

# Vidyasagar University

## Curriculum for B. Sc. (Honours) in Physiology [Choice Based Credit System]

### Semester-VI

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC- 13		C13T: Reproductive Physiology, Embryology and Chronobiology	Core Course- 13	4	0	0	6	75
		- Lab		0	0	4		
CC- 14		C14T: Renal Physiology, Skin and Body Temperature Regulation, Biomedical Instrumentation	Core Course- 14	4	0	0	6	75
		- Lab		0	0	4		
DSE-3		TBD	Discipline Specific Elective - 3	4	0	0	6	75
				0	0	4		
DSE-4		TBD	Discipline Specific Elective - 4	4	0	0	6	75
				0	0	4		
<b>Semester Total</b>							<b>24</b>	<b>300</b>

L= Lecture, T= Tutorial, P = Practical, CC - Core Course, TBD - To be decided, DSE: Discipline Specific Elective.

## **Semester-VI**

### **List of Core Course (CC)**

**CC-13: Reproductive Physiology, Embryology and Chronobiology**

**CC-14: Renal Physiology, Skin and Body Temperature Regulation,  
Biomedical Instrumentation.**

### **Discipline Specific Electives (DSE)**

**DSE-3: Medical Biochemistry**

**Or**

**DSE-3: Microbiology and Biotechnology**

**Or**

**DSE-3: Medical Microbiology and Immunology**

**Or**

**DSE-3: Genetics, Molecular Biology and Bioinformatics**

**DSE-4: Cognitive Science**

**Or**

**DSE-4: Community Medicine, Epidemiological Data Analysis**

**Or**

**DSE-4: Patho -Physiological logical Basis of Diseases**

**Or**

**DSE-4: Research methodology and Design**

**Semester-VI**  
Core Course (CC)

**CC-13: Reproductive Physiology, Embryology and Chronobiology Credits 06**

**C13T: Reproductive Physiology, Embryology and Chronobiology**

**Credits 04**

**Course Contents:**

**Reproductive Physiology:**

Reproductive physiology - introduction. Sex Differentiation & Development - Chromosomal Sex. Reproductive genetics. Aberrant Sexual Differentiation. Phenotypic sex differentiation. Gonadal development in the embryo. Pituitary Gonadotropins & Prolactin. Puberty in boys and girls and its control, onset of puberty. Secondary sexual characters, Human sexual response. Menopause.

The Male Reproductive System- Gross anatomy and microscopical anatomy of the male reproductive tract. Histoarchitecture of male reproductive system, testis , seminiferous tubules and interstitial cells of Leydig. Male Reproductive Physiology : gametogenesis - spermatogenesis, spermiogenesis & epididymal function, sperm maturation and ejaculation. Endocrine function of the testes. Control of testicular function, prostate and seminal vesicle. Abnormalities of testicular function.

The Female Reproductive system- Gross anatomy and microscopical anatomy of the female reproductive tract. Histological structure of ovary, Graafian follicle and Corpus luteum, Formation and maturation of ovum. Ovarian Hormones - Chemical nature and function. Steriodogenesis. Control of ovarian function. Physiological mechanism and control of ovulation. Abnormalities of ovarian function. Reproductive cycles: Menstrual Cycle – duration, description and hormonal control, Estrous cycle.

Pregnancy: Transport of ovum and sperm in female reproductive tract. Fertilization and the establishment of pregnancy. Hormones in pregnancy. Placenta - formation, structure, functions and fate of placenta. Placental hormones. Maternal adaptation to pregnancy : changes during pregnancy and its hormonal control. Pregnancy diagnosis : Pregnancy tests (immunological). Foeto-maternal relationship, faeto-placental unit. Ectopic pregnancy. Labour . Parturition: mechanisms and hormonal regulation.

Lactation and Mammary gland: Anatomical and histological structure of mammary gland. Phases of mammary development and their hormonal control. Hormonal control of lactation and milk ejection reflex.

Reproductive Health - Physiological concepts for a planned family. Demographic terminology of family planning. Infertility in male and female: causes, diagnosis and management. Assisted Reproductive Technology (ART): sex selection, sperm banks, frozen embryos, in vitro fertilization. Contraception- Concepts, methods, Process, modern contraceptive technologies. Stem cell biology- concept, characterization and application. Exfoliative cytology on gynecological smear –Use of exfoliative cytology on gynecological screening, sample type, fixation & staining, normal constituents, cytology of menstrual cycle, hormonal assessment of smear, inflammatory changes of smear, malignancy.

Reproductive Genetics, Human Genetics and Human Reproductive Disorders: Reproductive Genetics, Human Genetics: Principle of molecular genetics: Gene expression, Gene Structures. Medical genetics: General concepts, Genetic diseases, Population genetics, Pharmacogenetics and pharmacogenomics. Human Genetic Architecture and diseases - Human genetic architecture. Genes and Human diseases. Mendelian disorders. Complex multigenic disorders. Chromosomal disorders: Normal karyotype – concept, significance, techniques-staining, banding, FISH. Structural abnormalities of chromosomes, Cytogenetic disorders involving autosomes and sex chromosomes. Single gene disorders with non-classic inheritance. Mosaicism. Molecular diagnosis of genetic diseases.

Human reproductive disorders: Abnormalities of male and female sexual differentiation and development. Puberty: Precocious, delayed or absent puberty, Amenorrhoea: Primary and Secondary. Hyper-prolactinaemia, Sexual dysfunction, infertility, Pregnancy: multifoetal pregnancy and spontaneous pregnancy loss, Pre- eclampsia, eclampsia, endometriosis. Basic concepts of ovarian cysts. Genetic imprinting and reproductive tumors.

### **Embryology:**

Cleavage: cleavage plane, types, role of yolk in cleavage; cleavage process in mammals. Embryogenesis, morula, blastula, gastrula and blastocyst. Formation of trilaminar germ disc. Gastrulation, organogenesis. Development of alimentary system, heart and urogenital system. Development of eye as an example of reciprocal and repeated inductive events. Foetal circulation and its changes after birth.

### **Chronobiology:**

Introduction to Chronobiology. Historical developments in chronobiology; Biological oscillation: the concept of average, amplitude, phase and period.

Biological Rhythm – Definition, terminology of biorhythm, significance. Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms. Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates. Different types of physiological rhythms - ultradian, circadian, infradian. Circadian rhythms - concepts, types, explanation and experimental evidences.

Concept of synchronization and masking; Photic and non-photic zeitgebers. Importance of environmental synchronization (Zeitgeber or Synchronizer) on Circadian rhythms. Different

zeitgebers and their relation with circadian rhythm. Circadian rhythms in human. Biorhythms of LH, FSH, Prolactin, Estrogen, Progesterone, ACTH, GH, Cortisol. Light dark cycle and regulation of penial hormone.

Biological clock, physiological clock: Concepts, biological clock and environmental changes, classification and function of biological clock. Location and origin of biological clock. Fundamental nature of biological clock. Mechanism of biological clock. Master clock or central clock – types, location and mechanisms. Neural basis of biological clock and the role of suprachiasmatic nuclei. Adaptive significance of biological clocks. Sleep – wakefulness cycle. Body temperature rhythm. Time keeping Genes. Brief idea of jet-lag and shift work. Chronobiology in health. Biological clock and medicine.

### **C13P: Reproductive Physiology, Embryology and Chronobiology (Practical) Credits 02**

#### **List of Practical:**

1. Study of estrous cycle.
2. Tissue fixation, embedding in paraffin, microtomy, slide preparation and identification of uterus, testis, ovary.
3. Examination of histological sections of permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive system; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
4. Pregnancy test from human urine by kit method.
5. Sperm count, sperm motility test in rat. Sperm viability test by using eosin - Y.
6. Determination of diurnal and/or circalunar rhythm of body temperature of college going students.
7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
8. Project work on assessment of individual differences in human circadian rhythms (chronotype in human population) by questionnaire method among school children and college students.

#### **Demonstration:**

1. Surgical techniques: Principles of surgery in endocrinology and Reproductive Physiology.
2. Ovariectomy, Hysterectomy, Castration and Vasectomy in rats.
3. Human vaginal exfoliate cytology.

### **CC-14: Renal Physiology, Skin and Body Temperature Regulation, Biomedical Instrumentation Credits 06**

#### **C14T: Renal Physiology, Skin and Body Temperature Regulation, Biomedical Instrumentation Credits 04**

#### **Course Content:**

#### **Renal Physiology:**

Renal Physiology- introduction. Gross structure of kidney. Microanatomy (including electron microscopy) of a nephron and structural differences between cortical and juxtamedullary nephrons. Juxtaglomerular apparatus. Function of Malpighian corpuscle and renal tubule. Renal circulation-peculiarities and autoregulation.

Mechanism of urine formation: Concept of ultrafiltration, glomerular filtration rate, reabsorption by passive and active tubular transport. Concept of counter current system, counter-current mechanism countercurrent multiplier, exchanger and mechanism of concentrated urine formation. Water excretion, acidification of the urine & bicarbonate excretion. Regulation of  $\text{Na}^+$  &  $\text{Cl}^-$  excretion. Non-excretory function of kidney. Constituents of urine - normal and abnormal constituents of urine and their clinical significance. Concept of renal threshold. Renal Function Tests. Renal stone formation. Dialysis and artificial kidney. Diuretics. Disorders of Renal Functions.

Physiology of Urinary bladder, urine storage and micturation. Innervations of urinary bladder. Filling of the Bladder and emptying of the bladder. Micturition reflexes and its regulation by higher centers.

### **Skin and Body Temperature Regulation:**

Histological structure of skin. Colour of the skin. Organization of sweat gland. Composition and functions of sweat. Regulation of sweat secretion. Insensible and sensible perspiration. Composition and functions of sebum. Triple response.

Normal body temperature. Channels of heat loss and heat gain process. Regulation of body temperature in homeotherms : physical and physiological processes, roles of neural and hormonal processes, higher centers and mechanism of regulation.

Pyrexia, Hypothermia and hyperthermia, physiological basis of fever. Cold stress. Insulating effects. Acclimatization to heat and cold.

### **Biomedical Instrumentation and Techniques:**

**Biomedical basis of Diseases:** Basic concepts, pathogenesis to symptoms and diagnosis of infectious diseases, inherited/genetic diseases; immunological diseases, cancer.

**Basics of Biomedical Instrumentation:** Development of biomedical instrumentation, components of man-instrument system. Biomedical systems, design factors and limitations of biomedical instruments. Transducer, Biosensors - concept, classification. Bioelectric potentials, Bio potential electrodes – concepts, significance and application .Electric current - physiological effects. Shock hazards, safety. Measurement system and errors.

**Medical diagnostic techniques related equipment:** Principles of microscopy including Fluorescence microscopy, Atomic Force Microscopy, Transmission and Scanning Electron Microscopy. Flow Cytometry (FACS). Karyotyping – Chromosome banding, FISH. Spectroscopic Techniques - Principle, different types, instrumentation. Histopathology, Histochemistry, Cytogenetics – staining techniques. Chromatography – Principle and application of different chromatography including TLC, GLC, HPLC, Ion-exchange chromatography,

molecular sieve chromatography, affinity chromatography. Electrophoresis - Principle, instrumentation and medical significances of AGE, PAGE, SDS-PAGE. Centrifugation - Principle and physiological significances.

**Biomedical instruments** – Biomedical instruments and cardiovascular monitoring systems: Basic concepts, instrumentation of Cardiac monitor, ECG, Blood flow meters, Oximeter, equipments for blood pressure, cardiac output and heart sounds. Methods of monitoring fatal heart rate. Cardiac pacemakers, cardiac defibrillators. Clinical Laboratory Instruments: General principle and instrumentation of Blood Gases Analyzer, Auto-analyzer, Blood Cell Counters, ELISA reader, spectrophotometer, flame photometer. Auto analyzer. Biomedical Instruments for Respiratory measurement systems: Basic principles and instrumentation of pneumograph, Spirometer, pneumotachometers, Respiratory therapy equipment, apparatus for anaesthesia. Biomedical Instruments and Nervous system: Concept and basic principles of Psycho-physiological measurement techniques, instruments for measurements of nervous system, motor response, sensory response. EEG. Imaging systems: Basic principles, instrumentation of X-Ray machine, Mammography, X-ray computed tomography (CT Scanner) and computer-aided tomography (CAT), Fluoroscopy. Ultrasound Imaging - Ultrasonic imaging system. Echocardiography, Doppler effects, three dimensional ultrasound. Radioactivity : Radiation, Radio isotopes-concepts, Scintillation counter, Gamma camera & Gamma camera imaging , Radio nucleotide scan, Emission Tomography- ECT Emission Coupled Tomography, SPECT & PET - concept. Magnetic Resonance Imaging- Magnetism and nuclear magnetism, Magnetic Resonance Imaging (MRI) system, MRI Maps of body, Sports medicine, Breast imaging and Brain Mapping. **Optics, Fiber Optics, Diathermy equipment, Audiometer and Laser :** Optics: science of life. Fiber Optics - Endoscopes and Laparoscope - principles and applications. Diathermy: principles, types and biomedical significance. Audiometers: principle and methods. Laser- formation, mechanisms and medical application. Significances. **Application of computer in Biomedical field, Biotelemetry, Physiological modeling-** Computer: basic components, imaging techniques, database, web design, automation for instruments used for clinical laboratory, use of microprocessor in medical instruments, PC- based medical instruments, computerized critical care unit. Biotelemetry: concepts, components, application. Physiological modeling: biological modeling - modeling process, methods, equation. Deterministic & stochastic model. Compartmental model- concept. Physiological modeling software.

### **C14P: Renal Physiology, Skin and Body Temperature Regulation, Biomedical Instrumentation (Practical)**

**Credits 02**

#### **List of Practical:**

1. Tissue fixation, embedding in paraffin, microtomy, slide preparation and identification of kidney and ureter.
2. Identification for normal constituents of urine.
3. Identification for abnormal or pathological constituents of urine.
4. Tests for urinary deposits.
5. Detection of specific gravity of urine.

6. Estimation of albumin in urine.
7. Estimation of urea in urine.
8. Estimation of total phosphates in urine.
9. Routine clinical tests of urine.
10. Recording of body temperature.
11. Study the skin to blunt injury (triple response).
12. Measurement of heart sound using electronic stethoscope.

### **Demonstration**

1. SDS – PAGE electrophoresis for protein (**Demonstration**)
2. Physiological data acquisition by ECG, EEG (**Demonstration**)
3. Study of X ray/CT machine (**through demonstration**).
4. Study of mammograms and CT scan images (**Demonstration**).
5. Estimation of sodium and potassium in blood serum or urine sample by using auto analyzer (**Demonstration**).
6. Determination pulmonary function using spirometer (using mechanical system) (**Demonstration**).

## *Discipline Specific Electives (DSE)*

### **DSE-3: Medical Biochemistry**

**Credits 06**

#### **DSE3T: Medical Biochemistry**

**Credits 04**

#### **Course Contents:**

**Unit-I:** Basic Concepts and scope. Clinical Biochemistry - Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations.

**Unit-II: Evaluation of biochemical changes in diseases:** Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile. Pathophysiological significances of glucose, serum protein, albumin, urea, creatinine, uric acids, ketone bodies.

**Unit- III: Enzymes: Distribution and diagnostic significance-** Properties of enzymes used in diagnosis of metabolic disorders, clinical significance of diagnostically important enzymes: creatine kinase, lactate dehydrogenase, alanine and aspartate aminotransferases, amylase, acid and alkaline phosphatase, beta glucuronidase, with a detailed account of the biochemical

reactions catalysed by these enzymes and of their clinical assays; kinetic assay and end point assay for the enzymes. A detailed account on isoenzymes, their tissue distribution and clinical significance.

**Unit -IV: Hormones:** Classification with reference to their biochemical nature, mechanism of action (one example from each class of hormones), Function. Pathophysiology of disorders associated with hormones. Biochemical diagnosis of hormonal disorders.

**Unit-V: Structural complexities and diseases associated with carbohydrates and lipids:**

Carbohydrates: Sugars as information molecules; detailed account on Lectins: their role in physiological functions and their potential as drug targets in various infectious diseases. Dietary fibers. Assessment of glucose metabolism in blood: Clinical significance of variations in blood glucose. Diabetes mellitus. Glycosylated Hb

Lipid profile: Types of Lipoproteins (chylomicrons, VLDL, LDL, HDL); disorders associated with lipoprotein metabolism (hypercholesterolemia, atherosclerosis). Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein. Lipid profile in health and diseases.

Metabolism of ketone bodies in diabetic patients. Prostaglandins- classification, biosynthesis, role of COX-1, COX-2, NSAIDS in synthesis; functions Steroids-Cholesterol- biosynthesis and regulation, inhibitors of cholesterol biosynthesis (Statins-structure and mechanism of action).

**Unit -VI: Vitamins:** Definition, classification, requirement and recommended allowances, and dietary precursors; diseases due to deficiency of water-soluble and fat-soluble vitamins: the symptoms and the clinical significance. Assay of vitamin.

**Unit- VII: An overview of integrative metabolism:** Local and global regulation in tissue specific metabolism, interplay of insulin and glucagon integration of various metabolic pathways of proteins, lipids, carbohydrates and nucleic acids, obesity- role of Leptin, Ghrelin and other hormones in regulation of body mass, electron transport chain and inhibitors, oxidative phosphorylation, role of uncouplers and ionophores.

**Unit -VIII: Organ Function Tests:** **a. Liver function tests:** Structure of the liver, liver function tests, causes of different liver diseases, liver function tests in the diagnosis of liver diseases. Pathophysiological significance of bilirubin. **b. Renal function tests and urine analysis:** Composition of urine. Use of urine strip / dipstick method for urine analysis. Basic ideas on different types of test for renal diseases. **c. Tests for cardiovascular diseases:** Involvement of enzymes in diagnostics of heart disease: aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.

**DSE3P: Medical Biochemistry (Practical)**

**Credits 02**

**List of Practical:**

A. Collection of blood and storage. Preparation of serum and plasma from whole blood and storage.

B. Quantitative determination of the following in the whole blood/plasma/serum:

1. Estimation of blood glucose by glucose oxidase peroxides method.
2. Estimation of blood glucose by Nelson – Somogyi method.
3. Estimation of blood inorganic phosphates by Fiske - Subbaraow method.
4. Estimation of serum total protein by Biurate methods and determination of albumin globulin ratio.
5. Estimation of HDL/LDL and Triglycerides.
6. Estimation of bilirubin (direct and indirect).
7. Quantitative determination of serum creatinine, uric acid and urea.
8. Determination of serum amylase by iodometric method.
9. Estimation of creatine kinase.
10. Estimation of SGOT, SGPT, Acid & Alkaline Phosphatase.

**Demonstration:**

1. Estimation of Lactate dehydrogenase, beta glucuronidase (**Demonstration**).
2. SDS-PAGE Electrophoresis for Protein (**Demonstration**).
3. Five case studies based on above quantitative estimations performed (**Demonstration**).

**Or**

**DSE-3: Microbiology and Biotechnology**

**Credits 06**

**DSE3T: Microbiology and Biotechnology**

**Credits 04**

**Course Contents:****Microbiology:**

Viruses: structure, types. Lytic and lysogenic cycle. DNA & RNA Viruses. Viroids and Prions. Bacteriophages – structure & morphological classification.

Bacteria: structure, classification. Staining :- Principle , procedure, uses. Gram stain, Acid – fast stain, Albert stain .Biochemical tests for identification Pathogenic and non - pathogenic bacteria.

Nutritional requirements of bacteria, nutritional types culture media. Bacterial Growth curve-preparation, physiological factors required for growth. Bacterial metabolism: fermentation (ethanol, lactic acid, acetic acid), glyoxalate cycle, Entner – Doudoroff pathway, Phosphoketolase pathway.

Bacterial genetics: elementary idea of transformation, conjugation and transduction. Sterilization, disinfection and pasteurization: Physical and chemical methods used. Antibiotics, bacteriostatic & bacteriocidal agents. Bacteriolytic agents. Concepts of antiseptic, probiotics and prebiotics.

Basic idea about medical bacteriology, virology and mycology. Food microbiology – brief ideas about food spoilage (fish, meat, milk, vegetables) and its prevention. Industrial Microbiology: Elementary knowledge for production of fermented products like alcohol, glutamic acid, penicillin and milk products (cheese, dahi).

Environmental Microbiology: Role of microbes in Bio-geo chemical cycle (brief).

**Biotechnology:** History and importance. DNA and RNA. Gene, Genome and Genetic code, translation. Recombinant DNA technology: concepts, techniques and application., DNA manipulation. Cloning – concept and significances. Cloning vectors. cDNA libraries. DNA sequencing. Basic concepts of Southern, Northern, Western blot techniques and DNA micro array. Polymerase Chain Reaction (PCR). RT-PCR- Basic concepts. Enzyme immobilization: basic concepts. Tissue culture – basic concepts. Human genome projects. Transgenic animals. Hybridoma techniques - Basic concepts. Monoclonal antibody. Protein interaction technology. DNA technology and gene therapy. DNA technology in diseases diagnosis. Genetic Bar-coding. Fermentation technology: Fermentation, types, bioreactors, upstream and downstream processing. Physiology and biotechnology process. Bio-pesticides, bio-plastics, biosensors, biochips: concepts and significances. Bio-safety and intellectual property Rights. Genomics and Proteomics. Bio-safety and ethical issues in biotechnology

**DSE3P: Microbiology and Biotechnology (Practical)**

**Credits 02**

**List of Practical**

1. Study of disinfection and sterilization techniques.
2. Culture procedure and isolation of bacteria.
3. Biochemical characterization of microorganisms ( Biochemical tests – Catalase test, Oxidase test, Fermentation of sugar- Glucose, Lactose, Sucrose, Mannitol, Hydrolysis of Starch, Gelatin, Casein, Citrate and Propionate utilization test, Indole production test, Nitrate reduction test, Methyl red test and Voges Proskauer [V. P.] test).
4. Negative staining. Gram staining techniques of bacteria. Acid-fast staining of bacteria. Bacterial spore staining.
5. Isolation of DNA from blood and microbial culture.
6. Separation of DNA by agarose gel electrophoresis. Extraction of DNA from agarose gel. Quantification of DNA.
7. Prepare SDS-PAGE for protein. Gel electrophoresis of protein. Quantification of protein.

**Demonstration:**

1. Perform immunodiffusion by Ouchterlony methods (**Demonstration**).
2. Analysis of DNA sequences (**Demonstration**).
3. Application of PCR (**Demonstration**).
4. Prepare ELISA (**Demonstration**).
5. Perform Immunoprecipitation (**Demonstration**).

**Or**

**DSE-3: Medical Microbiology and Immunology**

**Credits 06**

**DSE3T: Medical Microbiology and Immunology**

**Credits 04**

**Course Contents:**

**Unit-I: Fundamental Concepts:**

a) History of microbiology, Discovery of microorganisms, Contributions of Louis Pasteur and Robert Koch in Medical Microbiology. b) Molecular methods of assessing microbial phylogeny- molecular chronometer, phylogenetic trees, rRNA, DNA and proteins as indicator of phylogeny. c) Microbial growth, growth factors, culture media - types of media. Pure Cultures, Growth curves and generation time, Control of microbial growth, general concept of effect of environmental factors on growth of microbes.

Normal microflora of the human body and host pathogen interaction : Normal microflora of the human body, importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection. Bacterial Cells - fine structure and function : Size, shape and arrangement of bacterial cells. Cell membrane, cytoplasmic matrix, inclusion bodies (eg. magnetosomes), nucleoid, ultrastructure of Gram +ve and Gram -ve bacterial cell wall, Pili, Capsule, Flagella and motility. Microbial Genetics. Principles of Diseases and Epidemiology: Relationship between normal microbiota and host, Opportunistic microorganisms. Development and spread of infectious diseases: invasion, pathogen, parasite, pathogenicity, virulence, carriers and their types.

**Unit-II: Sample collection, transport and diagnosis:** Collection, transport and culturing of clinical samples and their identification characteristics.

**Unit-III: Bacterial Diseases** (with reference to etiology, clinical symptoms, virulence factors involved, detection and prevention): Respiratory tract infections, Diphtheria and tuberculosis, Gastrointestinal tract infections, staphylococcal food poisoning and *E. coli* gastroenteritis, Urinary tract infections: gonorrhoea and syphilis.

**Unit-IV: Viruses, viroids, prions:** General characteristics of viruses, structure, isolation, cultivation and identification of viruses, viral multiplication, one step multiplication curve, lytic and lysogenic phages (lambda phage), concept of early and late proteins, clinical virology with reference to HIV virus and hepatitis virus (Life cycle and clinical symptoms), viroids and prions.

**Unit-V: Medical Mycology** (with reference to life cycle and clinical symptoms) : General and detailed life cycle of *Aspergillus* and *Candida albicans* in relation to human diseases caused by them.

**Unit-VI: Parasitology** (with reference to life cycle and clinical symptoms): Classification of medically important parasites. Common protozoan disease: Malaria, Infections caused by *Taenia solium* / *Taenia saginata*, *Fasciola hepatica* and *Ascaris lumbricoides*.

**Unit-VII : Antimicrobial chemotherapy and emerging antimicrobial resistance:** Spectrum of antimicrobial activity, action of antimicrobial drugs, anti-mycobacterial antibiotics, inhibitors of protein synthesis and nucleic acid synthesis, inhibition of cell wall synthesis, inhibitor of cell membrane function, inhibitor of metabolism. Antifungal agents: mechanism of actions of Amphotericin B, Griseofulvin , Antiviral agents :Mechanism of action of Amantadine,

Acyclovir, Azidothymidine. Anti - protozoan drugs; effectiveness of chemotherapeutic agents. Antimicrobial resistance – concepts.

**Unit-VIII: Overview of Immune System** - properties of immune system; types of immunity: innate immunity, acquired immunity, active and passive immunity. First and second line defence. Antigens and Antibodies: Characteristics of an antigen (foreignness, molecular size and heterogeneity); haptens; epitopes (T & B cell epitopes), Adjuvants : Structure, Types and Functions of antibodies.

**Unit-IX: Generation of Immune Response:** Primary and secondary immune response; Generation of humoral immune response (Plasma and Memory cells); Generation of cell mediated immune response. Cytokines. Complements.

**Unit-X: Immunological Disorders and Tumor Immunity & Immunological Techniques:** Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies – acquired immune deficiency. Animal models (Nude and SCID mice). Transplantation immunity. Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT.

**DSE3P: Medical Microbiology and Immunology (Practical)**

**Credits 02**

**List of Practical:**

1. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
2. Staining methods: Gram staining, Acidfast staining (permanent slide only), Capsule staining and spore staining.
3. Study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
4. Identify bacteria on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests .
5. Study of bacterial flora of skin by swab method.
6. Perform Widal test.
7. Staining and morphological characterization of *Aspergillus sp.*, *Pencillium sp.* and *Saccharomyces sp.*
8. Antibacterial testing by Kirby-Bauer method.
9. Immunodiffusion by Ouchterlony method. Immunodiffusion by Mancini method.
10. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
11. Study of various stages of malarial parasite in RBCs using permanent mounts.
12. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)

**Demonstration:**

1. Demonstration of PCR based method of detection of any causative gene (**Demonstration**).
2. Isolation of bacteriophages (any with a non-pathogenic host) and calculation of the plaque forming units (pfu) (**Demonstration**).
3. Complement fixation assay (**Demonstration**).
4. Agglutination inhibition assay (**Demonstration**).
5. Sandwich dot ELISA (**Demonstration**).

**Or**

**DSE-3: Genetics, Molecular Biology and Bioinformatics**

**Credits 06**

**DSE3T: Genetics, Molecular Biology and Bioinformatics**

**Credits 04**

**Course Contents:**

**Genetics:**

Introduction to Genetics: Mendel's work on transmission of traits, Genetic variation, molecular basis of genetic information. Mitosis and Meiosis.

Mendelian Genetics and its Extension: Principles of inheritance, Chromosome theory of inheritance, Laws of probability, Pedigree analysis. Monohybrid and dihybrid, test and back crosses. Incomplete dominance and codominance. Bacterial genetics - transformation, transduction, conjugation (mention of F<sup>+</sup> /F<sup>-</sup> , Hfr strain, function of pilus). Extension of Mendelism – Multiple alleles, Lethal alleles, Epistasis and its different types present in plants and animals. Penetrance, expressivity, pleiotropism. Environmental effects on phenotypic expression, sex linked inheritance. Linkage, Crossing over and Chromosome mapping. Mutations: Chromosomal mutations, Gene mutation. Detection of mutation: CLB method, Attached X method, DNA repair mechanism. Sex determination and sex linkage, Extrachromosomal inheritance. Quantitative genetics: Quantitative and multifactor inheritance, Transgressive variations, Heteriosis.

Chromosome structure: Concept of nucleosome, molecular organization, chromosomal proteins, the different levels of chromatin organization. Numerical and Structural variations in chromosome - basic concepts of aneuploids and polyploids.

Human Genetics: History of human genetics- Early Greek concepts about inheritance, Cytogenetics history (the works of Winiwater, Painter and Tjio and Levan), Landmark achievements of Galton, Garrod etc. Pedigree analysis. Patterns of inheritance for monogenic traits. Organization of Human Genome : General feature, gene clusters, diversity in size and organization of gene, types of repetitive DNA, pseudogene, gene families, endoreplication and amplification, genetic markers.

Human Cytogenetic – Techniques ( karyotyping and FISH), Human Karyotype –banding pattern and nomenclature (G and Q banding), Common syndrome – numerical chromosome changes, structural alterations. Use of human cytogenetics in medical science. Aneuploidy in humans. Chromosome abnormalities and cancer. Mapping strategies : Physical Map , Genetic Map. Techniques for genomics: DNA sequencing, DNA fingerprinting, polymorphism screening, expression analysis and proteomic analysis.

Identification of genetic basis of diseases. Population genetics. Prenatal diagnosis - introduction, significance and methods. Clinical genetics : inborn error of metabolism, genetic basis of colour blindness, familial cancer, infertility and in vitro fertilization, mental retardation. Genetic disorders of Haemopoietic systems.

Implications of Genome Research: Diagnosis and screening of genetic disorders, prenatal genotyping for mutations in  $\beta$ - globin gene and sickle cell anemia, DNA profiling: establishing identity and relationships, applications in personalized medicine (genetic polymorphism in drug metabolism genes e.g.  $\text{cytP}_{450}$  and GST and their effect on drug metabolism and drug response), genetic counseling.

### **Molecular Biology:**

Nucleic acids convey genetic information. The structure of DNA and RNA, DNA topology, organelle DNA. The Replication of DNA. The Mutability and Repair of DNA. Transcription ( Prokaryotes and Eukaryotes). RNA modification. Translation ( Prokaryotes and Eukaryotes). Regulatory RNAs. RNA editing. Gene and Genetic code - properties and wobble hypothesis. Gene expression and gene silencing. Methods for analysis of gene expression. Chromosomal aberration and gene mutations (agents and types). Gene Knockout. Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods. Molecular markers in genome analysis. Genetic counseling.

Basic idea of Recombinant DNA technology and its applications, Polymerase Chain Reaction (PCR) – concepts, and application in human disease diagnosis.

Concept of oncogenes, tumour suppressor genes and properties of cancer cells. Molecular basis of apoptosis in brief. Gene therapy, transgenic animal. Molecular Techniques: PCR, Western and Southern blot, Northern blot, Sanger DNA sequencing.

### **Bioinformatics:**

Introduction to bioinformatics - Definition, important contributions, task, application, challenge and opportunities. Computer Fundamentals – Programming languages in bioinformatics, Role of Super computer in biology. Historical background. Scope of bioinformatics – Genomics, Proteomics and Computer aided Drug Design (Structure based and ligand based approaches).

Biological databases and data retrieval: Information Network. Database, Tools and uses. Introduction to biological databases – primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL,DDBJ,NDB), Protein databases (PIR, Swiss- Prot, TrEMBL, PDB). Nutrient data bases. . Bioinformatic tools- FASTA, BLAST.

DNA sequence analysis. Sequence Alignment. Predictive method using DNA and Protein sequences. Introduction to computational biology- prediction of 3-D protein structure. Identification of unknown protein. Phylogenetic Analysis. Drug design, Discovery and Pharmacoinformatics. Bioinformatics and Health informatics – concepts and application in health and medicine.

### **DSE3P: Genetics, Molecular Biology and Bioinformatics (Practical) Credits 02**

#### **List of Practical:**

##### **Genetics:**

1. Preparation of human metaphase chromosomes and Giemsa staining.
2. Karyotyping with the help of photographs.
3. Abnormal karyotypes and chromosome aberrations.
4. PTC testing to prove monogenic inheritance.
5. Preparation of pedigree charts of some common characters like Tongue rolling, ear 6 lobes, blood groups, colour blindness.
6. Isolation of DNA from blood and microbial culture.
7. Estimation of DNA using colorimeter by Diphenyl reagent .
8. Estimation of DNA by Spectrophotometer (A 260 measurement). Quantify and analyze the purity of DNA using spectrophotometer (estimating at 260 nm, 280nm and 320nm).
9. Estimation of RNA by Orcinol method.
10. Separation of DNA by agarose gel electrophoresis. Extraction of DNA from agarose gel and quantification of DNA.
11. Determination of melting temperature of DNA.
12. Prepare SDS-PAGE for protein. Gel electrophoresis of protein and quantification of protein.
13. Searching of scientific information using NCBI or any search engine. Webbased analysis: retrieval of a desired human sequence from NCBI database and sequence alignment using BLAST.
14. Three dimension analysis of protein molecules.

##### **Demonstration:**

1. Demonstration of DNA fingerprinting (**Demonstration**).
2. Polymorphism analysis using PCR (**Demonstration**).
3. Demonstration of mammalian sex chromatin (**Demonstration**).
4. Demonstration Southern Blotting, Northern Blotting, Western Blotting (**Demonstration**).
5. Analysis of DNA sequences (**Demonstration**).
6. Phylogenetic analysis using PHYLIP (**Demonstration**).
7. Primer designing using software (**Demonstration**).
8. Microarray analysis using Bioconductor (**Demonstration**).

## **DSE-4: Cognitive Science**

**Credits 06**

### **DSE4T: Cognitive Science**

**Credits 04**

#### **Course Contents:**

#### **Unit-1: Anatomy of brain and spinal cord**

Gross anatomy of cerebrum, cerebellum, brain stem and spinal cord. Cranial and spinal nerves. Autonomic nervous system - sympathetic and parasympathetic nervous system. Neurogenesis in developing brain.

#### **Unit-2: Methods of neuroscience**

EEG, Event-related potential, CAT, MRI, fMRI, PET, Magnetoencephalography, Optical recording.

#### **Unit-3: Memory and Emotion**

Different types of memory. Neural organization of memory. Cellular and molecular basis of memory. Cortical and subcortical contribution to emotion: Fight or Flight response, Reward and motivation, Regulation of emotion, communicating emotion,

#### **Unit-4: Language and speech**

Neural basis of speech, Speech disorders. Neural organization of language, language processing. Hemispheric specialization in language and other functions. Split brain. Neural basis of attention and social cognition

#### **Unit-5: Developmental disorders**

Cognitive development theory, -piagets and Kohlberg moral reasoning theory, mental retardation, degree of mental retardation, causes of mental retardation, down syndrome, dyslexia, Attention deficit hyperactivity disorder, autism

#### **Unit-6: Cognitive disorders**

Cognitive changes with aging. Cognitive disorders: Alzheimer's disease, Frontotemporal dementia, Creutzfeldt Jakob disease, Vascular dementia, Schizophrenia, Depression, Anxiety disorders.

### **DSE4P: Cognitive Science (Practical)**

**Credits 02**

#### **List of Practical:**

1. Primacy and recency in short term memory in human subjects
2. Cognitive assessment by coloured matrices test in children

3. Test to assess the duration of short term memory
4. Psychometric tests for children- Developmental Assessment Scale for Indian Infants (DASII), Wechsler Preschool and Primary Scales of Intelligence (WPPSI), Children Apperception Test (CAT).
5. Animal study: Food retrieval in maze study

**Or**

**DSE-4: Community medicine, Epidemiological Data Analysis**

**Credits 06**

**DSE4T: Community medicine, Epidemiological Data Analysis**

**Credits 04**

**Course Contents:**

**Unit-I: Concepts of Health and Disease:** Definition of health, determinants of health. Agent, host and environmental factors in health and disease. Multifactorial etiology of disease.

**Unit-II: Epidemiology: a. Principle of Epidemiology and Epidemiological methods:** Terms used in describing disease transmission and control. Morbidity and mortality indicators. Measurements of epidemiological indicators, Epidemiology study designs. Concept of association, causation and bias. Screening for diseases. **b. Epidemiology of communicable diseases:** Extent of problem, Diagnosis- clinical and laboratory, Treatment and control, Health Programmes. Respiratory infections: measles, rubella, mumps, influenza, diphtheria, whooping cough, tuberculosis. Intestinal infections: poliomyelitis, viral hepatitis, cholera, typhoid, food poisoning, acute diarrheal diseases. Arthropod-borne infections: dengue, malaria, filariasis, leishmaniasis. Zoonosis : rabies, surface infections: leprosy, HIV/AIDS **c. Epidemiology of chronic non-communicable disease and conditions:** Coronary heart disease, cancer, diabetes, hypertension, blindness.

**Unit-III: Health & Nutrition and Reproductive & Child Health: a. Health & Nutrition:** Concept of Balanced diet - nutritional requirement. Nutrition related disorders- Protein energy Malnutrition, Vitamin A deficiency, Iron deficiency anemia, Iodine deficiency disorders. **b. Reproductive and Child Health:** Child Health, Maternal Health, Immunization, Population Control Measures.

**Unit-IV: Environment & Health and Occupational Health: a. Environment & Health** Water pollution: Indicators of water pollution, Prevention and Control. Air pollution: Indicators of air pollution, Prevention and Control. **b. Occupational Health:** Basic Concepts (Silicosis and Byssinosis)

**Unit-V: Health Care system in India:** Health planning, National Health Policy, Primary Health Care, Health Care delivery system in India.

**Unit-VI: Medicine and Society:** Introduction. Measuring diseases of a society - a. Prevalence. b. Incidence. Detection of causes of diseases and Risk factor - Methods of detection of diseases in a population. Assessing the effectiveness of the treatment of diseases: a. Effectiveness of treatment, b. Cost of therapy, c. Resource required to administer the therapy. The Socio-cultural context of medicine: a. Doctor- Patient's relationship, b. Illness behavior.

**Unit -VII: Epidemiological Data, epidemiologic methods and survey:** Components of epidemiology: Frequency, distribution and determinants of disease. Epidemiological approach and measurements - vital statistics ( rates, ratios and proportions), measurements of health indicators. **Epidemiologic methods and survey:** Data collection: observational (descriptive and analytical) and experimental studies. Epidemiology study designs - case control and cohort studies ( prospective and retrospective), techniques of sampling and matching, sources of bias.

**Unit-VIII: Data Organization & Presentation, Statistical Modeling and analysis using 'R' on NCRP data and survey conducted by the students:** Basic principles of 'R' software for tabulation and graphical representations, measures of central tendency, dispersion and skewness. **Statistical modeling and analysis using 'R' on NCRP data and survey conducted by the students:** Correlation analysis (scatter diagrams and Karl Pearsons coefficient of determination, standard and probable errors) and regression analysis. Inferential statistics: sampling distributions and standard error null and alternate hypothesis, basic concept and illustrations of type I and type II errors, concept of confidence interval estimation, large sample tests for single mean and difference of means, single proportion and difference of proportions, students t-distribution (test for single mean, difference of means and paired t-test), chi-square distribution, F-distribution, one-way and two-way ANOVA, non parametric analysis (sign and rank tests), p-value.

**DSE4P: Community medicine, Epidemiological Data Analysis (Practical) Credits 02**

#### **List of Practical**

1. Surveys/ Community based studies on the topics related to preventive and social medicine.
2. Designing a questionnaire for survey of prevalence diabetes/ hypertension/ allergy/ respiratory disorders/etc. Determining the target and control populations
3. Surveying the population for the diseases mentioned above.
4. Analysis of data from National Cancer Registry Program (NCRP). Understanding incidence, mortality (rates, ratios and proportions).

5. 'R' software and analysis of data from NCRP data and survey conducted by the students. Correlation studies. Regression studies. Probabilistic distribution studies. Comparison of groups and ascertaining statistical significance of differences.

**Or**

**DSE-4: Patho-physiological Basis of Diseases**

**Credits 06**

**DSE4T: Patho-physiological Basis of Diseases**

**Credits 04**

**Course Contents:**

**Unit-I: Introduction** - History of pathology, Basic definitions and common terms used in pathology, Survival mechanism and disease, microscopic and cellular pathology, scope and techniques used.

**Unit-II: Cell Injury and responses of cells: Cellular Adaptations and Cell Death** - An overview of cellular adaptation: Hyperplasia, Hypertrophy, Atrophy, Metaplasia; Causes and mechanisms of cell injury, reversible and irreversible injury, Necrosis, Apoptosis, Types of apoptosis, Intracellular accumulations, Cellular ageing

**Unit-III: Role of inflammation in disease (with suitable examples)** - Basic concepts with suitable examples of general features of acute and chronic inflammation: vascular changes, cellular events, important chemical mediators of inflammation, Morphological effects inflammation response, granulomatus inflammation.

**Unit-IV: Role of tissue repair healing and fibrosis (with suitable examples)** - Basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis

**Unit-V: Common Hemodynamic Disorders in diseases (with suitable examples)** - An overview of edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples

**Unit-VI: Nutritional diseases** - Protein energy malnutrition, deficiency diseases of vitamins, minerals, nutritional excess and imbalances. Roles and effects of metals.

**Unit-VII: Cancer** - Definitions, Nomenclature, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, invasion and metastasis, carcinogens and cancer, concept of oncogenes, tumor suppressor genes, DNA repair genes and cancer stem cells.

**Unit VIII: Infectious diseases epidemiology-** Modes of infections with suitable examples. Overview of cause, extent, prevention, treatment and control of the diseases: Respiratory infections, Intestinal infections, Arthropod-borne infections, Zoonosis and Surface infections

**DSE4P: Patho-physiological Basis of Diseases (Practical)**

**Credits 02**

**List of Practical:**

1. Urine analysis: Gross examination of urine for colour, odour, etc. Abnormal constituents like protein, ketone bodies, glucose, blood, and urea.
2. Measuring Erythrocyte Sedimentation Rate (ESR).
3. Tissue Processing, embedding and sectioning. Staining and preparation of permanent histological slide.
4. Study of histological slides showing hypertrophy, hyperplasia, dysplasia, leukemia, cirrhosis and any common cancer.
5. Diagnostic tests for detection of various diseases – CRP, VDRL, RA, Pregnancy, Dengue (any three)
6. PCR based diagnostics (for any one disease).
7. Physiological data acquisition like temperature, EEG, ECG.

**Or**

**DSE-4: Research Methodology and Design**

**Credits 06**

**DSE4T: Research Methodology and Design**

**Credits 04**

**Course contents:**

**Foundation of Research:** Meaning, Objectives, Motivation of research. Research Methods vs. Methodology, Types of Research: Analytical vs. Descriptive, Quantitative vs. Qualitative, Basic vs. applied.

**Planning of Research design and experiment,** - Need for research design: Features of good design, important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample design, working a proposal - Review of literature. Research hypothesis sampling and data collection.

**Ethics in research** - Code of ethics and research, Ethics and research process, Importance of ethics in research, bio-safety. Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement.

**Tools, techniques for research in Physiology and health science:** Microscopy, Spectrophotometry, Spectrofluorometry- principles and application in biological research. Chromatography: Principles and uses of Paper chromatography; Column chromatography, TLC,

GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography. Mass spectrometry, X-ray diffraction, X-ray crystallography: Basic principles and role in Characterization of proteins and nucleic acids. Electrophoresis: Principle, methods and uses of application of Agarose Gel Electrophoresis (AGE), PAGE, SDS-PAGE. Staining of DNA / RNA gel by ethidium bromide. Histology and Histopathology- principle and techniques. Karyotyping - techniques and staining. Cell fractionation – Cell fractionation techniques. Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl<sub>2</sub> gradient, analytical centrifugation, ultracentrifugation- principles, moving boundary and density gradient ultracentrifugation technique. Marker enzymes. Radioactivity – classification and properties. Concept of radiolabelling of biomolecules and their detection by autoradiography. Principles of radioimmunoassay (RIA), ELISA and immunoblotting.

**DSE4P: Research Methodology and Design (Practical)**

**Credits 02**

A Research project work on physiology/ or related health topics to be submitted based on any above tools and techniques. Formulation of the Project: meaning of scientific research and its methods, designing a project, types of project design, methods, tools and techniques, tabulation and interpretation.