TRIPURA UNIVERSITY

SURYAMANINAGAR - 799022

DEPARTMENT OF HUMAN PHYSIOLOGY

COURSE AND CURRICULUM

TRIPURA UNIVERSITY
Department of Human Physiology

Name of the Programme : Ph.D. in Human Physiology

Programme Specific Objectives :

The primary objective of the programme is to take up research work on various aspects of Human Physiology leading to Ph.D. degree in Human Physiology, offered by Faculty of Science of Tripura University.

The focused areas of research at present in the department are : Molecular Genetics, Cancer Biology, Immunology, Endocrinology, Reproductive Physiology, Nutritional Biochemistry & Toxicology. Students are to take up in-depth studies pertaining to any of these areas and to contribute to the knowledge in the specific field.

The students are trained to conduct original and globally relevant work on the chosen field which will make them competent to take up individual research in the field in future.

The students should become capable of publishing their research findings in both National and Internationally reputed scientific journals and also become capable of presenting and defending their research findings in front of experts from relevant field.

To produce manpower who can easily fit in to the pool of health science scientist and can take up globally competent newer researches in areas of health science thus contribute to the national goal of becoming "Atmanirvar" in health science research.

Basic Structural Framework of Ph.D. Programme :

The minimum duration of Ph.D. programme is three (3) years, including Ph.D. coursework, and the maximum of six (6) years from the date of admission into the Ph.D. programme. However, the women candidates and persons with disabilities (more than 40% disability) may be allowed a relaxation of two (2) years for the Ph.D. in the maximum duration.

In the Ph.D. programme, each six-month duration comprises a semester. Usually,the odd semester starts w.e.f. 1st day of July every year and the even semester from 1st day of January every year.

Credits, Credit Distribution and Semesters in Ph.D. Programme :

Codes	Semester/Particulars	Minimum Credits required to be qualified
	Passing Ph.D. Coursework	16
PHD-9005	Semester-1 (1st progress report)	8
PHD-9006	Semester-II (2nd progress report)	8
PHD-9007	Semester-III (3rd progress report)	8
PHD-9008	Semester-IV (4th progress report)	8
PHD-9009	Semester-V (5th progress report)	8
PHD-9010	Successful submission of synopsis	8
PHD-9011	Successful submission of summary (5000 words)	16
PHD-9012	Successful submission of a thesis (positive comments of all adjudicators)	16
PHD-9013	efense of a thesis through Viva- Voce examination	8
PHD-9014	ship /evaluation of answer scripts	2 + 2 = 4
Total credits required for awarding Ph.D. degree		**100**

Programme Outcomes

1. **Research:** The ability to conceptualize, design, and enforce research for the genesis of the novel knowledge, applications, and accommodation of research methodologies considering unanticipated problems. The ability to make effective judgments on complicated issues in specialized fields and produce original research to value publications.

2. **Methods:** An understanding of methods of research or creative activities, or both, in the area of study enables the students to measure distinct approaches for problem-solving using well-demonstrated techniques, invent, affirm statements, and remarks on current research.

3. **Communication:** Distinctly and effectively communicate the scientific activities to peers and the general public, both written and orally. Pursue effectively with the scientific community through conferences, meetings, and workshops engagement.

4. Professionalism: Building characters and skills necessary for employment,such as personal responsibility, self-reliant initiatives under challenging situations, ethical behavior with academic integrity, and appropriate guidelines for responsible conduction of research.

Ph.D. Coursework :

Paper Code	Paper Name	Credit Distribution			Total Credits	Marks	Remarks
		L	T	P			
PHD-HP 9001	Research Methodology-I	4	0	0	4	100	Common course for all science and engineering Ph.D. students offered by the university
HD-HP 9002 (Paper-II)	Research Methodology- II	4	0	0	4	100	
PHD-HP 9003 (Paper-III)	Recent Advances in Human Physiology Research	4	0	0	4	100	
HD-HP 9004 (Paper-IV)	Seminar/practical/project and assignments	0	0	4	4	100	
Total		**12**		**4**	**16**	**400**	

*** L - Lecture; T – Tutorial, P – Practical/Projects**

TRIPURA UNIVERSITY
Department of Human Physiology

Name of the programme : M.Sc. in Human Physiology
Programme Specific Objectives :

The primary objective of the programme is to impart knowledge on basic and applied aspect of normal functions of various systems of human body and to train students on basic techniques used in human health research. At the end of the programme students should be able to :

To understand the basic biochemical and biophysical principles applicable to human physiology and to understand how these principles can be applied to explain abnormalities that may occur during different conditions.

To explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system

To discuss the molecular basis of different body functions and the disease conditions that may arise due to changes in the molecular mechanisms.

To know about human diseases and modern tools and techniques including molecular techniques used in human health research.

To become equipped with all modern knowledge of human health and disease and capable of using acquired knowledge for future carrier development and development of mankind as a whole.

Basic Structural Framework of the Syllabus :

CORE COURSES :

Course Code	Subject Name of the Course	Credit Distribution			Total Credit	Marks (Scaled)
	1ST SEMESTER	**L**	**T**	**P**		
HP 701 C	Biomembrane Physiology, cell-cell communication & Enzyme Kinetics (Theory)	4	1	0	04	100
HP 702 C	Metabolic Biochemistry & Bioenergetics (Theory),	4	1	0	04	100
HP 703 C	Cell Biology (Theory)	4	1	0	04	100
HP 704 C	Basic Biophysical principles, Cardiovascular, & Respiratory Homeostasis (Theory)	4	1	0	04	100
HP 705 C	Lab work I (Biochemistry, Cell Biology, Enzymology) (Practical)	0	0	12	04	100
	TOTAL	16	4	12	20	500
	2ND SEMESTER					
HP 801 C	Blood, body fluid and Immunology (Theory)	4	1	0	4	100
HP 802 C	Molecular genetics & Molecular Biological Techniques (Theory)	4	1	0	4	100
HP 803 C	Neurophysiology, Neuroanatomy, Neurochemistry, Behavioral & Special sensory physiology (Theory)	4	1	0	4	100
HP 804 C	Lab work II (Haematology, Histology, Molecular Biology, Human experiments) (Practical)	0	0	12	4	100
	TOTAL	12	3	12	16	400
	3RD SEMESTER					
HP 901 C	Reproductive Physiology & Developmental Biology (Theory)	4	1	0	4	100
HP 902 C	Nutrition & Microbial Physiology (Theory)	4	1	0	4	100
HP 903 C	Lab Work III (Lab work on Advances in Human Physiology) (Practical/Review)	0	0	12	4	100
	TOTAL	8	2	12	12	300
	4th SEMESTER					
HP 1001 C	Endocrinology & Stress Physiology (Theory)	4	1	0	4	100
HP 1002 C	Project (including review) on Advances in Human Physiology	0	0	16	4	100
	TOTAL	4	1	16	8	200

ELECTIVE COURSES (TO BE OFFERED BY THE DEPARTMENT) :

Course Code	Subject Name of the Course	Credit Distribution			Total Credit	Marks (Scaled)
		L	T	P		
	1ST SEMESTER	**No course offered**				
	2ND SEMESTER					
HP 801 E	Pharmacological and Toxicological Principles (Theory)	4	0	0	4	100
HP 802 E.	Sports & Exercise Physiology (Theory)	4	0	0	4	100
	Required Credit (For Departmental students)				4	04
	3RD SEMESTER					
HP 901 E.	Advances in Molecular Cell Physiology, Cell signaling (Theory)	4	0	0	4	100
HP 902 E.	Advances in Microbiology (Theory)	4	0	0	4	100
HP 903 E	Advances in Molecular Endocrinology (Theory)	4	0	0	4	100
HP 904 E	Advances in Nutrition and Metabolism (Theory)	4	0	0	4	100
HP 905 E	Excretory Physiology(Theory)	4	0	0	4	100
HP 906 E	Research Methodology & Ethical Issues in Biomedical Research (Theory)	4	0	0	4	100
HP 907 E	Molecular Physiology of Human Diseases (Theory)	4	0	0	4	
	Required Credit (For Departmental students)				8	
	4TH SEMESTER					
10.	Molecular Cancer Biology & Onco-immunology (Theory)					04
11.	Advances in Immunology (Theory)					04
12.	Advances in Reproductive Physiology (Theory)					04
13.	Nutrition and Community Health (Theory)					04
	Required Credit (For Departmental students)					04

COMPULSORY FOUNDATION COURSE (DURING 1ST SEMESTER):

01.	Computer Application – To be offered by Dept. of Computer Science & IT.	04

ELECTIVE FOUNDATION COURSE (DURING 3RD SEMESTER) :

01.	Biostatistics- To be offered by Dept. of Statistics	04

OTHER ELECTIVE COURSES TO BE DONE BY THE STUDENTS OF M.Sc. IN HUMAN PHYSILOGY:

01. Elective Courses offered by other Departments of the University (Required credit – 04)- To be completed during 2nd Semester of the Course.

02. Compulsory Online PG Course of minimum 2 credit to be completed within the course period (any semester, preferably during 2nd semester).

M.Sc. Human Physiology

Programme Specific Outcomes :

PO1: Knowledge: Students will be equipped with an in-depth knowledge in the area of basic and applied Human Physiology including systemic physiology, cell biology, biochemistry, molecular biology, genetics, neurology, endocrine and reproductive physiology, developmental biology, sports, exercise and environmental physiology.

PO2: Planning abilities: Develop skills for planning with time management, analyse the outcome and capable of taking decisions to reach achievable goals.

PO3: Problem analysis: To develop skills for logical thinking to tackle detailed problem-solving and analytical tasks associated with questions in core and applied areas of human physiology.

PO4: Modern tool usage: Learn to select and use modern techniques associated with research in human physiology including cellular, immunological, molecular, histological, histochemical and biochemical techniques.

PO5: Leadership skill: Develop leadership skills to work in a team and take initiative for fulfillment of professional and societal responsibilities.

PO6: Professional Identity: Understand, analyze and communicate the value of their professional roles in different health science research environment including research on nutrition, toxicology, modern molecular and cell culture laboratories including cancer research and research with medicinal plants for human benefit.

PO7: Ethics in research: To develop knowledge of ethical issues associated with modern biological research including both animal and human ethical issues and their implications in developing research protocols and gather knowledge on different biosafety measures.

PO8: Communication: Develop skills used in reasoning and communication with scientific community and society. To synthesize information from literature and its communication in form of scientific papers, reports, poster and oral presentations.

PO9: Benefits to the society: Contribute to society, in the realms of different health issues concerning the local indigenous population and human as a whole.

PO10: Life-long learning: Develop independent, critical and creative thinker who has a self-motivated passion for life-long learning.

DETAIL COURSES (CORE COURSES)

1st Semester :

SL. NO. – 1: Biomembrane Physiology , cell-cell communication & Enzyme Kinetics (Theory)

Paper Code : HP 701 C **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand membrane transport and cell signalling mechanisms.
- Develop comprehensive understanding of endo-membrane system.
- Understand enzyme systems and their kinetics.
- Molecular mechanisms of enzyme actions..

SECTION – A

Molecular composition and arrangement of biomembrane. Transport across the cell membrane-channels and carriers, ion transport. Molecular structure, signalling process of K^+, Na^+, Ca^{2+}& Cl^- channels. Membrane potential – ionic basis, derivation and application Nernst equation, concept of Donnan membrane equilibrium.

Water transport, selective transport, molecular organization and role of aquaporins in water transport. Glucose transport and transporters – Glut proteins types- distribution and specific functions.

Membrane targeting proteins – signal sequences, translocon, co-translational and post-translational translocation, chaperones and their functions. Cell signaling: Cell surface Receptors, Second Messenger, positive & Negative Feedback in Signal System. Signaling through Enzyme-Linked Cell-Surface Receptors, Activated Receptor Tyrosine Kinases Phosphorylate Themselves, Ras Activates a Downstream Serine/Threonine Phosphorylation Cascade That Includes a MAP-Kinase, PI 3-Kinase Produces Inositol Phospholipid Docking Sites in the Plasma Membrane, The PI 3-Kinase/Protein Kinase B Signaling Pathway Can Stimulate Cells to Survive and Grow, Signaling proteins are frequently expressed as separate and independently controlled, Nuclear receptors regulate transcription, G-proteins regulate wide variety of receptors and are controlled by regulatory GTPase cycle. Wnt signaling regulates cell fate during development and other processes

Junction and non-junctions – basal lamina, cell cell adhesion and communication, gap junctions and connexions, integrins, focal adhesion, collagen, non-collagen components, fibronectins, elastin, laminin, vitronectin, paxillin, desmosomes and hemidespmosomes, adhenines, pectin, Ca2+ dependent and independent adhesions.

Cell-cell signalling, cell surface receptors, second messenger system, MDP kinase pathways, signalling from plasmamembrane to nucleus involving extracellular matrix and integrins.

SECTION – B

Nature of enzymes- Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. Classification of multisubstrate reactions with examples of each class. Ordered Bi-Bi reaction mechanism. Concept of Convergent and Divergent evolution of enzymes, Methods of examining enzyme-substrate complexes, Flexibility and conformational mobility of enzymes, methods of measuring kinetic and rate constants of enzymic reactions and their magnitudes, Enzymes turnover and methods employed to measure turnover of enzymes, Significance of enzyme turnover.

Behaviour of proteins, enzymes and their mechanism and control-protein-ligand binding. Hill and Scatchard plots. Allosteric enzymes, Sigmoidal kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance. Immobilized enzymes and their industrial applications. Effect of partition on kinetics and performance with particular emphasis on changes in pH and hydrophobicity.

Multienzyme system: Occurrence, isolation and their properties. Polygenic nature of multienzyme systems. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complexes.

Immobilized multienzyme systems and their applications. Concerted and sequential method of allosteric behaviour.

Coenzymes and cofactors, Metalloenzymes. Detailed mechanisms of catalysis of serine proteases, Ribonucleases and triose phosphate isomerases.

Enzyme regulation-General mechanism of enzyme regulation: Feedback inhibition and feed forward stimulation; Enzyme repression,induction and degradation, control of enzymic activity by products and substrate; Reversible and irreversible covalent6 modification of enzymes; Mono-cyclic and multi cyclic cascade systems with specific examples. Regulation of enzyme activity by phosphorylation, methylation and acetylation.

SL. NO. – 2: Metabolic Biochemistry & Bioenergetics (Theory),
Paper Code : HP 702 C **Credit : 04.**

Learning outcomes :
After successful completion of the course, students should be able to:

- Understand the basic biochemical principles working in the body..
- Develop comprehensive understanding of energy transformation and thermodynamics.
- Understand the metabolism of major metabolites of the body.
- Nucleic acid and its metabolism.

SECTION – A

Thermodyanamic principles and steady-state conditions of living organisms, organization of methods to study metabolism
Energy transformation, laws of thermodynamics, biological oxidations, oxyginase, hydroxylases, dehydrogenases & energy transducing membranes, Gibbs energy, free energy changes and redox potentials
Energy metabolism and high energy compounds – The mitochondrial respiratory chain, orders and organisation of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterisation, the Q cycle and stoichiometry of proton extraction and uptake, P/O and H/P ratios. Reversed electron transfer, respiratory controls and oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionaltion ond reconstitution of respiratory chain complexes, ATP synthetase complex, microsomal electron transport, partial reduction of oxygen. Comparison with mitochondrial E.T. C & photo systems, photorespiration, C3, C4 pathway.

SECTION – B

Carbohydrate metabolism – Glycolysis, citric acid cycle – its function in energy generation and biosynthesis of energy rich bonds, Pentose phosphate pathway and its regulation. Alternate pathways of carbohydrate metabolism.
Gluconeogenesis, interconversions of sugars, Biosynthesis of glycogen, starch and oligosachharides, regulation of blood glucosehomeostasis, hormonal regulation of carbohydrate metabolism
Lipid metabolism – fatty acid biosynthesis, acetyl CoA carboxylase, fatty acid synthase, desaturase and elongase. Fatty acid oxidation: α, β, ω oxidation and lipoxidation. Lipid biosynthesis: biosynthesis of triacylglycerols, phosphoglycerides and sphingolipids.

Biosynthetic pathway of tarpenes, steroids and prostaglandins. Ketone bodies formation and utilisation. Metabolism of circulating lipids, chylomicrons, LDL, HDL & VLDL. Free fatty acids, lipid levels in pathological conditions.

Amino acid metabolism – biosynthess and degradation of amino acids and their regulation, specific aspect of amino acid metabolism, urea cycle and its regulation, inborn errors of amino acid metabolism.

Nucleic acid metabolism – biosynthesis of purines and pyrimidines, degradation of purine and pyrimidine biosynthesis. Structure and regulation of ribonulcease reductase biosynthesis of ribonucleotides, deoxyribonucleotides & polynucleotide, inhibitors of nucleic acid biosynthesis.

SL. NO. – 3: Cell Biology (Theory)

Paper Code : HP 703 C **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to understand

- Ultrastructure of the organelles and their specific functions
- Cooperation between the organelles and execute the function
- The mechanism of cell growth and division and apoptosis
- The condition when uncontrolled cell division starts and develops cancer

SECTION – A :

Cell size, shape, complexity, functions Structural organization of prokaryotic and eukaryotic cells, Cell cycle, check points of cell cycle, regulations of cell cycle. Cyclin and cylcin dependent kinases (Cdks), Activation and deactivation CDKs, G1-CDK , G1 S-CDK, G1 cyclins, E2F, Rb, G2- M transition, DNA damage and cell cycle regulation, withdrawal of cell from cell cycle, growth factors and cell proliferation

The ultra structure of nucleus, mitochondria; Endoplasmic reticulum (rough & smooth);Glogi apparatus, lysosomes & peroxisomes and their functions. Molecular organization and mechanism of transport through nuclear ports, models.

The cytoskeleton- microtubules and microfilaments. General function of microtubules, α and β tubulin, micro tubal assembly and disassembly, stability of microtubules, microtubule based

motor protein, interaction between microtubule and actin filament, myosin structure and function.

Types of tissues; Epithelium-types, epithelial apices- glycocalyx, microvilli. Cell movement-intracellular transport, role of kinesin, cilia and flagella molecular structure and role in cell movement. Genomic organization- hierarchy in organization; Chromosomal organization of genes and non-coding DNA ; Mobile DNA, morphological and functional elements of eukaryotic Chromosomes.

SECTION – B :

Nerve cells- excitation and conduction, ionic basis of excitation and conduction, action potential, channels, properties of mixed nerve, nerve fiber types and function, regeneration of nerves, growth cones, nerve growth factors, axoplasmic flow, molecular mechanism of transport in axon, degenerative and regenerative changes in nerve fibers synapse and its properties, release of neurotransmitters. Cellular growth, development, elongation, telomerase

Apoptosis: Evolutionary origin of apoptosis, Morphological features of apoptosis, molecular and biochemical markers of apoptosis, Apoptosis eliminates unwanted cells, Apoptosis triggering mechanisms : extrinsic pathway depends on cell surface death receptors, Intrinsic pathway depends on mitochondria. Role of BCl_2 and IAPs in apoptosis.

Cancer biology: Cancer cell origin, derive from a single abnormal cell, cancer cells contain somatic mutation, cancer growth depends on defective control of cell death, cell differentiation or both, cancer cells may achieve immortality, metastasis, angiogenesis, causes of cancer, treatment.

<u>SL. NO. – 4:</u> Basic Biophysical principles, Cardiovascular, & Respiratory Homeostasis (Theory)

Paper Code : HP 704 C **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the basic biophysical principles working in the body for regulation of cardiovascular and respiratory homeostasis.
- Develop comprehensive understanding of cardiovascular regulatory mechanisms.
- Understand the mechanism and regulation of respiration in human.
- Pathophysiology of cardiovascular and respiratory disorders and physiological basis of treatment

SECTION – A :

Physiological anatomy of cardiac muscle, cardiac contraction, function of ventricles as pumps, the chemical energy of cardiac contraction, intrinsic regulation of heart pumping, role of sympathetic and parasympathetic nerve on control of heart.

Specialized excitatory and conducting system of heart , rhythmical excitation of heart, cardiac potentials, pacemakers, control of excitation and conduction in the heart.

Characteristics of normal electrocardiogram, principles of vectorial analysis of normal electrocardiograms, the mean electrical axis of heart, cardiac arrythmias and their electrocardiographic interpretations.

Physical characteristics and basic theory of circulation, relationship between blood pressure and flow, resistance to flow, vascular distensibility and functions of arterial and venous systems, laminar and turbulent flow, the Reynolds' number, models for flows of liquids: Bernoulli and Poiseuille's equations and their applications.

The microcirculation and lymphatic system, capillary fluid exchange, interstitial fluid and lymph flow, endothelium in regulation and transcapillary exchange, lymphatic return, local control of blood flow by tissue and humoral regulation, development of collateral circulation.

Nervous regulation of circulation, arterial blood pressure and role of nervous system for rapid control of arterial pressure, role of vasomotor centre in regulation of blood pressure, role of kindney in long term regulation of blood pressure, renal body fluid and rennin angiotensin system.

Control of cardiac output and venous return, Frank-Starling mechanism of heart, coronary circulation and its regulation, special features of cardiac muscle metabolism, muscle blood flow and cardiac output during exercise

Integrated system of blood pressure control, hypertension - types causes, benign and malignant hypertension, experimental hypertension, ischemic heart disease, cardiac failure.

SECION – B :

Mechanisms of pulmonary ventilation, pulmonary volumes and capacities – clinical significance, alveolar ventilation, functions of respiratory passageways, pulmonary circulation, ventilation perfusion ratio, pulmonary edema and pleural fluid, pulmonary capillary dynamics.

Physical principles of gas exchange, composition of alveolar air, diffusion of gases through respiratory membrane, transport of oxygen and carbon dioxide in blood and body fluids, respiratory exchange ratio.

Regulation of respiration: respiratory center, peripheral chemoreceptor system, central chemoreceptor system and their regulatory function, regulation of respiration during exercise.

Respiratory insufficiency, hypoxia, asphyxia, emphysema, asthma, cyanosis, dyspnea, atelectasis, Cheyne-Stokes breathing, periodic breathing, hyperbaric oxygen therapy.

SL. NO. – 5: Lab work I: Biochemistry, Cell Biology and Enzymology (Practical)
Paper Code: HP 705 C **Credit: 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the basic principles of biochemical analysis of biological samples and use relevant instruments for the purpose of analysis.
- Develop comprehensive understanding of electrophoresis techniques and able to use of the techniques for analysis.
- To perform assay of different enzymes and metabolites from blood and tissue samples.
- To do Gram staining of different bacterial cultures.

1. Demonstration of Beer's law.
2. Standrdisation of secondary standard solution by primary standard solution.
3. Spectrophotometric estimation of nucleic acids.
4. Estimation of protein.
5. Electrophoretic separation of DNA.
6. Electrophoretic separation of protein.
7. Determination of pK_a value.
8. Effect of temperature on enzyme action.
9. Effect of pH on enzyme action.
10. Determination of Km value of enzyme.
11. Assay of enzymes- acid phosphatise.
12. Assay of enzyme- Alkaline phosphatise.
13. Assay of enzyme Amylase.
14. Estimation of Glucose.
15. Gram staining of bacteria.
16. Paper chromatography- separation of amino acids.

2nd Semester:

SL. NO. – 6: Blood, Body Fluid & Immunology (Theory)
Paper Code: HP 801 C **Credit: 04**

Learning outcomes :

After completion of the course student should understand the following:

- The composition and function of blood and body fluid
- Individual function of immune cells in terms of humoral and cell mediated immunity.
- Development of antibody against pathogen and determination techniques of antigen and antibody in the body
- Hypersensitive reaction in the body and autoimmune disease development.

SECTION – A :

Erythropoiesis, regulation of erythropoiesis, pathological condition related to erythrocyte, fate of erythrocyte. Life span and destruction of RBC, Platelets, Reticulocytes. haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.
Body fluid balance, body fluid compartments, Blood volume, Regulation of body fluid exchange and osmotic equilibria. Homeostasis.
General characteristics of WBC, Genesis of WBC and their life span General principles of immunology, kinds of immunity, antigens, immunogens, haptens, Adjuvants, antigenicity and immunogenicity
Major histocompatibility complex (MHC), types, structure and functions. Role in immune response, mechanism of MHC – restrictions of T-cells for endogenous antigens (class I), for exogenous antigens(class – II), Syngenic and congenic, MHC haplotypes
Cells and organs of the immune system – cells, primary and secondary lymphoid organs, MALT, CALT.

SECTION – B:

Humoral immunity, primary response, secondary response, Role of Th in hapten carrier conjugate, Class switching. Regulation of immune effector response. Cell mediated immunity – mechanisms, Effector molecules, Cytotoxic T cell, destruction of target cell by CTL, , NK cell, Mechanism of NK cell killing, ADCC, Cell mediated lympholysis, MLR, Graft vs Host reaction.

B-Cell receptor, maturation and structure, T – cell receptor, selection of T – cell repertoire, positive and negative selection, thymic education, Activations of T and B cells by antigens. Clonal selection theory, Generation of effector and memory T cell, T and B cell cooperation in antibody production

Immunoglobulins – structure, functions, classifications, properties, isotypic, allotypic, idiotypic determinants, immunoglobulin superfamily,production of monoclonal antibodies and their applications.

Antigen antibody interactions, affinity, avidity, cross reaction, precipitation, agglutination, radio-immunoassay, Enzyme Linked Immuno Sorbant Assay (ELISA), Western blotting and their practical applications,

Complement – components, classical and alternative pathways of complement activation, biological consequences of complement activation, complement deficiencies.

Hypersensitivity – classification of hypersensitive reactions, Type –I, Type II, Type III and Type IV hypersensitivity reactions, mediators, consequences and therapy.

Autoimmunity – organ specific and systemic autoimmune disorders, mechanisms and treatment of autoimmune diseases.

SL. NO. -7: Molecular Genetics and Modern Molecular Biological Techniques (Theory)
Paper Code : HP 802 C **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the molecular basis of genetics.
- Develop comprehensive understanding of various componets of DNA and RNA and their functions.
- Understand the structure of gene and genome.
- Concept of gene expression and its regulation.

SECTION – A :

DNA: Chemical composition of DNA, DNA structure, single stranded DNA, detailed account of double stranded NDA, B-DNA, Z-DNA, and other structural forms, triple stranded DNA and quadruplex DNAs, curved DNA, rod shaped DNA, and their importance, types of topoisomerase and their function in adding or removing superhelical structures.

Prokaryotic DNA replication, replication origin and site and structure and DNA Ter regions and structure. DNA polymerases, composition and features, replication factors and the mechanism of replication, leading strand and lagging strand synthesis, procesessivity, fidelity and regulation of replication. Replication of single stranded DNA, M13 viral DNA, Eukaryotic replication origins, replication initiation complexes and their assembly, licensing factors, DNA polymerases and their composition, teleomerase and mode of action.

DNA damages, types and their repair mechanism, mechanism of DNA repair and the regulation of it, direct repair, excision repair, transcriptional excision repair, glycosylase pathway, mismatch repair, UVr A.B and C mechanism, broken end repair, recombination repair and SOS repair system

RNAs: coding and non-coding RNAs, tRNAs: structural features, their anticodon features, mRNAs, prokaryotic and eukaryotic mRNAs, structural features,

SECTION – B :

Concept of gene, genome sizes, kinds of genes, gene numbers, functional genes, cryptic genes, pseudogenes, processed genes, overlapping genes, family of genes, Gene structure: structural organization of prokaryotic and eukaryotic genes, regulatory elements of genes, (proximal or internal including promoter, operator, activator and enhancers), coding region and terminal region of genes, prokaryotic gene expression: transcriptional apparatus, RNA polymerase structure, subunits and their function: sigma factor, their character, and role, mechanism of transcription, initiation, elongation and termination (rho dependent and rho independent mechanism). Regulation prokaryotic genes expression and operons, regulation of Lac operon, Tryptophan operon, and arabinose operon, concept of regulons, stimulons, global regulators.

Lambda phage: regulation lytic and lysogenic pathway in lambda phage, cI-repressors, crorepressors, transcriptional terminators, and antiterminator, early and late genes, their expression and regulation, eukaryotic gene expression, DNA binding proteins, concise account of helix turn helix proteins, helix loop helix proteins, helix turn beta, zinc finger proteins, leucine zipper proteins, homeodomain proteins, beta barrels, bZIP and bZLH domains, and proteins with combination of the above and how they bind and bring about regulation of gene expression. Transcription factors (TFs), concept of activators, activator domains, coactivators, and mediator complex, enhancer proteins, and their binding factors, characterisation of TATA box, upstream elements to TATA box, InR elements, Downstream promoter elements(DPE), enhancer elements activator elements, response elements, silencer elements/repressor elements, insulators:

Promoters with TATA, InR and DPE, promoters without TATA, promoters without TATA and InR elements, their structure and function. gene expression and chromosome remodelling, effect of histone modification on transcription of classI genes, changes in nuclear positioning, histone acetylation and deacetylation, methylation and demethylation, phosphorylation and dephosphorylation. Post-transcriptional processing of RNA: processing of rRNA, precursor rRNAs of prokaryotic and eukaryotic types, structural and functional features of U3RNA RNPs. snoRNAs and snoRNPs, scaRNAs and their role in modification and splicing of rRNAsand some snRNA

SL. NO. -8: Neurophysiology, Neuroanatomy, Neurochemistry, Behavioral & Special sensory physiology (Theory)
Paper Code: HP 803 C **Credit: 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the neurophysiological and neuroanatomical basis of human nervous system
- Develop comprehensive understanding about different neural structures in human and their functional relevance
- Understand the behavioral aspect of human brain.
- Different special sensory organs and their structure function relationship..

SECTION - A :

Structure of the nervous tissue- neurone, nerve fiber, neuroglia, myelination,structure of spinal cord, spinal segment, spinal and cranial nerves,nerve supply to the body wall, upper and lower limbs, dermatomes of the upper and lower limbs, segmental innervation of muscles regulating joint movements, applied anatomy of spinal nerve roots, organisation of autonimic nervous system,morphology of synapse and neuromuscular junction, motor end plate,sensory receptors and their organization.
The brain – subdivisions and coverings of brain, the telencephalon, gross anatomy of cerebral hemisphere, ventricles of the brain(third&lateral), base of the brain, structure of neocortex, functional areas of cerebral cortex, nerve fibers of cerebrum, interna capsule, corpus callosum, basal ganglia and related structures, gross anatomy of corpus striatum, the limic system structure, the diencephalon- the thalamus, epithalamus, hypothalamus and circumventricular organs.

The brain stem and cerebellum – general consideration, the medulla oblongata, the pons, the mid brain, the reticular formation, subdivisions of cerebellum, cerebellar nuclei, cerebellar connections, extrinsic cerebellar circuitry.

Synaptic and junctional transmission- presynaptic grid, chemical transmission of synaptic activity, principal neurotransmitter systems, molecular mechanism of presynaptic release of neurotransmitter, electrical events in postsynaptic neurones, inhibition and facilitation at synapse, integrative functions of synapse , neuronal pool, neuromodulation at synapse, synaptic plasticity and learning , neuromuscular transmission, active zone, quantal release, nerve endings in smooth and cardiac muscle, neuromuscular blockers, molecular basis of autoimmune neuromuscular disorders, denervation hypersensitivity.

Initiation of impulses in sense organs- sense organs and receptors- types and properties, receptor potential, tonic and phasic receptors, coding of sensory information, cutaneous, deep
and visceral sensations, pathways for touch, pain and temperature sensation, proprioception, ki9nesthetic sensation, CNS modulation of pain sensation, gate control theory, indegenous analgesic system.

Reflexes- general properties, monosynaptic and polysynaptic reflexes, stretch reflex and withdrawal reflex, muscle spindle and golgi tendon organ, deep and superficial reflexes, pathological reflex, spinal reflex, effect of transection of spinal cord at various levels.

Control of posture of and movement- pyramidal and extrapyramidal system, corticospinal and corticobulbar pathway, regulation of posture and equilibrium, vestibular apparatus, spinal integration, medullary components, midbrain components, cortical components, , cerebellar circuit and its role, basal ganglia circuit and its role, effect of transection of spinal cord at various levels effect of UMN and LMN lesion, effect of pyramidal and extra pyramidal lesion, effect of lesion of cerebellum and basal ganglia.

Thalamocortical and corticothalamic projection and consciousness- functions of thalamus, basis of electrical waves of the cortex (EEG & EKG), synchronizing and desynchronizing mechanism, ascending and descending reticular activating system, neurophysiology of sleep and wakefulness cycle, sleep disorders.

The autonomic nervous system and central regulation of visceral function- functional organisation of autonomic outflow, chemical transmission at autonomic junctions, response of effector organs to autonomic nerve impulse, medulla oblongata and its role, hypothalamic control of visceral function – cyclic phenomena, hunger, thirst and temperature regulation.

Higher functions of nervous system – learning and memory, molecular basis of memory, conditioned reflex, encoding of memory, functions of neocortex, complementary specialization of hemispheres, concept of dominance, physiology of language and speech , speech disorders

Neuroscience methods – neuroimaging, noninvesive electrophysiology, classical electrophysiology, neuroanatomy imaging technology, optogenetics.

SECTION – B :

Behaviour: Basic idea and its types (passive, aggressive, assertive, passive-aggressive and alternator), factors affecting (genetic, social norms, creativity, core faith and culture, attitude), emotion, learning, motivation, perception, personality development, Emotion: Limbic system control on emotion and behaviour: neural circuitry of limbic system, amygdala septum hippocampus, fear and rage, septal rage, Khuer-Bucy syndrome. Brain chemistry and behaviour: role of aminergic systems, acetylcholine, opoid peptides on brain functions.

The Sensory System: Types of sensation, Special and general senses, Sensation and perception, coding of sensory modality, intensity

The Visual System: Retinal morphology, retinal neural circuitry, visual pathway, primary visual cortex-topographic map, organization and function, Chromatic properties of retina, colour blindness, accommodation of eye, binocular and stereoscopic perception.

The Auditory System: Sound transmission in auditory system, Organ of Corti-structure and function relationship, central auditory pathway, descending auditory pathway, primary and

secondary auditory cortical areas, auditory system-frequency analysis of sound by cochlea and central auditory pathway. Intensity coding of auditory system, cochlear potentials.

Gustatory System: Receptor organs-distribution, ultramicroscopic structure and innervations, taste modalities, neural circuitry of gustation, sensory processing, abnormalities of taste.

Olfactory System: Organization of receptors in olfactoepithelium, olfactory receptor potential, olfactory pathways-olfactory bulb and central olfactory connections, coding of olfactory information, abnormalities of smell sensation.

Neurochemitry: Principles of neutortransmitters, acetylecholine, norepinephrine, epinephrine, dopamine, serotonin, histamine, inhibitory amino acid - GABA, glycine, substance P and other tachykinins, excitatory amino acid -glutamate, aspartate, opoid peptides- encephalins, metencephalin, leuencephalin, proopiomelanochortin, prodynorphin, other polypeptides-calcitonin gene related peptides, neuropetide Y.

SL. NO. -9: Lab work II : Haematology, Human Physiology, Histology, Molecular Biology (Practical)

Paper Code : HP 804 C **Credit: 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Undertake analysis of different hematological parameters using human blood samples.
- Develop skills to perform clinical examination of cardiovascular system, respiratory and central nervous system..
- Learn steps in of staining the tissues for histological study.
- Learn the method for protein electrophoresis and use of the method for hemoglobin analysis.
-

01. **Haematology Experiments** — TC,DC, Platelet, Absolute Eosinophil Count, Reticulocyte Count, Determination of CT/BT and Prothrombin Time.

02**. Human Experiments:**

Study of Respiratory System- Recording of Lung volumes and capacities.

Study of cardiovascular system- Recording of Blood Pressure & Pulse Rate

Effect of variation in posture on & Effect of exercise on BP/P

Recording of ECG and Determination of Cardiac Axis

Study of Central Nervous System- Study of Sensory System:

Pain/ Touch/ Temperature/ Smell/ Taste Senses

Study of Motor System- Study of Deep Reflexes --Tendon jerk/Biceps/Triceps jerk/Knee jerk/Ankle jerk/ Study of Superficial Reflexes- Planter Reflex/ Corneal/ Abdominal Light Reflex.

Anthropometric Study--- Recording of Height/Body Weight and Head Circumference / Calculation of BMI and Waist and hip circumference/Recording of Skin fold thickness- Determination of TBF content

Exercise Physiology— Physical Fitness Index by Harverd Step Test.

Calculation of Vo_2 max by Queen's college step Test and Trademill Test.

03. **Histology**- Study of stained Histological Slides .

04. Protein electrophoresis , Identification of abnormal hemoglobins by electrophoretic method.

3rd Semester:

SL. NO. -10: Reproductive Physiology & Developmental Biology (Theory)
Paper Code : HP 901 C Credit : 04

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the function of reproductive organs in both male and female.
- Develop comprehensive understanding of modern methods of contraception and assisted reproductive techniques.
- Understand the basic concept of developmental biology in human.
- Human embryology and development of organ system in human..

SECTION – A :

Male and female reproductive system Sex differentiation–disorders of sex, gonadal differentiation, female and male pseudohermaphroditism, sexual infantilism, folliculogenesis, ovulation, spermatogenesis, hormonal control, menstrual cycle; steroidogenesis - steriodogenesis and its hormonal regulation;
Physiology of pregnancy and lactation: Physiology of implantation, pregnancy maintenance, sex biorhythm, role of endocrine, autocrine, paracrine factors in pregnancy regulation, ectopic pregnancy, endometriosis, foeto-placental unit, role of blastocyst in pregnancy maintenance.maternal adaption to pregnancy endocrinology of parturition physiology of lactation and physiological importance of lactation, application of molecular biology to reproduction
Contraception: Principle of contraception, male and female contraceptives, hormonal contraceptive and their molecular action, IUD and their molecular action, emergency contraception.

SECTION – B :

Introduction to Developmental Biology., Details of Mitotic and Meiotic cell division.
Ultra structure of egg and sperm, Spermatogenesis in mammals and its regulation.
Oogenesis in mammals and its regulation., Molecular gene expression and regulation of diffrenent genes related to development, different embryological pathways regulating the embryonic development of fetus, Fertilization, different proteins involved in fertilization,

Cleavage, gastrulation and axis formation, Derivatives of ectoderm layer, formation of neural tube, neural crest and epidermis, Derivatives of mesoderm, paraxial mesoderm, somites, myogenesis, osteogenesis, intermediate mesoderm and urogenital system., Lateral mesoderm and endoderm- their derivatives, Development of limb, Molecular basis of sex determination, Molecular basis of aging and senescence, Medical aspects of developmental biology, Comparative development.

SL. NO. -11: Nutrition & Microbial Physiology (Theory)
Paper Code : HP 902 C **Credit : 04**

Learning outcomes :

After completion of the course student should understand the following:

- The total digestion and absorption process of different kinds of food.
- Nutritional requirement in normal and different pathological conditions of human being and in pregnant mother.
- Concept of disease development by different microorganisms and their different virulent factors
- The mechanism of development of antibiotic resistance in bacteria.

SECTION – A :

Digestion, absorption and related disorders: Secretary function of elementary tract, secretion of saliva, gastric juice, pancreatic enzyme, bile, mucous, digestion of carbohydrates, protein, fats, gastrointestinal absorption of carbohydrates, proteins and fats, physiology of gastrointestinal disorders (peptic ulcer, pancreatic failure, sprue, constipation, diarrhoea, vomiting, nausea).
Different food groups and nutrients, Dietary fibres, antioxidant nutraceuticals

Short-term regulation of hunger and food intake, Neural signals from the GI tract, Nutrient signals, Hormone signals, Psychological factors, Long-term regulation of hunger and food intake, Physiological factors, Set-point theories of hunger and eating
Nutrition during normal life: Nutrition in infancy: Nutritional requirements during infancy, breast feeding, nutritional and other factors affecting growth and development, colostrum, infant milk substitute (IMS) act, formula feeding,Nutritional requirement of pre-term babies, feeding problems,food allergies, cow's milk protein allergy, lactose intolerance, diarrhoea, vegetarianism.Nutrition in childhood, adolescence and adults: nutritional requirement of pre-

school and school children, nutritional related problems of children, childhood obesity, dental caries, allergies, PEM symptoms,Nutritional requirement in adults

Nutrition in pregnancy: Physiological changes during pregnancy, factors affecting pregnancy outcome, maternal age, pre-pregnant weight gain during pregnancy, life style factors, birth weight standards, requirements during pregnancy, problems in pregnancy, nausea and vomiting, constipation, oedema and leg cramps, heart burn, excessive weight gain.
Nutrition in lactating woman: Nutritional requirements, factors affecting the volume and concentration of breast milk

SECTION – B :

General Characteristics of Microbes, brief introduction to pathogenic microbes: viruses, rickettsiae, spirochoates and bacteria, important human pathogens.
Modes of cell division, Normal growth cycle of bacteria, Continuous culture, Quantitative measurement bacterial growth, plate count method, Turbidimetric method, Importance of quantitative measurement of growth.
Natural microbial population, Selective methods, Pure culture, Methods of isolating pure culture, Maintenance and preservation of pure culture
Host parasite relationship, normal microbial flora of humans, transmission of microorganisms, microbial pathogenicity and virulence, determining etiology and host factors.
Antimicrobial chemotherapy, Antibiotics and their mode of action, Inhibition of cell wall synthesis, Penicillin, Damage to cytoplasmic membrane, Inhibition of nucleic acid and protein synthesis, Streptomycin, Inhibition of specific enzyme synthesis, Antifungal antibiotics, Antiviral chemotherapeutic agents, Antitumor antibiotics, Development of resistance to Antibiotics, microbiological susceptibility to therapeutic agents
Identification of microorganisms from specimen, Infectious disease cycle, virulence and mode of transmission.
Human diseases caused by bacteria, Airborne, food borne, water borne arthropod borne and zoonotic diseases.
Eukaryotic viruses; RNA DNA viruses, retrovirus and hepatitis B virus
Viral bacterial protozoal and fungal human diseases; Antibiotics and antiviral agents and their mode of action; development of antibiotic resistance mechanism

SL. NO. -12: Lab work III: Techniques in Physiology (Practical)

Paper Code: HP 903 C **Credit: 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Use the modern molecular biology techniques for analysis of tissue samples..
- Develop comprehensive understanding of different experimental procedures using animal.
- Understand the mechanism of complete tissue processing for histological analysis..
- Biochemical analysis of different tissue samples and use of immunological techniques..

1. Isolation of Nucleic Acids (RNA & DNA) and Proteins from Liver Tissue
2. Estimation of Nucleic Acids (RNA & DNA) and Proteins Isolated from Liver Tissue
3. Isolation of Plasmid DNA & Gel Electrophoresis
4. Total Histological Process-

i) Tissue Processing
ii) Sectioning
iii) Staining

5. Biochemical Analysis-

i) Cholesterol Estimation from Reproductive Organs of Male and Female
ii) Estimation of Steroidogenic Enzymes

6. Experimental Procedure-

i) Study of Oestrus Cycle
ii) Sperm Count and Sperm Mortality

7. Ash Content of Food
8. Estimation of Mineral Content of Food-

i) Calcium/Iron/Phosphorus

9. Estimation of Vitamin-C
10. Single Colony Isolation by Streak Method
11. Ouchterlony Double Diffusion Method of Antigen-Antibody Interaction
12. Antibiotic Susceptibility Assay

4th Semester:

SL. NO. -13: Endocrinology & Stress Physiology (Theory)

Paper Code: HP 1001 C **Credits: 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the structure and function of different endocrine glands.
- Develop comprehensive understanding of neuroendocrine control of body functions.
- Understand the basic concept of different stress and stressors.
- Stress at cellular level and environmental stress.

SECTION – A :

General concepts of Endocrinology: Endocrine, paracrine and autocrine secretion.Hormone chemistry, synthesis, storage, release and transport of hormones; Feedback regulation of hormone secretion. Hormone receptors-types, properties, synthesis and life cycle, up and down regulation of receptors; Mechanism of hormones action – hormone that act on nuclear receptors and the hormones act at the cell surface.

Neuroendocrinology: Neural control of glandular secretion – neurosecretion; hypothalamus-pituitary unit, hypophyseotropic hormones and neuroendocrine axes –TRH, CRH, GHRH somatostatin, prolactin regulatory factors, Endocrine functions of Hypothalamus and Pituitary - Hypothalamo-hypophysial axis and anterior pituitary hormones : Functional significance, pituitary transcription factors and anterior pituitary control, Growth hormone and physiology of growth, physiology and disorders of different pituitary (anterior) axes: Neurohypophyseal hormones: Synthesis, release and regulation of neurohypophyseal hormones.

Thyroid hormones – synthesis, plasma transport, intracellular binding, mechanism of action; regulation of thyroid function; role of thyroid hormones in growth, differentiation and metabolism, calorigenic action of thyroid hormone, thyroid functions in pregnancy, and in the fetus and newborn; thyrotoxicosis endemic and exopthalmicgoiter and autoimmune.

Endocrine function of pancreas and carbohydrate metabolism- Islet cell structure, structure, biosynthesis and secretion of insulin, fate of secreted insulin, effects of insulin, insulin receptors, mechanism of insulin action, consequences of insulin deficiency and insulin excess, glucagon and other islet cell hormones, hypo and hyperglycaemic hormones and their role in carbohydrate metabolism, hypoglycaemia and diabetes mellitus.

Parathyroid gland and Hormonal control of calcium metabolism and the physiology of bone – parathyroid hormone, calcitonin, Vitamin D3 and Hydrocholecaciferols, role of hormones in calcium and phosphorous metabolism, bone physiology and bone disorders, effect of other hormones and humoral agents in calcium metabolism.
Adrenal cortical and medullary hormones - action of corticoids and catecholamines Roles in metabolic, vascular, physical and emotional stress ,anti inflammatory role; mineralocorticoids in sodium and potassium metabolism, general idea about cushing syndrome, pheochromocytoma – diagnosis and management.

SECTION – B :

Stress Physiology: Basic concept, Types: Chronic and Acute Stress, Eustress, Distress, Stressor, Basic concept of homeostasis,Fight or flight response, Strain.
Neurophysiological basis of Stress: Neuroanatomy of Stress: Brain, hypothalamus, Amygdala, Hippocampus, Prefrontal cortex, Locus Raphe nucleus, The spinal Cord, Adrenal Gland.
Neurochemistry of Stress: Corticotrophin releasing hormone, Adrenocorticotropic hormone, Cortisol, Norepinephrine, Serotonin, Neuropeptide Y

Effects of Stress on Biological system: Effects on nervous system, Pain stress, (Anxiety, Depression, Eustress, Distress, Cognitive, Emotional and behavioural symptoms), Endocrine system, Hypothalamus pituitary Adrenal Axis, Immune System.
Environmental Stress: Thermal Stress: Heat Stress (Causative factors, Types Physiological effects and Prevention), Cold Stress (Causative factors, Effects of human Body and Prevention).
Stress at High Altitude: Effects on Physiological Systems, Prevention, Chronic Mountain Sickness. Stress at Deep Sea Diving: Effects on Physiological Systems, Prevention,
Positive and Negative G Forces: Stress Responses, Precautions.
Noise: Adverse Health Effects and Prevention
Radiation: Hazardous effects and Preventive measures.

Stress at Cellular Level: Oxidative Stress (Basic Concept: Pro-oxidant Metals, Pro-oxidant Vitamins and Anti-Cancer Drugs Oxidant: Electron Acceptor), Basic Mechanism of generation of free radicals and Oxidative Stress, Basic idea of Stress Proteins, Antioxidant: Exogenous and Endogenous, Metabolites (Uric acid, Vitamin C, Vitamin E, Melatonin, Glutathione), Antioxidant Enzymes: Catalase, Superoxide dismutase (SOD), glutathione Stranferase (GST), glutathione peroxidise (GPx), glutathione reductase (GR).

SL. NO. -14: Project on Advances in Human Physiology
Paper Code: HP1002C **Credit: 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the method of literature survey and identification of problem for investigation.
- Develop comprehensive understanding of protocol writing.
- To take up individual study on a problem based on literature survey using the available methodologies.
- Analyse the obtained results, prepare a report and use power point to present the report in front of a select audience.

Project and Review work will be conducted by the student under the assigned faculty members (special paper).

DETAIL SYLLABUS (ELECTIVE COURSES)

1st Semester : NIL

2nd Semester:

SL. NO. -1: Pharmacological & Toxicological Principles (Theory)
Paper Code : HP 801 E **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the basic pharmacological principles applicable for drug development.
- Develop comprehensive understanding of drugs acting against different pathological conditions.
- Understand mechanism of action of different toxic components.
- Xenobiotics and their action, concept of genetic toxicology.

General pharmacology: Introduction regarding drugs, sources , routes of administration, drug absorption, bioavailability, bioequivalent, bioconversion, mechanism of drug action, factors modifying drug action, dose response relationship, adverse drug reaction, autonomic pharmacology, cholinergic drugs, anti cholinergic drugs, adrenergic drugs, anti adrenergic drugs, examples: antacids, histamines, anti histamines, serotonin, agonists and antagonists, prostaglandins and bradykinins; Hematopoietic system, Haematinics, iron vit- B12 and Folic acid, erythropoietin, coagulants and anticoagulants, Anti platelets. Fibrinolytic and antifibrinolytic, Renal system, diuretics, antidiuretics, Nephrotoxic drugs, drugs for acid base balance, Respiratory; cough suppressants and mucolytic agents, pharmacotherapy of bronchial asthma.

Toxicity- Measurements, toxic reactions, toxins. Mechanism of different toxic compounds, Introduction and different areas (mechanistic, descriptive, regulatory, forensic, clinical, environmental, developmental toxicology), classification of toxic agents, different toxic responses (allergic reaction, idiosyneratic reactions, immediate and delayed toxicity, reversal and irreversal toxicities, local and systemic toxicities), Characteristics of exposure (route and site of exposure, duration and frequency of exposure), variation in toxic responses (selective toxicity, species difference , individual difference, acute lethality, sub acute, sub chronic and chronic toxicity) Mechanism of toxicity (absorption, distribution, excretion, and detoxification, reaction of the toxicant with target molecules), Mechanism of toxic cell death, Biotransformation, and

concept of xenobiotics, Mechanism of xenobiotic transformation (hydrolysis, reduction, oxidation and conjugation). Basic concept of genetic toxicology, toxic responses of immune system, toxic responses of blood, renal toxicity, hepatotoxicity, respiratory toxicity, and cardiovascular toxicity, reproductive toxicity. Toxic effects of arsenic, lead, fluoride and chromium on human health

SL. NO. -2: Sports and Exercise Physiology (Theory)

Paper Code : HP 802 E **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand various tools used to measure the physical fitness.
- Develop comprehensive understanding on changes in various physiological parameters in response to physical exercise.
- Understand role of yoga in physical fitness and sports performances.
- Molecular mechanisms of enzyme actions

Ergometry- Bicycle ergometer, Trademill and Telemetry- their principles and uses in sports and Exercise Physiology. Circulatory, respiratory and haematological responses during exercise.
Biochemical responses during exercise; Physical fitness test—methods for evalution and significance of anaerobic power, O_2 -- debt, anaerobic threshold, aerobic power, (VO_2 max) , strength, flexibility, endurance and agility. Nutrition in sports performance–diet for different sports events, pregame meal, spacing of meals, glycogen loading, fluid replacement.

Sports anthropometry—methods of assessment of body composition, desired body weight and weight control, somatotyping. Importance of physical condition, principle and methods of physical conditioning, aerobic and anaerobic training. Physiological adaptation due to training.
Age and sex differences in sports performance, Women in atheletics and sports. Pregnancy and menstruation in relation to exercise.

Importance of hormones in exercise and sports. Oxidative stress-its management.
Yoga and its therapeutic application.
Ergogenic aids in sports. Doping agents—types, tolerance limits, blood doping, Physiological problems associated with doping IOC guidelines.

3rd Semester:

SL. NO. -3: Advances in Molecular Cell Biology and Cell Signalling (Theory)
Paper Code : HP 901 E **Credit:04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the molecular organization of cell membrane structure.
- Develop comprehensive understanding of cell signaling mechanisms
- Understand the regulation of gene expression
- Immunophysiology and various molecular techniques.

Biomembrane, organization and composition of bio membrane, fluidity & asymmetry of lipid bi-layer, cortical cytoskeleton, restriction of membrane protein diffusion, transport across the membrane pump, channels, ion channels, voltage and transmitter gated ion channels, protein sorting within the cells, NPCs, Mitochondrial protein transport, Membrane and Secretory proteins, Transport vescicle and Intra cellular Membrane Traffic, Role of Clathrin.
Signaling Through G-Protein Coupled Receptors, GPCRs, cAMP & phospholipid G-Protein signaling, Calcium Ion Signals, Channels control by G-Protein, NO mediated signals, Enzyme coupled receptor and signaling, RTKs, Ras, MAP Kinase, Rho family GTPase, PI-3-Akt signaling, Cytokine Receptors & JAK-STAT signaling, TGF-Beta super family mediated signal and Smads, Protein degradation & signaling, Notch signaling, Wnt signaling, β catenin, Hedgehog pathway, NF-kB dependent pathway, Nuclear receptors & steroid Hormones, Cell polarization & migration, Integrins mediated cell signaling. Epithelial- mesenchymal Transitions, Mesenchymal –epithelial Transitions.
Regulation of Gene Expression, Active & repressed Chromatin. Histone as an activation of Switch, Histone Acetylation, Methylation, DNA methylation & control of transcriptions, Inheritance and Stabilization of DNA methylation pattern, Differential RNA processing, Control of Expression at the level of Transmission, Differential mRNA longevity, selective inhibition of mRNA translation, Micro RNAs as specific regulator of gene expression, stored mRNA in brain cells, Brain derived neurotrophic factor, Post translational Regulation of Gene Expression. Gene polymorphism, SNPs, Multiple alleles, Linkage and Genetic Mapping, Physical Mapping.
Molecular basis of oxidative stress, cellular response in stress, stress proteins, metabolic integration, energy metabolism.

Immunophysiology: T & B cell Biology, Thymic Education, Class-I & Class-II MHC molecules, Antigen processing and presentation, HLA, Activation of CD4+ T-cell, CD-8+ T-cells, Functions of NK T-cells and γ δ T cells, Cytokines, Functional integrins of Cytokines, Cytokine Receptor mediated signal transduction, Therapeutic exploitation of cytokines,
Flow cytometry, cell cycle analysis, Flourescence microscopy, TEM, SEM, AFLP, RFLP, FISH

SL. NO. -4: Advances in Microbiology (Theory)
Paper Code : HP 902 E **Credit : 04**

Learning outcomes :

After completion of the course student should understand the following:

- How the genetic material recombine in microorganism
- How different types of mutation occurs in prokaryotes.
- How different microorganism used in industry.
- Microorganism present in soil and how they decompose different compounds in soil.

Microbial Growth yield and characteristics, strategies of cell division, stress response
Transcription and translation of genetic information, The process of protein synthesis
Study of microbial genetics; The inheritance of characteristics and variability, Phenotypic changes due to environmental alterations. Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
Regulation and expression of gene activity, Genetic engineering
Organization, alteration and expression of the genetic information, Genotypic changes;
Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
Bacterial Recombination; Bacterial conjugation; Transduction; Bacterial transformation
Homologous and non-homologous recombination including transposition

Bacteriophage: Discovery and significance, General characteristics, Morphology and structure, The classification and nomenclature of bacteriophage, Some bacteriophages of E. Coli, Replication of bacterial viruses, The viral multiplication (replication) cycle, Lysogeny and transducing bacteriophage
Microbial flora of fresh foods; Microbial spoilage of foods; Microbiological examination of foods; Preservation of foods; Fermented foods

Microbial flora of soil; Biogeochemical role of soil microorganisms; Biochemical transformation of carbon and carbon compounds; Biodegradation of herbicides and pesticides
Microbial fermentation and production of small and macromolecules
Microorganisms and industry; Industrial uses of bacteria; industrial uses of yeast; Industrial uses of molds; Deterioration of materials; Analytical microbiology
Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal host cells, alteration of host cell behaviour by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals, cell-cell fusion in both normal and abnormal cells.

SL. NO. -5: Advances in Molecular Endocrinology (Theory)
Paper Code: HP 903 E **Credit: 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the techniques for quantification of different hormones..
- Develop comprehensive understanding on genetic control of hormone formation.
- Understand the neuroendocrinological principles.
- Role of hormones in pathophysiology of different diseases.

Discovery of hormones as chemical signals for control and regulation of physiology processes . Techniques for quantitation of hormones ; RIA , immunoradiometric assays (IRNA) , immunochemilumetric assays (ICMAS) , radioreceptor assays , functional hormonal bioassays ; statistical procedure for immunoassay data-reduction , origin and development of hormone assay.
Structure of peptide and protein hormones ; purification of peptide hormones . Characterization , structural and functional relationship and pharmacokinetics of peptide hormones . Phylogenic analysis of pheromone structure and function of pheromones , kinetics of hormones .
Genetic control of hormone formation : subcellular structure of cells that secrete protein hormones , storage and secretion of hormones – molecular mechanism of regulation , structure of a gene encoding a polypeptide hormone ; regulation of gene expression , transcriptional and post transcriptional mechanisms of hormone biosynthesis and secretion .

Hormonal genes and hormone regulated genes in the context of biosynthesis . Inhibitors of biosynthesis and their use. Metabolism of hormones by target and non-target tissues.

Discovery of receptors in target tissues ; biochemistry and molecular biology of steroid receptors , hormones , control of gene expression , RNA synthesis , RNA stability and steroid hormone action . Hormones that act at the cell surface ; mechanism of hormonal action and signal attenuation . Signal discrimination , signal transduction and signal amplification in hormone regulated physiological processes . Receptor antagonists and their applications .

Neuroendocrinology – neuronal control of glandular secretion ; hypothalamic-pituitary unit ; regulation of secretion of tuberohypophysial hormones ; feedback concept in neuroendocrinology , neuroendocrine control of pituitary hormones ; pineal gland ; circumventricular organs , neuroendocrino-diagnosis , neuro-endocrine-immuno interaction , neurone as target cells for hormone action , neuronal modification of hormone metabolism and regulation of neuronal function – effect of ion channel , electrical events.

Autoimmunity and endocrine disorders – generation of specificity , recognition of antigens , tolerance of self antigens , mechanism of autoimmunity , genetics of autoimmunity , non-endocrine function of endocrine molecules , nonconventional endocrine molecules in health and disease . Endocrine disruption .

Endocrinology of growth and development, normal and aberrant growth, growth factors, adolescent growth, obesity and metabolic syndrome, endocrine control of energy stores, disorders of lipid metabolism, complications of diabetes mellitus, endocrine responsive cancer, immunoendocrinopathy syndrome.

SL. NO. -6: Advances in Nutrition and Metabolism (Theory)

Paper Code : HP 904 E **Credit : 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand basic mechanism of energy metabolism and energy expenditure.
- Develop comprehensive understanding of nutrient requirements.
- Understand food technology, preservation and processing of food materials..
- Food adulteration, food toxins and detoxification.

Energy Metabolism:Energy content of food, Measurement of energy expenditure (direct and indirect methods) and energy requirement of an individual at rest and work

Nutritional Aspects of Dietary proteins, fats and carbohydrates, their role in energy metabolism,Metabolic disorders in relation to over or less intake of carbohydrates, proteins and fats

Hormonal control of nutrient metabolism: Post-absortive nutrient metabolism and role of pancreatic hormones, role and corticoids in nutrient metabolism

Nutrient Requirement, RDA, Balanced Diet, Food habits and dietary patterns: Role of social, cultural, economic and psychological factors

Vitamins, their sources, importance, toxicity, nutritional value and implementation(Vit.A, B complex, vit. C, vit. D, vit. E, vit. K) and minerals (sodium, potassium, calcium, zinc, chromium, fluoride, magnesium)

Food Technology, Food preservation and processing, Food fortification, Food quality control

Food additives, DNA technology, Food faddism, Food adulteration, Food toxins-Natural and artificial

Role of nutrients in detoxification and nutrient-drug interaction, food allergy and food intolerance, Food microbiology Nutrition and Immunity, Role of microbes in nutrition (gut micro flora) .

SL. NO. -7: Excretory Physiology (Theory)

Paper Code: HP 905 E **Credit: 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand basic principles of renal function.
- Develop comprehensive understanding of structure function relationship of kiney.
- Understand the effect of disorders in kidney function..
- Mechanism of use of artificial kidney and related technologies.

Functional anatomy of kidneys, renal blood flow & its autoregulation, Glomerular filtration & its regulation, Tubular reabsorption & secretion . Concentration & dilution of urine, Mechanism of regulation of urine volume and osmolality,. Acidification of urine & bicarbonate excretion regulation of Na^+ &Cl^- Excretion, Regulation of K^+ Excretion, Body fluid compartments, Control of body fluid osmolality, Regulation of extracellular fluid volume and composition,

Diuretics, Renal function tests, Effects disordered renal function. Filling of Bladder, Emptying of bladder, Physiology of micurition, abnormalities of micturition,. Dialysis & renal transplantation.

SL. NO. -8: Research Methodology & Ethical Issues in Biomedical Research (Theory)
Paper Code : HP 906 E **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand concept of different types of research.
- Develop comprehensive understanding On steps to be followed before undertaking a research activity.
- Understand the method for literature survey and protocol writing.
- Ethical issues in research involving animal and human subjects.

Research methodology: Formulation and testing of hypothesis, selecting the level of significance, making decision regarding hypothesis, research design, concepts relation to research design,
Experimental group, control group, treatment schedule, control, mechanism experimental units, Experimental errors, validity of research design, internal and external validity, threats to the validity of research design, Exploratory or formulating research design, descriptive or diagnostic research design, experimental research design,
Principle of experiment design, Principle of replication, Principle of randomisation, principle of local control, pilot study, selecting matching groups, Concept of experimental research, requirement for experimental research, characteristics of scientific methods, objectivity, generality, verifiability, predictability,
Steps in conducting research, formulating the research problem, survey and review of literature, Developing hypothesis and verifying concepts, deciding on research design, defining the population & selecting the sample, choice of methods,
Types of research, fundamental or basic research, applied or practical research, Experimental research, Lab experiments and field experiments,
Reporting: Preparation & submission of research report.
Research Ethics: Approved Guidelines by CPCSEA on the norms and practices for regulation of Animal Experimentation, CPCSEA Guidelines for Laboratory Animal Facility. Quarantine,

stabilization and separation, surveillance, diagnosis, treatment and control of disease, Personal hygiene, Animal experimentation involving hazardous agents, Physical restraint, Caging or housing system, Activity, food, bedding, water, sanitation & cleanliness, waste disposal, pest control, record keeping, Standard Operating Procedures, anaesthesia and euthanasia, Transgenic animal, Ethical Guidelines for biomedical Research on Human Participants (2006). Informed consent process, compensation for participation, Selection of special groups as research participants, essential information of confidentiality for prospective research participants, compensation for accidental injury, Statement of Specific Principles for Clinical Evaluation of Drugs/Devices/Diagnostics/Vaccines/Herbal Remedies

SL. NO. -9: Molecular Physiology of Human Diseases (Theory)
Paper Code : HP 907 E **Credit : 04.**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand mechanism of origin of cancer cells.
- Develop comprehensive understanding of cancers of different organs.
- Understand pathophysiology of disease associated with molecular and metabolic pathways..
- Molecular mechanisms of different neural disorders.

Cancer Metabolism and Possible Outcomes
Cancer biology: Cancer cell origin, derive from a single abnormal cell, cancer cells contain somatic mutation, cancer growth depends on defective control of cell death, cell differentiation or both, cancer cells may achieve immortality, metastasis, angiogenesis, causes of cancer, treatment.
Cell signaling: Cell surface Receptors, Second Messenger, positive & Negative Feedback in Signal System. Signaling through Enzyme-Linked Cell-Surface Receptors, Activated Receptor Tyrosine Kinases Phosphorylate Themselves, Ras Activates a Downstream Serine/Threonine Phosphorylation Cascade That Includes a MAP-Kinase, PI 3-Kinase Produces Inositol Phospholipid Docking Sites in the Plasma Membrane, The PI 3-Kinase/Protein Kinase B Signaling Pathway Can Stimulate Cells to Survive and Grow, Signaling proteins are frequently expressed as separate and independently controlled, Nuclear receptors regulate transcription, G-proteins regulate wide variety of receptors and are controlled by regulatory GTPase cycle. Wnt signaling regulates cell fate during development and other processes

Cancer Metabolism and Possible Outcomes, Breast and prostate cancer
Anatomy and Physiology of the Liver, Liver-Specific Metabolic Pathways and Processes, Inside-Out: Metabolites of the Liver Affecting Other Tissues, Outside-In: Metabolites of Other Tissues Affecting the Liver, Pathophysiology of Cirrhosis and Metabolic Alterations
Anatomy and Physiology of Fat Tissue
Fat Tissue-Specifi c Metabolic/ Molecular Pathways and Processes
Inside-In: Metabolites of Fat Tissue Affecting Itself, Inside-Out: Metabolites of Fat Tissue Affecting Other Tissues, Outside-In: Metabolites of Other Tissues Affecting Fat Tissue
Pathophysiology of the Metabolic Syndrome
Heart-Specifi c Metabolic/Molecular Pathways and Processes, Atherosclerotic Plaque Formation and Myocardial Metabolic Changes, Anatomy and Physiology of Blood Vessels
Pathological Changes in Metabolism Following Stroke Onset, Pathophysiology of Varicose Veins and Metabolic Alterations, Pathophysiology of Sickle Cell Disease and Metabolic Alterations
Physiological Lipoprotein Metabolism
Kidney-Specifi c Metabolic and Molecular Pathways and Processes
Kidney and hypertension, Chronic kidney disease and kidney stone
Brain-Specifi c Metabolic/Molecular Pathways and Processes, Inside-In: Metabolites of the Brain Affecting Itself, Inside-Out: Metabolites of the Brain Affecting Other Tissues
Outside-In: Metabolites of Other Tissues Affecting the Brain, Molecular physiology of Depressive Disorders and Metabolic Alterations
Monoamine Systems, Molecular physiology of Schizophrenia and Metabolic Alterations
Molecular physiology of Parkinson’s Disease , Alzheimer’s Disease and Metabolic Alterations
Anatomy and Physiology of Joints, Inside-In and Outside-In Signaling: Metabolites Affecting the Joints, Pathophysiology of Osteoarthritis
Molecular physiology of Rheumatoid Arthritis and Metabolic Alterations, Gout
Pancreas-Specifi c Metabolic Pathways and Processes, Pathophysiology of Diabetes Mellitus and Metabolic Alterations

4th Semester:

SL. NO. -10: Molecular Cancer Biology & Onco-immunology (Theory)
Paper Code: HP1001E ` Credit: 04

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the mechanism and regulation of cell cycles..
- Develop comprehensive understanding of oncogenes and their function.
- Understand abnormalities in cell signaling pathways leading to cancer development..
- Understand the molecular mechanisms of tumor immunology and animal cell culture.

Cell cycle and its regulation, check points of cell cycle, different length of cell cycle of different types, cyclin dependent kinases (Cdks), cyclin dependent kinases cyclin complexes, G1-Cdk , G1 S-Cdk, G1 cyclins, E2F, Rb, G2- M transition, DNA damage and cell cycle regulation, withdrawal of cell from cell cycle, growth factors and cell proliferation. Apoptosis – death and mitochondrial pathwy, caspases – executioner and intrinsic, Bcl-2 family proteins, activation of Bax & Bak, BH3 only protein, cytochrome C, inhibition of apoptosis by extracellular survival factors, Autophagy- induction and mechanism,

Phenotypic characters of cancer cells, types and derivation of cancer cells, protooncogenes and oncogenes, conversion of protooncogenes into oncogenes, tumor suppressor genes, oncogenes and their proteins – classification and characteristics, Role of cellular oncogenes in carcinogenesis, multicausal, multistep nature of carcinogenesis, telomere length and cancer cell survival, DNA viruses as transforming agents, RNA containing retro viruses as trans forming agents, Human tumor viruses, HPV and cancer, E6 and E7 onco-proteins, their mechanism of action.

Abnormalities in signaling pathways, cell cycle and apoptosis in cancer, mutations in pathways common to majority of cancers, PI3 K/AKT/mTOR pathway, mutation in P53 pathway, cancer cells survival in stress, angiogenesis, HIF, VEGF expression regulation, epigenetic changes in cancer, abnormal acetylation and methylation of histones and DNA in cancer.

Cancer stem cells, markers, stem cells signaling pathways, cancer diagnostic markers, diagnosis, therapy, phytochemicals.

Tumor Immunology, Tumor Antigens, Tumor antigen encoded by Oncogenes, Effector mechanism in Tumor Immunity, B-Cell response to Tumor, Cell mediated Response to Tumors,

cytokines, Limitation of effectiveness of Immune Response against Tumors, Tumor Immuno Prophylaxis, Immuno diagnosis.
Animal tissue culture, culture media and conditions, cancer and non cancer cell lines, cell migration assay, proliferation assay, FACS, Sanger's, chemical and next generation DNA (NGS) sequencing, RT PCR , Q PCR, DNA micro array, Reporter assay, Proteomics, Bioinformatics, protein and DNA data bank, sequence BLAST, DNA data submission, data mining.

SL. NO. -11: Advances in Immunology (Theory)
Paper Code: HP 1002 E **Credit: 04**

Learning outcomes :

After completion of the course student should understand the following:

- Different immunological techniques used in diagnosis of disease.
- Concept about vaccine development.
- How genetically modified rodents is developed for research purpose.
- Determination of tumor antigen and how immune cells protect the body from tumor.

Antigenic determinants on immunoglobulins; B-cell receptor; B-cell maturation; B-cell activation and proliferation; Regulation of B-cell development; regulation of complement system; Complement deficiencies; Monoclonal antibody, Antibody generation, detection of molecules using ELISA, RIA, Immunoprecipitation
T-cell receptor, T-cell maturation, development and proliferation, T-cell activation.
Inflammation; Mediators of inflammation; The inflammatory process; Anti-inflammatory agents
Vaccines: Active and passive immunization; designing vaccines for passive immunization; Whole organism vaccines; purified recombinant vaccine; recombinant vector vaccines; multivalent subunit vaccines
Gene transfer into mammalian cell; Transgenic mice; gene targeted knockout mice; Inducible gene targeting-the Cre/lox system
Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies. Toll-like receptor, antibody engineering
Tumor Immunology, Tumor Antigens, Tumor antigen encoded by Oncogenes, Effector mechanism in Tumor Immunity, B-Cell response to Tumor, Cell mediated Response to Tumors, cytokines, Limitation of effectiveness of Immune Response against Tumors, Tumor Immuno Prophylaxis, Immuno diagnosis.

Introduction to cell culture; choice of materials for cell culture; Procedures of cell culture
General methods and culture parameter; monolayer culture; suspension culture; immobilized culture, Cell line freezing and quantitation of recovery; cell line authentication, Cytotoxicity assay and viability assay. Fluorescence In Situ Hybridization (FISH), and GISH, Transfection Basic principles for identification and purification of stem cells, Methods for the separation of different cell population

SL. NO. -12: Advances in Reproductive Physiology (Theory)
Paper Code: HP 1003E **Credit : 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the basic mechanism of sex determination and development of gonads in human.
- Develop comprehensive understanding of male and female reproductive organs and their functions.
- Understand the mechanism of actions of various contraceptive methods sexual dysfunction in male and female.
- Principles of use of different tools used in research on reproduction.

Sex determination and differentiation – mechanism of determination and sexual differentiation, chromoomal and gonadal sex, psychosexual development differentiation of gonads and differentiation of genital tract, disorders of sex development, neuroendocrinology of puberty.
Male reproductive system: overview of male reproductive physiology. Sex steroid production, transport and metabolism, germ cell development in testis, control of germ cell production, role of Y chromosome, Male sterility, azoospermia, oligozoospermia, asthenozoospermia, varicocele, genetic basis of male infertility, androgen deficiency syndrome .

Female reproductive system: overview of female reproductive physiology; ovarian differentiation and folliculogenesis, ovarian steroidogenesis, , ovulation, luteinization, luteolysis, follicular atresia, endometrium and regulation of endometrial cycle, menopause and menopausal changes, management of menopause, hormone replacement therapy, disorders of female reproductive system, anovulation, polycystic ovary syndrome.

Fertilization, capacitation, acrosomic reaction, sperm-egg fusion, activation of egg, prevention of polyspermy, implantation , placental development, placental hormone production, maternal adaptations to pregnancy, fetal growth and fetal endocrine system, intrauterine growth retardation, parturition and lactation .

Contraception leading to prevention of fertilization – surgical, hormonal and immuno-methods, emergency contraceptive measures, contraceptives from natural products. Assisted reproductive techniques, IVF.

Sexual dysfunction in men and women, erectile dysfunction, women's sexual dysfunctions, reproductive senescence in male and female, effect of endocrine disrupters on reproductive system, effect of heavy metals on reproductive system,

Designing experiments for the study of breeding and fertility – breeding of laboratory animals., principle and techniques of animal cloning

SL. NO. -13: Nutrition and Community Health (Theory)

Paper Code: HP 1004 E **Credit: 04**

Learning outcomes :

After successful completion of the course, students should be able to:

- Understand the nutrition during different stages of life..
- Develop comprehensive understanding on nutrition related health defects..
- Understand the national and international policies on nutrition
- Current trends in nutrition research and its advancement.

Nutrition during life: Infancy, Childhood, Adolescent and youth, Aged, Adults and geriatric nutrition

Nutrition in special physiological need: Pregnancy, Lactation, geriatric nutrition, Exercise and sports, Menstruation, Space travel

Nutrition related health problems: Nutritional anaemia, prevalence, iron deficiency, megaloblastic, prevention over weight and obesity, complication of obesity and its management, Protein calorie malnutrition, Osteomalacia, Xeropthalmia, Endemic goitre

Dietary Management in: Diabetes mellitus, Hypertension, Gastro-intestinal disorders (Inflammatory Bowel Syndrome and diahrroea), Pancreatic and Hepatic disorders, Renal diseases, Coronary Heart Diseases

Nutritional Survey: Dietary survey, Anthropometric and Biochemical evaluationsAssessment of nutritional and growth status,Growth study: growth rate, maturation, growth during childhood, adolescence period, and adult stage, growth stunting.

National Nutritional Policy and Intervention Programmes: Role of National and International Organizations and NGOs in community nutrition, Food Standard and Consumer Protection

Current Trends in Nutritional Research and Development (sustainable and environmentally friendly nutrition, vegan and plant based nutrition, alternative proteins, ketogenic nutrition, sugar free nutrition, nutrition confusion and nutrition education).