meaning, Types of meditation: mindfulness, transcendental, guided, mantra-based, Techniques and Benefits of Meditation, Om meditation, body scan, breath awareness Concept of dhyana (meditation) and its stages, Brain waves, attention, neuroplasticity, and mental health, performance, focus, and emotional stability

Yoga and Sports: Yoga Supplemental Exercise – Yoga Compensation Exercise – Yoga Regeneration Exercise-Role of Yoga in Psychological Preparation of athlete: Mental Wellbeing, Anxiety, Depression Concentration, Self Actualization. Effect of Yoga on Physiological System: Circulatory, Skeletal, Digestive, Nervous, Respiratory, Excretory System.

4. Environment and Exercise:

Thermal Balance Heat Exchange, Temperature, humidity, RH, dew point, GTI,

Thermoregulation: Normal Body Temperature, Behavioural and Physiological Thermoregulation, Fluid Ingestion during and after Exercise, Type of Fluid Ingested Exercise-Associated Hyponatremia (EAH)

Exercise in the Heat: Body Temperature during Exercise in the Heat, Heat Exchange during Exercise, Cardiovascular Demands of Exercise in the Heat Factors Affecting Cardiovascular Response to Exercise in the Heat, Heat Illness, Minor Exertional Heat Illness, Serious Exertional Heat Illnesses, Prevention of Exertional Heat Illness

Exercise in the Cold: Cold-Induced Injuries, Prevention of Cold-Induced Injuries, Influence of Sex and Age on Cold Tolerance

Hypobaric and Hyperbaric Condition: Physiological changes in Hypobaric and Hyperbaric Condition, Safety and management. Exercise underwater. Pressure, O_2, CO_2, *Altitude training:* effect of altitude on sports performance –adaptation to altitude detraining

Influence of Sex and Age on the Exercise Response in Heat and cold

5. Exercise for Special population

Genetic determinants of physical performance, Female and performance, Exercise for pregnant female, Exercise prescription for diabetic patients, chronic heart disease, renal, pulmonary and neuromuscular disease patients, exercise and training for young athletes, exercise and cancer outcome

6. Bioinstrumentation-Principles and applications in sports physiology

Bioinstrumentation: scope, types, and applications in sports science, Signal acquisition: analog vs. digital systems, Noise, signal filtering, and data integrity

Treadmill, bicycle ergometer and applications in exercise physiology, Electromyography, ECG, 3D motion capture systems and goniometers, Accelerometers and inertial measurement units (IMUs), Dual-energy X-ray absorptiometry (DEXA), Bioelectrical impedance analysis (BIA), Spirometry, Blood gas analysers. Monitoring ventilatory threshold, Determination of VO2 max

7: Research methodology in Sports and Athletic studies

Types of research: Basic, applied, qualitative, quantitative, experimental, and action research, *Emerging areas in sports research:* biomechanics, sports technology, performance analysis, injury prevention, *Ethical principles in sports research:* (informed consent, confidentiality, plagiarism, human/animal ethics), Role of research in evidence-based practice and policy-making in sports, Research Design and Sampling and formulation of hypothesis, Tools and Techniques of Data Collection, Qualitative research methods: ethnography, case study, grounded theory, Use of AI, big data, and wearable technology in sports research, Interdisciplinary approaches in sports science, Research article writing and presenting research data in sports science.

8: Statistical methods in Sports and Athletic studies:

Descriptive statistics: mean, median, mode, SD, range, percentiles, Z-scores and standard error, Binomial and Poisson distribution in sports data, *Inferential statistics*: t-test, ANOVA, chi-square, correlation, regression. non-parametric tests, Use of statistical software: SPSS, R, Excel

FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION- 25

OR

RP-2B-T Theory Full Marks=50

BIOCHEMISTRY OF CELL

1.Hormonal Biochemistry:

Molecular structure and Biosynthesis of hormones- adreno-cortical and medullary hormones, thyroid hormones, gonadal hormones. Molecular mechanism of action of peptide and steroidal hormones. Hormone-receptor interactions and signal transduction. Regulation and function of Insulin and Glucagon; Clinical endocrinology: Type II Diabetes, Goiter etc.-Mechanisms and Management, Hormonal replacement therapy.

2.Immunobiochemistry:

Chemical nature of antigens and antibodies. Antibody production. Clonal selection theory. Immunoglobulin genes and generation of antibody diversity; antigen-antibody interactions, complement fixation reactions, cytokines, antigen processing and presentation. T-cell receptors. Monoclonal antibodies, Hybridoma technology, Types of cellular interactions – helper and suppressor functions helper/suppressor determinants, mechanism of suppression, macrophage-T cell interaction, idiotype recognition. Transplantation and graft rejection. Vaccines.

3.Biochemistry of oxidative stress and toxicology:

Chemistry of biologically important radicals and non-radicals. Measurement of reactive oxygen species (ROS) and reactive nitrogen species (RNS) through different techniques. Cellular responses to oxidative stress: adaptation, damage, repair, senescence and death. Reactive species and diseases. Antioxidant defenses: endogenous and diet derived. Physiological significance of and mechanism of action of Superoxide Dismutase, Catalase, Glutathione Peroxidase, Glutathione Reductase, Glutathione S- Transferase; their role in combating oxidative stress. Thioredoxin peroxidases. Thioredoxin reductase. Different types of stress proteins and their functions. Pro-oxidant enzymes; their mechanism of action. Role of hydrogen peroxide, nitric oxide in stress mechanisms and management. Acute and chronic toxicity testing. LD50 determination. Therapeutic index. Biochemical basis of detoxification.

4.Biochemistry of cancer:

Molecular basis of cancer, Types and general pathology, Chemical and physical carcinogens, Oncogenes and Proto-oncogenes, Cancer and immune system, Genetic basis of cancer, Tumor markers. Tumour immunology. Angiogenesis; mechanism and significance. Diagnosis and management of cancer, Cancer therapeutics: present and future.

5.Applied Biochemistry:

Advanced Biochemical Techniques: Auto-analyzer, Spectroscopy, Mass Spectroscopy, (FAB-MS), Liquid crystal Mass Spectroscopy (LC-MS), NMR, Flow Cytometry. Role of Artificial Intelligence in disease detection.

FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION- 25

OR

RP-2C-T Theory Full Marks=50

ENDOCRINOLOGY & REPRODUCTIVE PHYSIOLOGY

CLINICAL AND APPLIED ENDOCRINOLOGY

1. Molecular Basis of Endocrine Disorders

Pituitary Disorders: Genetic causes of hypopituitarism (PROP1, POU1F1, HESX1, etc.); Molecular basis of pituitary adenomas, vasopressin and oxytocin related disorders, SIADH, ASD etc. Growth hormone disbalance and molecular defects in GH and IGF axis

Mechanisms of Thyroid disorders: Autoimmune thyroid disease- Hashimoto's Thyroiditis, Graves' Disease; Thyroid nodules; Thyroid cancers; Goitre and goitrogens; Thyroiditis; non-thyroid illness

Dyslipidaemia: Types, mechanism and clinical implications; Integration of hormonal and metabolic signals in lipid metabolism in normal and lipid disorders

Pancreatic Endocrine Disorders: Monogenic diabetes (MODY genes: HNF1A, GCK, etc.); Neonatal diabetes: KCNJ11, INS gene mutations; Molecular mechanisms of insulin resistance, Pancreatic Endocrine Neoplasms

Endocrine hypertension: molecular mechanisms - roles of adrenal, gonads, thyroid, parathyroid and pituitary

Stress Physiology: General Adaptation Syndrome; Stress axes - Neuroendocrine integration; Role of hypothalamus and brain regions (limbic system, amygdala, hippocampus); HPA axis in stress; Hormonal response to stress; Metabolic and immune responses to stress

Disorders of calcium metabolism: Calcium-Phosphate Homeostasis & role of hormone; Endocrine cross-talk: PTH–vitamin D axis, bone–kidney–intestinal interconnections; Thyrocalcitonin; Parathyroid disorders

Feeding Disorders: Neuroendocrine Regulation of Metabolism and Appetite; Hypothalamic regulation of hunger, satiety, and body weight; Role of neuropeptides: NPY, AgRP, POMC, CART; Leptin and ghrelin signalling pathways; Anorexia nervosa; Bulimia nervosa

Molecular neurohormonal disintegration: Bipolar Disorder, Schizophrenia, Epilepsy, Circadian Sleep disorder, Alzheimer's Disease

2. Immunoendocrinology:

Molecular and Cellular Basis of Immune-Endocrine Interactions: Receptors for hormones on immune cells; Cytokine receptors, Toll-like receptors in endocrine tissues cytokines; interleukins and interferon effects on endocrine tissues; Endocrine regulation of immune cell development and differentiation, Neuroendocrine-Immune Axis; Immune regulation of endocrine function; Pathogenesis of organ-specific autoimmunity; Role of HLA and autoantibodies; Immunodeficiency and endocrine dysfunction,

Thymus: Structure, Active principles of thymus and their role in immune function; Endocrine role of the thymus

Special Immune endocrine disorders: Endocrinopathies in chronic infections (e.g., TB, HIV) COVID-19 and immune-endocrine consequences; Paraneoplastic endocrine-autoimmune syndromes; Systemic Lupus Erythematosus (SLE); Rheumatoid Arthritis; Sjögren's syndrome

3. Techniques in Molecular Endocrinology

Principles and types of ELISA; RIA; Immunohistochemistry and Immunofluorescence; Chemiluminescent immunoassay; LCMS/MS; HPLC; Autoradiography; Southern blotting; Western Blotting, Chromatography; Electrophoresis; Experimental models: Knockouts, transgenics, hormone ablation AI assisted technologies in disease diagnosis

CLINICAL AND APPLIED REPRODUCTIVE PHYSIOLOGY

4. Reproductive Endocrine disorders

Hypogonadism types and mechanism: Primary hypogonadism, secondary hypogonadism, idiopathic hypogonadism, Erectile Dysfunction; Premature Ejaculation; Varicocele and infertility; Amenorrhea (primary and secondary); Dysmenorrhea; Abnormal Uterine Bleeding (AUB)

Molecular basis of Congenital diseases: Cryptorchidism; Hypospadias; Klinefelter Syndrome; Androgen Insensitivity Syndrome

Disorders of prostate: endocrine causes and cell signalling in prostatic hyperplasia and carcinoma; BPH, Malignancy of prostate;

Breast cancer: types, endocrine causes and hormonal signalling in malignancies of breast tissue

PCOS, Ovarian, cervical, and endometrial cancers-Molecular mechanisms; endocrine basis of ovarian cysts and hormonal crosstalk

Microbial insults on reproductive function: Pathophysiology of bacterial, viral, fungal infection of reproductive tissues, bacterial prostitis, Epididymitis, Orchitis Sexually transmitted infections (STIs): Chlamydia, Gonorrhoea, HIV, Syphilis; Vaginitis; Cervicitis; Tuberculosis of the reproductive tract

Reproductive Immunology and Autoimmune Disorders: Anti-sperm antibodies; antiphospholipid syndrome; Recurrent pregnancy loss

Ageing and gonadal dysfunctions: theories of ageing, oxidative stress and free radicals' role in reproductive dysfunctions; gonadal-endocrine axes responses in ageing; Menopause: hormonal changes, symptoms, physiology; Andropause and testicular aging

5. Reproductive Technology and Infertility:

Pathophysiology of male and female infertility; subfertility Assisted reproductive technologies (ART); physiology and hormonal assessment of Ovarian reserve; Ovarian Hyperstimulation Syndrome (OHSS); IVF and complications; ICSI; embryo transfer Gamete/embryo preservation and cryobiology; Molecular diagnostics in infertility; Contraceptive technology: hormonal, immunological, gene-based approaches, amniocentesis, HRT-risks and applications

6. Comparative and Evolutionary Reproductive Physiology:

Reproductive adaptations in vertebrates and invertebrates; Environmental endocrine signals and seasonal breeding; Hormonal regulation of sexual differentiation; Evolution of reproductive hormone systems; Endocrine control of parental care and Neuroendocrine integration of reproductive behaviour and seasonality

FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION- 25

OR

RP-2D-T **Theory** **Full Marks=50**

ENVIRONMENTAL PHYSIOLOGY

1. Environmental Microbiology

Microorganisms in natural environments: air, water, soil, sediments, Microbial diversity (bacteria, archaea, fungi, protists, viruses), Microbial interactions: symbiosis, commensalism, competition, predation, Methods in microbial ecology: culture-dependent and culture-independent techniques, Microbes in carbon, nitrogen, sulfur, and phosphorus cycle, Role of methanogens, nitrifiers, denitrifiers, and sulfur oxidizers, Microbial food webs and ecosystem functioning, Microbial role in greenhouse gas emissions (CO_2, CH_4, N_2O), Ocean acidification and microbial responses, Microbial feedbacks in global warming, Potential of microbes in carbon sequestration

Soil microbiology: Soil as a microbial habitat: structure, porosity, and organic matter, Rhizosphere, phyllosphere, and mycorrhizal associations, Nitrogen-fixing mechanisms and biofertilizers, Biodegradation of organic matter in soil

Aquatic Microbiology: Freshwater and marine microbiology: planktonic and benthic communities, Microbes in oxygen-rich vs. oxygen-depleted environments, Wastewater microbiology: indicator organisms, coliform tests, pathogens, Drinking water microbiology and treatment processes,

Air Microbiology: Microbes in the atmosphere and aerobiology, Airborne pathogens and disease transmission, Sampling and detection methods for airborne microorganisms, Indoor air quality and microbiological monitoring

Environmental Stress and Extremophiles: Microbes in extreme environments: thermophiles, psychrophiles, halophiles, acidophiles, alkaliphiles, Adaptations at biochemical and genetic levels, Microbial life in deep sea, polar ice, deserts, and space analogs, Environmental biotechnology potential of extremophiles

2. Environmental genetics

Historical perspectives: ecological genetics and evolutionary genetics, Genotype–environment interactions at molecular level, Phenotypic plasticity and adaptation, Natural selection, adaptation, and speciation under environmental stress, Genetic diversity in conservation biology, Regulation of gene expression under environmental stress, Epigenetics and environment (DNA methylation, histone modifications, non-coding RNAs), Environmental control of developmental genes, Environmental mutagens: physical, chemical and biological – mechanisms and consequences, Biomarkers of genetic damage (micronucleus test, comet assay), Genetic variation in natural populations, Hardy–Weinberg equilibrium and its disturbances by environment, Molecular markers in population monitoring (RAPD, RFLP, AFLP, microsatellites, SNPs), Genetic mechanisms of pesticide resistance, antibiotic resistance and heavy metal tolerance, Genes involved in drought, salinity, and temperature tolerance in plants, Genetic basis of hypoxia tolerance in animals (high altitude, aquatic systems), Genetic responses to pollutants and toxicants, Oxidative stress and genetic instability, Genotoxicity testing methods (Ames test, SOS response assays), Transgenic models for environmental toxicology.

3. Environmental Toxicological Physiology:

Principles of toxicology: dose-response, LD_{50}, NOAEL, Bioaccumulation, biomagnification, and biotransformation of pollutants, Acute and chronic effects: Endocrine disruptors and biochemical interference in hormonal regulation, Hepatotoxicity, reproductive toxicity, nephrotoxicity, neurotoxicity, genotoxicity, immunotoxicity effects, Long-term effects of pollutants: carcinogenesis, teratogenesis, mutagenesis. Apoptosis, necrosis, and cell cycle effects of radiation, Acute radiation syndrome (ARS): stages and clinical manifestations, Xenobiotic Biochemistry- Introduction to xenobiotics and toxicants, Phase I and Phase II detoxification pathways (cytochrome P450 system, conjugation reactions), Biochemical basis of pesticide, heavy metal (mercury, cadmium), pesticides, organic pollutants: and drug toxicity, Assessment of environmental risks and exposure limits (WHO, OSHA, NIOSH)

4. Physical Environmental and Human Physiology

Work and Exercise physiology in hot, cold, and high-altitude environments: Heat stress indices- Wet Bulb Globe Temperature (WBGT), Heat Index, Physiological Strain Index Work physiology in industrial and outdoor environments, Occupational and work physiology in high-humidity environments (mines, tropics, industry), Acclimatization and adaptation strategies, heat stress prevention and management

Cold stress- mechanism of thermoregulation in cold, thermogenesis (shivering and nonshivering), hormonal regulation of thermogenesis, Physiological Responses to Cold Exposure, Cold-Induced Illnesses: Frost bite- pathophysiology and stages, Hypothermia: mild, moderate, and severe, Trench foot, chilblains, and cold urticaria

Nutrition and hydration in extreme conditions, Military, space, and sports physiology applications in tropical and temperate climates,

Barometric pressure and human physiology- Low oxygen (hypoxia) at high altitude: acute mountain sickness, acclimatization, Physiological adaptations to high altitude: hematological, respiratory, and metabolic, genetic adaptations in high-altitude populations (Tibetans, Andeans, Ethiopians), Role of erythropoietin (EPO) and haematocrit, Long-term hypoxia tolerance and maladaptations (chronic mountain sickness),Hyperbaric physiology: acute and chronic responses to hypobaric environment, Nitrogen narcosis: mechanism, symptoms, prevention, Oxygen toxicity: CNS and pulmonary oxygen toxicity, Carbon dioxide retention and hypercapnia under hyperbaric stress, Inert gas narcosis and high-pressure nervous syndrome (HPNS), Decompression physiology- effects of diving, underwater environments,

Dissolution and release of gases in tissues (Henry's law in diving), Decompression sickness (the "bends"): Etiology, symptoms, treatment, Barotrauma of ear, sinuses, lungs, and gastrointestinal tract, Decompression protocols and safety standards, Barotrauma and decompression sickness,

Space physiology: Definition of g-force and units of measurement, Types of acceleration: linear, radial, angular, Positive g (+Gz), negative g (−Gz), and lateral g-forces, Thresholds of human tolerance to g-forces, microgravity and cosmic radiation, Blood pooling and hydrostatic pressure changes, Orthostatic intolerance, Acceleration-induced loss of consciousness (G-LOC), Countermeasures: anti-g suits, pressure breathing, centrifuge training, Pulmonary function and ventilation under g-forces, Effects on ribcage, diaphragm, and respiratory mechanics, Bone loading, joint stress, and muscle physiology under acceleration, Recovery mechanisms after g-stress, Vestibular system and motion sickness, Visual disturbances: "grey-out," "black-out," "red-out" phenomena, Neurological impairment under high g forces, Reflexes and coordination in altered gravity, Systemic effects of weightlessness

Environmental Epidemiology and Health Surveillance: Methods in environmental and occupational epidemiology, Disease burden, Surveillance of occupational diseases and environmental health trends, Outbreak investigation and cluster analysis, Biomonitoring and biological indicators of exposure, respiratory diseases: pneumoconiosis, asthma, COPD, occupational lung disease, Skin disorders: dermatitis, chemical burns, UV exposure, Noise-induced hearing loss and vibration disorders

5. Environmental Protection Policies Acts and Ethics:

Environment Protection Act, Forest Conservation Act, Wildlife Protection Act, Water and Air (Prevention and Control of Pollution) Acts, Municipal Solid Waste Management: Urban and rural perspectives, Rules for Industrial, Biomedical, and E-waste Disposal, Wetland Management Rules, Global Environmental Health in Developing Countries, Alternative Systems of Medicine and Universal Immunization Programme (UIP), Environmental injustice, racial inequality in policy and management

FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION- 25

OR

RP-2E-T **Theory** **Full Marks=50**

NUTRITION &DIETATICS

1. **Nutrition, Growth and National Nutrition Policy:** Nutritional survey and assessment, Nutritional counselling, epidemiology, National and international bodies of research organization, Community nutrition, midday meal, ICDS, Nutritional education, policies and laws. Interaction of national and international organizations (FAO, WHO, UNESCO, ICMR, etc.) and their role in determining dietary goals and guidelines, sustainable diets, nutrition in emergencies
2. **Dietary and Nutritional Imbalances:** Malnutrition: Prenatal, postnatal malnutrition and their impact on the growth and development of the child. Protein-energy malnutrition – Kwashiorkor, Marasmus; classification and management. Anaemia. Under nutrition: (i) Starvation as a model of undernutrition; (ii) Behavioral disorders affecting food intake – Anorexia nervosa and Bulimia nervosa.
   Obesity – Definition of Obesity, Physiology of Energy Balance, Energy Expenditure, pathogenesis of obesity: Genes and environment, metabolically normal obesity, adverse consequences of obesity. Obesity management by very low-calorie diet, timing of meals, anorectic drug treatment, exercise, etc.
3. **Nutrition & Exercise:** Nutrition in relation to work, sports, exercise and other environmental, stresses (e.g., space travel etc.). Adequate fluid and electrolyte replacement in maintaining exercise performance;

carbohydrate loading for well-trained endurance athlete. Importance of glycogen loading in the athlete, Nutrition for endurance sports (marathon, cycling, swimming), Nutrition for strength/power sports (weightlifting, wrestling, sprinting), Team sports (football, cricket, basketball), Nutrition for adolescent and female athletes, Nutrition in injury, recovery, and rehabilitation

4. **Hospital nutrition and dietetics:** Nutrition Care Process (NCP): Assessment, Diagnosis, Intervention, Monitoring & Evaluation (ADIME), Ethics and professional standards in clinical nutrition, nutritional assessment in clinical settings, Hospital Food Service & Dietetic Management, Planning menus for hospital patients, Nutrition Counseling and Communication, Documentation and dietetic records (SOAP, PES statements), immune-nutrition and pharmaco-nutrition, Nutrigenomics in hospital nutrition., Digital tools in patient monitoring and diet planning, Role of dietitians in ICU and critical care nutrition.
5. **Food Microbiology:** Scope and history of food microbiology, Important groups of food microorganisms: bacteria, yeasts, molds, viruses, Sources of contamination in foods (soil, water, air, handling, processing), Factors affecting microbial growth in foods (intrinsic & extrinsic), spoilage of perishable, semi-perishable, and canned foods, Indicators of spoilage in dairy, meat, fish, fruits, and vegetables, Foodborne infections: *Salmonella, Shigella, E. coli, Listeria, Campylobacter.* Food intoxications: *Staphylococcus aureus, Clostridium botulinum, Bacillus cereus, Mycotoxins* (aflatoxin, ochratoxin) and viral foodborne diseases (Hepatitis A, Norovirus)
6. **Food Preservation Microbiology:** Food Quality Assurance and Safety, Microbiological standards of food and water, Principles of microbial control in foods, Physical methods: heat (pasteurization, sterilization), cold storage, drying, irradiation, Chemical preservatives: organic acids, nitrates, sulfites, natural antimicrobials, Modern preservation methods: high-pressure processing, pulsed electric fields.
7. **Fermented Foods and Probiotics:** Microbiology of dairy fermentations: yogurt, cheese, kefir, Fermented vegetables and cereals: sauerkraut, idli, dosa, bread, Alcoholic beverages: wine, beer, Probiotics, prebiotics, and functional foods, Industrial production of microbial enzymes and metabolites.
8. **Food engineering:** Principles of heat transfer, mass transfer, fluid flow, Unit operations in food processing, Food rheology & process design basics, food processing technology of cereal, pulse, fruit, and vegetable, Bakery and confectionery technology, Oilseed & fat technology, Dairy processing & dairy products, Meat, poultry, fish processing, Food plant layout & design, Process equipment in food industries, GM foods, fermentation technology, Enzyme technology, bioactive compounds, Packaging materials and technology, Ready-to-eat (RTE) foods, convenience foods
9. **Food Quality Assurance and Safety:** Microbiological standards of food and water, HACCP (Hazard Analysis Critical Control Points), Food Safety and Standards Act (FSSA), Codex Alimentarius, Rapid detection methods: immunoassays, PCR, biosensors, Role of food microbiologists in industry and public health
10. **Role of dietitian:** In community nutrition monitoring, hospital critical care, ICU and rehabiliation patients, Multidisciplinary team approach (with doctors, nurses, physiotherapists), Diet prescription, counseling, enteral and parenteral nutrition, Monitoring and evaluation in hospitals and communities.

FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION- 25

OR

RP-2F-T Theory Full Marks=50

IMMUNOLOGY AND MICROBIOLOGY

IMMUNOLOGY

Immunogenetics

1. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2), MHC polymorphism, Genetic Basis of Antigen Recognition.
2. Molecular mechanisms responsible for generating diversity of antibodies, Organization of Immunoglobulin (Ig) gene loci, Regulation of Ig gene transcription.

3. Organization of TCR gene loci, Generation of TCR diversity.
4. Organization of HLA complex, Structure of class I and II HLA molecules, Expression of HLA genes, HLA polymorphism.
5. Hybridoma technology and monoclonal antibodies, antibody engineering, Chimeric antibodies, transgenic animals and their use in immunology, Molecular modelling and Bioinformatics

The immune system in human health and diseases.

1. Breakdown of Self-tolerance, autoimmunity, autoimmune diseases.
2. Immunodeficiency, genetic immune deficiencies, transplantation immunology, tissue grafting and organ transplantation.
3. Molecular mechanism of immune malignancies/tumor immunology, stem cell therapy, cancer immunotherapy.
4. Infectious disease immunology and vaccinology, concept of immunotherapy.
5. Allergy, Hypersensitivities, Ageing and stress related immunosenescent/ immunocompromised
6. Tumour immunology
7. Transplantation immunology

MICROBIOLOGY

1.Organisation of genomes – Repeated sequences - C value – cot curves" Multigene families; Molecular markers (RFLP and RAPD) Polymorphisms.

2. Mutagenesis: mutagenic agents, Types of mutations, mutagens, mechanism of mutation, Mutagenesis, induction and isolation of mutants, Expression of mutations- gene mutation, Control of gene expression in bacteria, Positive gene regulation, negative gene regulation and attenuation, using the lactose, arabinose and tryptophane operons with emphasis on recent advances.

3. Bacterial genetics – Inheritance of characteristics and variability. Phenotypic changes due to environmental alterations. Genotypic changes. Transposable genetic elements, Bacterial recombination. Bacterial conjugation. Transduction – Generalized and specialized transductions. Bacterial transformation, PBR 322 and other synthetic plasmids - isolation and uses, Linkage map of bacterial chromosome, Transposons in prokaryotes and eukaryotes.

4. T4 virulent phage: structure, life cycle, genetic map and DNA replication. Lamda temperate phage, Structure of Bacteriophages and their use in the study of molecular genetics – lytic cycle replication, Lysogeny and its regulation, Transfection and cosmids, Bacterial defence (CRISPR Gene turning on).

5. Microbial genomics, Genetic mapping applications of Bacteriophages in microbial genetics. Multidrug resistance in microbes' mechanisms (recent concepts of Multidrug efflux pumps, extended spectrum β-lactamases (ESBL), XMDR M) microbial control by antimicrobial agents, Physiology of antimicrobial chemicals, Diagnosis and tracking of microbe, General idea of control of microorganisms

6. Screening and development strategies for new antimicrobial agents acting on bacterial cell wall, cell membrane, nucleic acid and protein metabolism, Bioassay of antibacterial agents in liquid media and in agar media using standard guidelines (e.g. National Committee for Clinical Laboratory Standards (NCCLS) /Clinical and Laboratory Standards Institute (CLSI)), Factors affecting bioassay, Laboratory methods to assess activity of antimicrobial combinations (antagonism, synergism and additive effect).

7. Concepts of microbial diseases, pathogens and epidemiology, Global warming lead increase in vector-borne and water-borne infectious diseases; Impact of increasing urbanization, international travel and trade on infectious diseases.

8. Methodologies for testing of antimycobacterial, antifungal, antiparasitic and antiviral drugs (in vivo and in vitro infectivity mode.

FIELD STUDY/ COMMUNITY STUDY AND REPORT SUBMISSION- 25

RP-3 P **LABORATORY COURSE** **Full Marks = 50**

(Any one topic is to be selected in continuation of RP-2 paper)

RP-3A- P **Practical** **Full Marks=50**

SPORTS , EXERCISE PHYSIOLOGY, ATHLETICS AND YOGA

1. Determination of Hb concentration before and during graded exercise.
2. Electrocardiographic changes before and during graded exercise
3. Exercise-Tolerance test to determine cardiac efficiency.
4. Hand-muscle strength by Hand-grip-Dynamometer.
5. Hand-muscle-strength during different postures.
6. Blood pressure changes during hand-muscle-endurance study.
7. Study of recovery cardiac cost following exposure to treadmill running at different speed and inclination
8. Serum Lactate Measurement – indicator of anaerobic metabolism
9. Enzyme Activity Assays: Creatine kinase (CK) activity (muscle damage marker), Lactate dehydrogenase (LDH) activity (anaerobic metabolism)
10. Estimation of Lipid Profile – total cholesterol, HDL, LDL, triglycerides
11. Estimation of Vitamins (C & E) in Blood/Urine.– antioxidant status
12. Mineral Estimation (Calcium, Magnesium, Iron, Zinc) in athletes
13. Dietary Macronutrient Analysis – protein, carbohydrate, fat in diet logs
14. Salivary/Plasma Cortisol Measurement – stress hormone in athletes
15. Plasma Testosterone/Estradiol Assays – anabolic-catabolic balance in athletes
16. Urea, Creatinine & Uric Acid Estimation – muscle metabolism & purine breakdown
17. Estimation of Vitamins (C & E) in Blood/Urine – antioxidant status
18. Mineral Estimation (Calcium, Magnesium, Iron, Zinc) in athletes
19. Oxidative Stress Markers – Malondialdehyde (MDA) / TBARS assay

Institute / Laboratory visit to have exposure to instruments and technologies related to topic-Report to be submitted. **25**

OR

RP- 3B-P | Practical | Full Marks=50

BIOCHEMISTRY OF CELL

1. Cell and tissue culture techniques:
   - (i) Acquiring knowledge on the preparation of different types of cell culture media, cell counting and plating.
   - (ii) Determination of cellular stress using COMET assay –Apoptosis, Necrosis and DNA damage.
   - (iii) Acquiring knowledge on short-term culture of eukaryotic cells.
   - (iv) Experiments to study microbial morphology: a) gram staining and acid fast staining b) spore staining, c) staining of molds, d) staining of yeast.
2. Isolation and Separation of proteins by Polyacrylamide Gel Electrophoresis (PAGE).
3. Isolation and Separation of DNA by Agarose gel electrophoresis
4. Immuno-electrophoresis and Immunodiffusion techniques and/ or Western Blotting technique (demonstration only)
5. Primer designing and PCR Biochemical Separation Techniques:
   - (i) Separation of amino acids by paper chromatography (Ascending, descending and two dimensional).
   - (ii) Separation of sugars by paper chromatography.
   - (iii) Separation of amino acids and lipid fractions by thin layer chromatography.
   - (iv) Purification of proteins by salt precipitations and column chromatography.

Institute/ Laboratory visit to have exposure to instruments and technologies related to topic-Report to be submitted. 25

OR

RP-3C-P | Practical | Full Marks=50

ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY

1. Determination of toxicology markers in reproductive tissue and blood- AST, ALT, ALP etc.
2. Sperm count, sperm motility and sperm abnormality studies in mammals.
3. Study of estrous cycle in female rats under normal and experimental conditions.
4. Bioassay of drugs on rat's intestine and uterus.
5. Study on the effect of Oxytocin on rat's uterine contraction.

6. Acetylcholine on intestinal motility (iii)Adrenaline on intestinal motility.
7. Experimental surgery on the following and histological studies: Gonadectomy, Adrenalectomy, Thyroidectomy, Vasectomy.
8. Estimation of seminal fructose, ascorbate, cholesterol content of endocrine tissues.
9. Differential centrifugation techniques to isolate sub-cellular fractions.
10. Serum Calcium Estimation (Kramer & Tisdall method).
11. Estimation of seminal fructose, ascorbate, cholesterol content of endocrine tissues
12. Differential centrifugation techniques to isolate sub-cellular fractions.
13. Separation of amino acids and lipid fractions by thin layer chromatography.
14. Separation of sugars by paper chromatography.
15. Determination of cellular stress using COMET assay –Apoptosis, Necrosis DNA damage and flow cytometry for sperm viability (demonstration).
16. Isolation and Separation of proteins by Polyacrylamide Gel Electrophoresis (PAGE).
17. Isolation and Separation of DNA by Agarose gel electrophoresis.

Institute / Laboratory visit to have exposure to instruments and technologies related to topic-Report to be submitted. 25

OR

RP-3D-P Practical Full Marks=50

ENVIRONMENTAL PHYSIOLOGY

1. Portability Test of Water by coliform count.
2. Bacterial and Fungal Staining from various food (curd, milk, bread, fruits, sweets) and water sources (tube well, river, tap): Sample Preparation, Inoculation, Staining and Identification,
3. Kymographic Recording: Effects of Hg, Pb, As compounds and food additives on: Perfused toad heart contraction, Isolated gastrocnemius muscle contraction, Intestinal motility in Dale's bath.
4. Lung Function Tests: Smokers, non-smokers, and occupationally exposed individuals.
5. Physiological Effects Studies: Temperature impact on thyroid function, Light effect on gonadal activity, Iodine influence on thyroid physiology.
6. MBT Measurement: In hypothermic and hyperthermic states.

7. Blood Parameters in Exposed Individuals: TC, DC, ESR, Reticulocyte count, Hemoglobin estimation.
8. Noise Exposure Effects: Measurement of noise levels in zones; assessment of blood pressure, light reflex, and auditory reflex changes.
9. Histochemical Studies of chronic exposure to food additives and arsenic compounds in tissue samples.
10. Determination of visual acuity in human subjects.
11. Visit to any institute / laboratory to get exposed to various bio-instruments and techniques (Report to be submitted)

Institute / Laboratory visit to have exposure to instruments and technologies related to topic-Report to be submitted. 25

OR

RP-3E **Practical** Full Marks=50

NUTRITION AND DIETETICS

1. Abnormal constituents of urine: Urea, uric acid, creatinine
3. Estimation of moisture and ash content of foods.
4. Determination of total carbohydrate, protein and fat in food.
5. Determination of Iodine value of fat.
6. Estimation of Mineral content in food: Ca, P, Fe, Cu.
7. Determination of Vitamins in Food and biological samples: Ascorbic acid, (ii) Vitamin A, (iii) Thiamine (iv) Tochopherol.
8. Estimation of blood calcium and inorganic phosphate

Institute / Laboratory visit to have exposure to instruments and technologies related to topic-Report to be submitted. 25

OR

RP-3F-P **Practical** **Full Marks=50**

IMMUNOLOGY AND MICROBIOLOGY

1. Separation of human lymphocytes, monocytes and neutrophils from whole blood
2. SDS-PAGE: Separation of Protein & Western Blot experiment on microbiology
3. Culture characteristics of microbes, identification of unknown bacteria by biochemical tests.
4. To study pathogenicity of Staphylococcus aureus by coagulase test,
5. Starch hydrolysis assay for the identification amylase-producing microorganisms,
6. Gelatin hydrolysis assay for the identification of protease-producing microorganisms'
7. Microbiological Assay of antibiotics, Bioassay of chloramphenicol/streptomycin by plate assay method or turbidimetric assay method, Determination of minimum inhibitory concentration
8. (MIC) of an antibiotic for pathogenic bacteria.
9. Determination of antibiotic resistance profile by disc agar diffusion (DAD) technique
10. Isolation of bacterial DNA, Estimation of DNA and purity determination by UV absorption method,
11. Agarose gel electrophoresis and detection of bacterial DNA.
12. Separation of amino acids by Paper Chromatography (demonstration only).
13. Experiment on bacterial conjugation in *E.coli* and bacteriophage plaque formation-transduction experiments
14. Use of Internet/software for sequence analysis of nucleotides and proteins; Studies of public domain databases for nucleic acid and protein sequences. Concept of various web based biomolecular specific databases used in Bioinformatics, Idea of homology modelling and docking with their relevance to drug designing, Exposure to different sequence/structural/Genome database through web (NCBI, SWISS-PROT, PDB, JCVI/CMR, IMG, EBI, GOLD etc.); Sequence similarity searching by different types of BLAST, Genome sequence analysis (Demonstration only)
15. Visit to any institute to have exposure to instruments and technologies related to topic-Report to be submitted.

Institute / Laboratory visit to have exposure to instruments and technologies related to topic-Report to be submitted. **25**

RP-4 T | Theory | Full Marks = 50

SCIENTIFIC COMMUNICATION, COMPUTER APPLICATION AND DATA ANALYTICS

Group A
Full Marks =25

SCENTIFIC COMMUNICATION

1. Scientific Writing: Principles of scientific writing, Writing style and scientific language, IMRAD format Preparation of Research articles, Review articles, Case reports, technical reports. Scientific Correspondence
2. Structure of Scientific Papers: Title, Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusion
3. Academic Writing: Dissertation and thesis preparation, Referencing systems: APA, Vancouver, Harvard, Citation management tools: Zotero, Mendeley. EndNote
4. Scientific Presentation: Oral presentation skills, Poster preparation art, Conference communication Research dissemination and outreach, Public engagement in science, Social media for scientific dissemination, Communicating physiology to non-specialist audiences
5. Presentation Tools: PowerPoint design principles, Visual communication, Infographics and graphical abstracts

COMPUTER APPLICATION

1. Classification of computer: Importance of computer application in Physiology and biomedical sciences, brief history of development of computer, computer generations, classification of computer – analogue, digital, hybrid, micro, mini, mainframe and super computers.
2. Computer 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.
3. File management – usage of peripheral data storage devices such as tapes, discs and floppies, methodology of programming using flow charts; sample programmes for statistical methods, email, internet.
4. Basic concept of email, Internet- components of Internet, www, searching biological information from Internet, library-searching technique, LAN. Word processor- basic operation and its application in biological sciences; Ms excel – basic operation and it application in biological sciences

Group B
Full Marks =25

DATA MANAGEMENT AND EXPLORATORY DATA ANALYSIS

1. Data Visualization: Principles of scientific data presentation, Construction and interpretation of - Bar diagrams, Histograms, Frequency polygons, Pie charts, Scatter plots, Box plots, Line graphs
2. Data Integrity and Reproducibility: Data sharing and repositories, FAIR data principles, reproducible research practices, Validation and reproducibility of results
3. Data Distribution and Assumption Testing: Normality testing, Homogeneity of variance, Data transformation methods, Detection of outliers. Identification of bias and confounding factors
4. Analysis of Independent Effects: Independent sample t-test, One-way ANOVA, Factorial ANOVA, Fixed-effect model, Multiple comparison procedures
5. Analysis of Dependent Effects: Paired t-test, Repeated measures ANOVA, Longitudinal data analysis . Within-subject and between-subject effects
6. Interaction Effects: Main effects and interaction effects, Two-factor and multifactor designs, Interpretation of interaction plots, Effect modification, Effect Size Analysis- Cohen's d, Eta squared (η^2), Partial eta squared, Hazard ratio

7. Multivariate Analysis: Principal component analysis, Factor analysis, Cluster analysis Discriminant function analysis, Correlation Analysis - Pearson correlation, Spearman correlation, Partial correlation, Multiple correlation, Regression Analysis- Simple linear regression, Multiple linear regression, Logistic regression, Multinomial logistic regression, Poisson regression, Cox proportional hazard model (overview)
8. Outcome Prediction Models: Predictive versus explanatory models, Model development and validation, ROC curve analysis, Sensitivity and specificity, Positive and negative predictive values
9. Handling Complex Datasets: Missing data analysis, Imputation methods, Multicollinearity assessment, Model diagnostics.

LABORATORY COURSES

RP-4 P — Practical — Full Marks = 25

1. MS Word for scientific document preparation.
2. MS Excel for data entry, data management and formula applications.
3. Creation of spreadsheets and electronic databases.
4. Construction of bar charts, histograms, pie charts, scatter plots, box plots and line graphs.
5. Selection of appropriate graphical presentation for different datasets.
6. Interpretation of graphical outputs.
7. Preparation of publication-quality figures.
8. Statistical data analysis using software: t-test, ANOVA, correlation and regression analysis

FINAL SUBMISSION OF RESEARCH WORK

Full Marks = 75

DISSERTATION

Evaluation Criteria:

Research Proposal and Synopsis	10 marks
Interim Report Submission	10 marks
Laboratory/Experimental Work	5 marks
Data Analysis and Interpretation	10 marks
Dissertation/Thesis Report Submission	15 marks
Seminar Presentation	15 marks
Viva Voce	10 marks