UNIVERSITY OF CALCUTTA

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Ref.No : CUS/31 /18
Dated the 17th January, 2018

To
The Principals/T.I.C.
of all the Undergraduate Colleges
offering B.Sc. (Honours) in Physiology
affiliated to the University of Calcutta

Sir/Madam,

The undersigned is to inform you that the proposed **revised semesterised draft Syllabus for Physiology (Honours)** Courses of Studies under **CBCS has been uploaded in the Calcutta University website (www.caluniv.ac.in).**

The said syllabus has been prepared by the **U.G. Board of Studies in Physiology, C.U.**, suppose to be implemented from the academic session 2018-2019

You are requested kindly to go through it and send your feedback within 31st January, 2018.

In this regard you may send your observation/ suggestion to the **Department of U.G. Councils, C.U**. or through email (u.g.councilsc.u@gmail.com), and you also may contact **Prof. Debasish Bandyopadhyay,** Department of Physiology through e-mail **(debasish63@gmail.com).**

Your cooperation in this regard will be highly appreciated. Kindly treat the matter as urgent.

Thanking you,

Yours faithfully,

12/1/18

Secretary

Secretary
Councils for U. G. Studies
University of Calcutta
Kolkata-700 073

DRAFT

PHYSIOLOGY (HONS.) SYLLABUS FOR CBCS

Core Courses

1. Cellular Basis of Physiology
2. Biological Physics and Enzymes
3. Physiology of Nerve and Muscle Cells
4. Chemistry of Bio-molecules
5. Circulating Body Fluids
6. Circulation
7. Functions of Nervous system
8. Energy Balance, Metabolism and Nutrition
9. Gastrointestinal Function
10. Respiration
11. Special Senses
12. Endocrinology
13. Reproductive Function
14. Renal Function and Micturition

Discipline Specific Electives (DSE)(Any Four)

1. Biological Statistics
2. Microbiology and immunology
3. Ergonomics and Occupational Physiology
4. Sports and Exercise Physiology
5. Human Nutrition and Dietetics
6. Genetics and Molecular Biology
7. Toxicology
8. Nano-biotechnology and Bioinformatics
9. Research Methodology
10. Environmental Physiology

Generic Elective (GE)(Any Four)

1. **Developmental Biology/ E**mbryology
2. Instrumentation
3. Environmental Pollution and Human Health
4. Biotechnology

5. Plant Physiology/ Parasitology
6. Community and Public Health

Ability Enhancement Course (AEC) (Compulsory)

1. Environmental Science
2. English/MIL Communication

Skill Enhancement Course (SEC) (Any two)

1. Detection of Food Additives /Adulterants
2. Histopathological Techniques
3. Clinical Biochemistry
4. Hematological Techniques
5. Pathological Microbiology/Bio-Medical Technology
6. Diet Survey and formulation of Diet Chart

Outline of Courses and Credits in Each Semester

Semester I

(A)Core Courses (CC).

Theoretical (T)

CC1T. Cellular Basis of Physiology (4)

CC2T. Biological Physics and Enzymes (4)

Practical (P)

CC1P.Histology (2)

CC2P. Biological Physics and Enzymes (2)

(B)Ability Enhancement Courses (AEC)

AEC1A. Environmental Science (1)

AEC 2A.English/MIL Communication (1)

(C) **Generic Elective**

Theoretical (T)

GE1T ……(4)

Practical (P)

GE1P…… (2)

*1. **Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days.**

2. One Credit is equivalent to one (1) hour of teaching (lecture) or two hours of Practical work per week.

Total credits in Semester I: [(4X2)]+(2X2)]+(2X1)+(4+2)=[8+4]+2+6 =20

Semester II

(A)Core Courses (CC). Theoretical (T)

CC3T. Physiology of Nerve and Muscle Cells (4)

CC4T. Chemistry of Bio-molecules (4)

Practical (P)

CC3P.Histological Study of Nerve and Muscle (2)

CC4P. Biological Chemistry (2)

(B)Ability Enhancement Courses (AEC)

AEC1B. Environmental Science (1)

AEC 2B.English/MIL Communication (1)

(C)Generic Elective

Theoretical (T)

GE2T……. (4)

Practical (P)

GE2P…… (2)

Total credits: [(4X2)]+(2X2)]+(2X1)+(4+2)=[8+4]+2+6=20

Semester III

(A)Core Courses (CC). Theoretical (T)

CC5T. Circulating Body Fluids (4)

CC6T. Circulation (4)

CC7T. Functions of Nervous System (4)

Practical (P)

CC5P.Hematological Experiments (2)

CC6P. Cardiovascular Experiments (2)

CC7P. Neurological Experiments (2)

(B) Skill Enhancement Courses (SEC)

SEC1T. …… (1)

SEC 1P…….. ……(1)

(C) Generic Elective

Theoretical (T)

GE3T……. (4)

Practical (P)

GE3P…… (2)

Total credits:[12+6]+2+(4+2) =26

Semester IV

(A)Core Courses (CC). Theoretical (T)

CC8T. Energy Balance, Metabolism and Nutrition (4)

CC9T. Gastrointestinal Function (4)

CC10T. Respiration (4)

Practical (P)

CC8P.Biochemical Estimation (2)

CC9P. Dale's Experiments (2)

CC10P.Respiratory Human Experiments (2)

(B)Skill Enhancement Courses (SEC)

SEC2T**.** …… (1)

SEC 2P…….. (1)

(C)Generic Elective

Theoretical (T)

GE4T…… (4)

Practical (P)

GE4P…….. (2)

Total credits:[12+6]+2+(4+2) =26

Semester V

(A)Core Courses (CC). Theoretical (T)

CC11T. Special Senses (4)

CC12T. Endocrinology (4)

Practical (P)

CC11P.Histological and Human Experiments (2)

CC12P. Endocrinological Assay/Experiments related to Experimental Physiology (2)

(B)Discipline Specific Electives(DSE)

Theoretical (T)

DSE1T**.** …… (4)

DSE2T…….. (4)

Practical (P)

DSE 1P…… (2)

DSE 2P…… (2)

***Optional Dissertation/ Project Work in place of one DSE paper (6 Credits) may be adopted.**

Total credits:[8+4]+(6X2) =24

Semester VI

(A)Core Courses (CC). Theoretical (T)

CC13T. Reproductive Function (4)

CC14T. Renal Function and Micturition (4)

Practical (P)

CC13P. Reproductive Histology and Biochemistry (2)

CC14P. Renal Biochemistry (2)

(B)Discipline Specific Electives (DSE)

Theoretical (T)

DSE3T**.** …… (4)

DSE4T……..... (4)

Practical (P)

DSE 3P…… (2)

DSE 4P…… (2)

***Optional Dissertation/ Project Work in place of one DSE paper (6 Credits) may be adopted.**

Total credits:[8+4]+(6X2) =24

Credit Distribution Across Courses

COURSE TYPE	TOTAL PAPERS	CREDITS THEORY+ PRACTICAL
Core Courses	14	14X4=56 14X2=28
Discipline Specific Electives	4	4X4=16 4X2=8
Generic Electives	4	4X4=16 4X2=8
Ability Enhancement Language Courses	2	2X2=4
Skill Enhancement Courses	2	2X2=4
TOTALS	**26**	**140**

Details of Courses and Components
Core Courses

CC1T: Cellular Basis of Physiology

Introduction
Body Fluid Components
Organ Systems, Tissues, and Cells
Functional Morphology of Cell
Transport Across cell Membranes
Capillary Wall
Intercellular Communication
Cell Cycle
Cell Division
    Mitosis
    Meiosis
Homeostasis
Aging

CC2T: Biological Physics and Enzymes

Units for Measuring Concentration of solutes: Moles, Equivalents, Osmoles; Principles of dilution, pH, Buffers
Bonds and Forces in Biomolecules
Colloids,Properties, Importance
Surface tension, Specific Gravity
Viscosity and Resistance
Acids, Bases, Buffers, and pH
Flow and Pressure
Dialysis and Ultracentrifugation
Chromatography
Electrophoresis
Autoradiography
Cell Fractionation and Tracer Techniques
Nanoparticles and its application in Physiology
Laminar and Streamline flow
Poiseuille-Hagen Formula

Laws of Laplace
Thermodynamics
Laws
Application in Physiology
Osmosis and Diffusion
Enzymes
Structure, coenzymes, Prosthetic Groups
Mechanism of enzyme action
Kinetics
Michaelis constant
Enzyme Inhibition
Modulation of Enzymes Activities
Factors regulating enzyme activities
Isoenzymes, Allosteric enzymes
Pro- enzymes
Ribozymes, Abzymes
Concept of Rate limiting enzymes

CC1P: Histology

Study and Identification of Stained Sections of Different Mammalian Tissues and Organs:

Bone, Cartilage, Trachea, Lungs, Spleen, Lymph gland, Esophagus, Stomach, Duodenum, Ileum, Jejunum, large Intestine, Liver, Kidney, Ureter, Salivary glands, Pancreas, Adrenal gland, Thyroid gland, Testes, Ovary, Spinal Cord, Cerebral cortex, Cerebellum, Skin, Cardiac muscle, Skeletal muscle, Smooth muscle, Artery, Vein, Tongue, Uterus.

CC2P: Biological Physics and Enzymes

Determination of oncotic pressure of colloidal solutions; Determination of Systolic, Diastolic, Pulse and Mean Blood Pressure by non-invasive methods (Auscultatory Methods).
Determination of enzyme activities (e.g., SOD, CAT, Amylase, Transaminase etc.).

CC3T: Physiology of Nerve & Muscle Cells

1. **Excitable Tissue: Nerve**
   Introduction
   Nerve Cells

Excitation & Conduction
Measurement of Electrical Events
Ionic Basis of Excitation & Conduction
Properties of Mixed Nerves
Nerve Fiber Types & Function
Neurotrophins
Glia

2. Excitable Tissue: Muscle

Introduction
Skeletal Muscle
- Morphology
- Electrical Phenomena & Ionic Fluxes
- Contractile Responses
- Energy Sources & Metabolism
- Properties of Muscle in the Intact Organism

Cardiac Muscle
- Morphology
- Electrical Properties
- Mechanical Properties
- Metabolism
- Pacemaker Tissue

Smooth Muscle
- Morphology
- Visceral Smooth Muscle
- Multi-Unit Smooth Muscle

3. Synaptic & Junctional Transmission

Introduction
Synaptic Transmission
- Functional Anatomy
- Electrical Events at Synapses
- Inhibition & Facilitation at Synapses
- Chemical Transmission of Synaptic Activity
- Principal Neurotransmitter Systems
- Synaptic Plasticity & Learning

Neuromuscular Transmission
- Neuromuscular Junction
- Denervation Hypersensitivity

4. **Initiation of Impulses in Sense Organs**

Introduction
Sense Organs & Receptors
The Senses
Electrical & Ionic Events in Receptors
"Coding" of Sensory Information

CC4T: Chemistry of Biomolecules

Classification, structure, Properties and Functions of Carbohydrates, Proteins and lipids. Structure, types and Function of DNAs and RNAs.

CC3P: Histological Study, Experiment of Nerve and Muscle

Isolation and Staining of nerve fibres with node(s) of Ranvier ($AgNO_3$) and muscle fibres (H and E).
Preparation of sciatic nerve innervated gastrocnemius muscle of toad.
Study of Kymograph, Induction coil, Key and other instruments used to study mechanical responses of skeletal muscle.
Kymographic recording of mechanical responses of gastrocnemius muscle to a single stimulus and two successive stimuli.
Kymographic recording of the effects of variations of temperature and load (after-load) on single muscle twitch.
Calculation of work done by the muscle.
Determination of nerve conduction velocity.

CC4P: Biological Chemistry

Qualitative tests for the identification of physiologically important substances: Hydrochloric acid, lactic Acid, Uric Acid, Glucose, Galactose, Fructose, Sucrose, Lactose, Albumin, Gelatin, Peptone, Starch, Dextrin, Urea, Glycerol, Bile salts.

CC5T: Circulating Body Fluids

Introduction, Blood ,Bone Marrow,White Blood Cells, Immune Mechanisms, Platelets, Red Blood Cells, Blood Types, Plasma,Hemostasis, Lymph, Clinical implications

CC6T: Circulation

1. **Origin of the Heartbeat & the Electrical Activity of the heart**

Introduction
Origin & Spread Of Cardiac Excitation
The Electrocardiogram
Cardiac Arrhythmias
Electrocardiographic Findings in Other Cardiac & Systemic Diseases, hypertrophy and cardiac myopathy

2. **The Heart as a Pump**
   Introduction
   Mechanical Events of the Cardiac Cycle
   Cardiac Output
3. **Dynamics of Blood & Lymph Flow**
   Introduction
   Anatomic Considerations
   Biophysical Considerations
   Arterial & Arteriolar Circulation
   Capillary Circulation
   Lymphatic Circulation & Interstitial Fluid Volume
   Venous Circulation
4. **Cardiovascular regulatory Mechanisms**
   Introduction
   Local Regulatory Mechanisms
   Substances Secreted by the Endothelium
   Systemic Regulation by Hormones
   Systemic Regulation by the Nervous System
5. **Circulation Through special Regions**
   Introduction
   Cerebral Circulation
      Anatomic Considerations
      Cerebrospinal Fluid
      The Blood-Brain barrier
      Cerebral Blood Flow
      Regulation of Cerebral Circulation
      Brain Metabolism & Oxygen Requirements
   Coronary Circulation

Splanchnic Circulation
Circulation of the skin
Placental & Fetal Circulation

6. **Cardiovascular Homeostasis in Health & Disease**
   Introduction
   Compensation for Gravitational Effects
   Exercise
   Inflammation & Wound Healing
   Shock
   Hypertension
   Heart Failure, stroke

CC7T: Functions of the Nervous System

1. **Reflexes**
   Introduction
   Monosynaptic Reflexes: The Stretch Reflex
   Polysynaptic Reflexes: The Withdrawal Reflex
   General Properties of Reflexes

2. **Cutaneous, Deep & Visceral Sensation**
   Introduction
   Pathways
   Touch
   Proprioception
   Temperature
   Pain
   Other Sensations

3. **Arousal Mechanisms, Sleep, & the Electrical Activity of the Brain**
   Introduction
   The Reticular Formation & the Reticular Activating System
   The Thalamus & the Cerebral Cortex
   Evoked Cortical Potentials
   The Electroencephalogram
   Physiological Basis of the EEG, Consciousness, & Sleep
   Interpretation of abnormal EEG pattern

4. **Control of Posture & Movement**
   - Introduction
   - General Principles
   - Corticospinal & Corticobulbar System
     - Anatomy & Function
   - Posture and its regulation
   - Basal Ganglia
   - Cerebellum
   - Movement disorders

5. **The Autonomic Nervous System**
   - Introduction
   - Anatomic Organization of Autonomic Outflow
   - Chemical Transmission at autonomic Junctions
   - Responses of Effector Organs to Autonomic Nerve Impulses
   - Cholinergic and Adrenergic Discharge

6. **Central Regulation of Visceral Function**
   - Introduction
   - Medulla Oblongata
   - Hypothalamus
     - Anatomic Considerations
     - Hypothalamic Function
     - Relation to Autonomic Function
     - Relation to Sleep
     - Relation to Cyclic Phenomena
     - Hunger
     - Thirst
     - Control of Posterior Pituitary Secretion
     - Control of Anterior pituitary Secretion
     - Temperature Regulation, fever

7. **Neural Basis of Instinctual Behavior & Emotions**
   - Introduction
   - Anatomic Considerations
   - Limbic Functions
   - Sexual Behavior
   - Fear & Rage

Motivation

8. **" Higher Functions of the Nervous System": Conditioned Reflexes , Learning, & Related Phenomena**

Introduction
Methods
Learning & Memory
Functions of the Neocortex
Disorders relating learning and memory

CC5P: Hematological Experiments

Preparation and staining of blood film with Leishman's stain.
Identification of the blood corpuscles.
Differential count of WBC.
Total count of RBC and WBC.
Bleeding time and clotting time.
Hemoglobin estimation.
Preparation of haemin crystal.
Preparation and staining of bone marrow.
Measurement of diameter of megakaryocyte.
Reticulocyte staining.
Blood group determintation.

CC6P: Cardiovascular Physiology Experimental

Preparation of Amphibian Ringer solution.
Kymographic recording of the movements of perfused heart of toad.
Study of the effects of changes in perfusion fluid pressure, changes in temperature, excess calcium and potassium ion concentration, acetylcholine, adrenaline on the on the movement of heart.

CC7P: Neurological Experimental

Experiments on superficial (plantar) and deep (knee jerk) reflex

Measurement of grip strength

Reaction time by stick drop test

Short term memory test (shape, picture word)

Two point discrimination test

CC8T: Energy Balance, Metabolism, and Nutrition

Introduction
Energy metabolism
Carbohydrate metabolism
Protein metabolism
Fat and cholesterol metabolism
Integration of carbohydrate, fat and protein metabolism
Nutrition – BMR, RQ, RDA, SDA, NPU, Biological value of proteins, vitamins and minerals

CC9T: Gastrointestinal Function

1. **Digestion & Absorption**
   Introduction
   Carbohydrates
   Proteins & Nucleic Acids
   Lipids
   Absorption of Water & Electrolytes
   Absorption of Vitamins & Minerals
2. **Regulation of Gastrointestinal Function**
   Introduction
   General Considerations
   Gastrointestinal hormones
   Mouth & Esophagus
   Stomach
   Exocrine Portion of the Pancreas
   Liver & Biliary System
   Small Intestine
   Colon

CC10T: Respiration

1. **Pulmonary Function**

Introduction
Properties of Gases
Anatomy of the Lungs
Mechanics of breathing
Gas Exchange in the lungs
Pulmonary Circulation
Other Functions of the Respiratory System

2. **Gas Transport Between the Lungs & the Tissues**
   Introduction
   Oxygen Transport
   Carbon Dioxide Transport
   Respiratory acidosis and alkalosis

3. **Regulation of Respiration**
   Introduction
   Neural control of Breathing
   Chemical Control of Breathing
   Nonchemical Influences on Respiration

4. **Respiratory Adjustments in Health & Disease**
   Introduction
   Effects of Exercise
   Other Forms of Hypoxia
   Oxygen Treatment
   Hypercapnia & Hypocapnia
   Other Respiratory Abnormalities
   Effects of Increased Barometric Pressure
   Artificial Respiration

CC8P: Biochemical Estimation

Quantative estimation of glucose and sucrose by Benedict's method.
Quantitative estimation of amino nitrogen (Sorensen's formol titration method [percentage as well as total quantity to be done]).
Estimation of percentage quantity of lactose in milk by Benedict's method.

CC9P: Dale's Experimental

Kymographic recording of normal movements of rat's intestine in Dale's apparatus.
Effects of hypoxia, acetylcholine and adrenaline on normal intestinal movements.

CC10P: Respiratory human experiments

Measurement of peak expiratory flow rate

Measurement of oxygen saturationby pulse oxymeter before and after exercise

Measurement of forced expiratory volume (FEV) in first second.

CC11T: Special Senses

1. **Vision**
   Introduction
   Anatomic Considerations
   The Image-Forming Mechanism (accommodation and visual acuity)
   The Photoreceptor Mechanism: Genesis of Electrical Responses
   Visual Pathways and effects of lesions of these pathways
   Color Vision
   Other Aspects of Visual Function
   Eye Movements
   Errors in visual process

2. **Hearing & Equilibrium**
   Introduction
   Anatomic considerations
   Hair cells

Mechanism of hearing
Vestibular function
Loss of hearing

3. **Smell & Taste**
   Introduction
   Smell
   Receptors & Pathways
   Physiology of Olfaction
   Taste
      Receptor Organs & Pathways
      Physiology of Taste

CC12T: Endocrinology

1. **The Thyroid Gland**
   Introduction
   Anatomic Considerations
   Formation & Secretion of Thyroid Hormones
   Transport of Thyroid Hormones
   Effects of Thyroid Hormones
   Regulation of Thyroid Secretion
   Clinical Correlates

2. **Endocrine Functions of the Pancreas & the Regulation of Carbohydrate Metabolism**
   Introduction
   Islet Cell Structure
   Structure, Biosynthesis, & Secretion of Insulin
   Effects of Insulin
   Mechanism of action
   Insulin Excess
   Regulation of Insulin Secretion
   Glucagon
   Other Islet Cell Hormones
   Hypoglycemia & Diabetes Mellitus in Humans

3. **The Adrenal Medulla & Adrenal Cortex**
   Introduction

Adrenal Morphology
Adrenal Medulla
Structure & Function of Medullary Hormones
Regulation of Adrenal Medullary Secretion
Adrenal Cortex
Structure & Biosynthesis of Adrenocortical Hormones
Effects of Adrenal Androgens & Estrogens
Physiologic Effects of Glucocorticoids
Pharmacologic & Pathologic Effects of Glucocorticoids
Regulation of Glucocorticoid Secretion
Effects of Mineralocorticoids
Regulation of Aldosterone Secretion
Summary of the effects of Adrenocortical Hyper & Hypofunction in Humans

4. **Hormonal Control of Calcium Metabolism & the Physiology of Bone**

Introduction
Calcium & Phosphate Metabolism
Bone Physiology
Vitamin D & the Hydroxycholecalciferols
The Parathyroid Glands
Calcitonin
Effects of Other Hormones & Humoral Agents on Calcium Metabolism

5. **The Pituitary Gland**

Introduction
Morphology
Posterior pituitary hormones
Growth Hormone
Physiology of Growth
Pituitary Insufficiency
Pituitary Hyperfunction in Humans

6. **Endocrine Functions of the Kidneys, Heart, & Pineal Gland**

Introduction
The Renin-Angiotensin System

Erythropoietin
The Endocrine Function of the Heart: Atrial Natriuretic Peptide
Pineal Gland

7. Human chronobiology, biological rhythms; basic concepts and implications

CC11P: Histological and Human Experiments

Principles of fixation and staining, staining and identification of fixed endocrine glands and nervous tissue. Determination of visual acuity by Snellen's chart / Landolt's C chart. Determination of colour blindness by Ishihara chart.

CC12P: Endocrinological assay / Experiments related to experimental Physiology: Study of the effects of oxytocin on uterine contraction. Study of the effects of adrenaline on intestinal / uterine movements.

CC13T: Reproduction

Introduction
Sex Differentiation & Development
- Chromosomal Sex
- Embryology of the Human Reproductive System
- Aberrant Sexual Differentiation
- Puberty
- Precocious & Delayed Puberty
- Menopause

Pituitary Gonadotropins & Prolactin
The male reproductive System
- Structure
- Gametogenesis & Ejaculation
- Endocrine Function of the Testes
- Control of Testicular Function
- Abnormalities of Testicular Function

The Female Reproductive system
- The Menstrual Cycle
- Ovarian Hormones
- Control of Ovarian Function
- Abnormalities of Ovarian Function

Pregnancy
Lactation
Physiological concepts for a planned family

CC14T: Formation and Excretion of Urine

1. **Renal Function & Micturition**
   Introduction
   Function of Malpighian corpuscles and renal tubule, counter-current mechanism
   Water Excretion
   Acidification of the Urine & Bicarbonate Excretion
   Regulation of Na^+ & Cl^- Excretion
   Renal Circulation
   Diuretics
   Disorders of Renal Functions
   Filling of the Bladder
   Emptying of the Bladder
   Non-excretory function of kidney

CC13P: Reproductive Histology and Biochemistry: Study of estrous cycle. Staining and identification of kidney and ureters. Estimation of estrogen by spectrophotometric method. Pregnancy test from human urine by kit method.

CC14P: Renal Biochemistry: Identification of normal and abnormal constituents of urine.

Discipline Specific Electives (DSE)(Any Four)

1. Biological Statistics
2. Microbiology and Immunology
3. Ergonomics and Occupational Physiology
4. Sports and Exercise Physiology
5. Human Nutrition and Dietetics
6. Genetics and Molecular Biology
7. Toxicology
8. Nano-biotechnology and Bioinformatics
9. Research Methodology
10. Environmental Physiology

Biological Statistics (DSE1T)

Scope of statistics – Principles of statistical analysis of biological data. Basic concepts – variable, parameter, statistics. Sampling. Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram. Parameters. Different classes of statistics- mean, median, mode, mean deviation, variance, standard deviation, standard error of mean. Standard score. Degrees of freedom. Probability. Normal distribution. Student's t-distribution. Testing of hypothesis - Null hypothesis, errors of inference, levels of significance, students' t-test and z score for significance of difference. Distribution-free test - Chi-square test.

Biological statistics practical (DSE 1P)

Computation of mean, median, mode, standard deviation and standard error of the mean with physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in frequency polygon and histogram. Student's t test for significance of difference between means.
Demonstration: Statistical analysis and graphical representation of biological data with computer using One way ANOVA.

Microbiology and Immunology (DSE 2T)

Bacteria - structure & morphological classification. Gram positive, gram negative, pathogenic & nonpathogenic bacteria. Sterilization, pasteurization, brief idea about antibiotics. Bacterial growth curve. Elementary idea of bacteriostatic and bacteriocidal agents Bacterial genetics. Viruses - Structure and types, Lytic and lysogenic cycle. Prions – basic ideas and prion diseases.
Overview of Immune System. Idea about innate and acquired immunity. Immuno-competent Cells. Humoral and cell mediated immunity. Antigen-antibody interaction. Immunoglobulin - classification, basic structure and function. Antigen presentation. Major Histocompatibility Complex (MHC). Cytokines. Complement system. Vaccination - principles and importance of immunization. Basic principles of immunological detection of pregnancy. Immunization program - immunization against Polio, Hepatitis-B, Tetanus, Measles,Whooping cough, Tuberculosis, Rabbies through vaccine, AIDS-causative virus, mode of transmission, effects on human body, preventive measures, principles of diagnostic test for AIDS (ELISA). Immunopathology - basic principles of autoimmune disease and transplantation immunology.

Microbiology and Immunology Practical (DSE 2P)

Gram staining of bacteria and identification of Gram positive and Gram negative bacteria.
Demonstration: Spore Staining, Radial immuno-diffusion.

Ergonomics and Occupational Physiology (DSE 3T)

Genesis and concept of ergonomics.
Importance of ergonomics in occupational health and well being.
Classification of Physiological work load. Concept of work rest cycle.
Physical work environment : (a) Thermal environment, its' effect, Heat stress indices, (b)Noise and vibration, its' effect on workers. Occupational deafness, (c) Illumination level and its' effect on visual performances, (d) Ergonomic principles of control of Physical hazards.
Static anthropometry, Application of anthropometric data in design.
User interface and control display compatibility.
Prevention of accidents, concept of Industrial safety.
Occupational Diseases: pneumoconiosis, asbestosis, silicosis and work-related musculoskeletal disorders.

Ergonomics and Occupational Physiology (DSE 3P)

1. Measurement of working heart rate by ten beats methods.
2. Determine cardiac cost of specific work.
3. Measurement of blood pressure before and after different grades of exercise.
4. Measurement of Some common anthropometric parameters. Calculation of BSA and BMI from anthropometric data.

5. Measurement of WBGT indices.
6. Measurement of noise level by noise level meter.

Sports and Exercise Physiology (DSE 4T)

Importance of regular exercise in health and wellbeing.

Basic concept of Bioenergetics, Energy sources during exercise (Phosphagen, Anaerobic system and Aerobic system).

Cardio-respiratory responses during different grades of exercise.

Concept of excess post exercise oxygen consumption (EPOC), physiological fatigue and recovery.

Aerobic work Capacity: Measurement, physiological factors and applications.

Training: Principles of physical training, Training to improve aerobic and anaerobic power. Effect of overtraining and detraining.

Nutritional supplements and ergogenic aids.

Sports injury and its' management.

Basic idea sports rehabilitation and sports medicine.

Sports and Exercise Physiology (DSE 4P)

(a) Measurement of blood pressure before and after different grades of exercise.

(b) Recording of recovery heart-rate after standard exercise.

(c) Determination of Physical Fitness Index by Harvard Step Test (Modified).

(d) Determination of VO_{2max} by queen college step test.

(e) Measurement of body fat percentage.

(f) Six minute walk test.

(g) Determination of endurance time by hand grip dynamometer.

(h) Pneumographic recording of effect of talking, laughing, coughing, breath holding and hyperventilation.

Human nutrition and dietetics (DSE 5T):

Constituents of food and their significance. Basal metabolic rate -factors, determination by Benedict-Roth apparatus. Respiratory quotient. Specific dynamic action. Basic concept of energy and units. Calorific value of foods. Body calorie requirements – adult consumption unit. Dietary requirements of carbohydrate, protein, lipid and other nutrients. Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nitrogen balance, essential amino acids, biological value of proteins. Supplementary value of protein. Protein efficiency ratio and net protein utilization of dietary proteins. Dietary fibres. Vitamins. Principle of diet survey. Composition and nutritional value of common food stuffs. Physiology of starvation and obesity. Sources and physiological significances of vitamins and minerals. Space nutrition.

Nutrition and Dietetics - Diet Survey (Field Study Record) (DSE 5P):

a) Diet survey report (hand-written) of a family (as per ICMR specification) : Each student has to submit a report on his/her own family.

b) A report (hand-written) on the basis of field survey from ONE of the followings: (1) Physiological parameters of human (at least three parameters). (2) Anthropometric measurements on human (at least three parameters). (3) Epidemiological studies on human.

Genetics and Molecular Biology:

Genetics: Basic principles of Mendelian genetics - monohybrid and dihybrid, test and back crosses, Bacterial genetics-transformation, transduction, conjugation (mention of F+ /F- , Hfr strain, function of pillus). Extension of Mendelism **-** Epistasis and its different types present in plants and animals. Penetrance, expressivity, pleiotropism. Crossing over and Gene mapping. Numerical and Structural variations in chromosome - basic concepts of aneuploids and polyploids. Human Cytogenetics - human karyotype, banding technique, use of human cytogenetics in medical science, inborn errors of metabolism, aneuploidy in humans. Sex determination and sex linkage.

Molecular Biology: Genes - definition. DNA- structure, DNA replication, transcription of RNA in prokaryotes, Genetic code – properties and wobble hypothesis, translation in prokaryotes, regulation of gene expression – operon concept: lac operon, gene mutation, DNA repairing processes. Basic idea of Recombinant DNA technology and its applications, Polymerase chain reaction (PCR) - basic concepts.

Genetics and Molecular Biology (DSE 6P):

DNA gel electrophoresis (agarose gel)

Toxicology (DSE 7T):

Toxins and Toxicology
Factors Affecting toxicity
LD_{50}, LOD_{50}, ED_{50}, NOEL, LOEL
Concept of Acute and Chronic Effects
Birth defects and Teratogens
Concepts of Biomagnification and Bioconcentration
Popular Food Additives and Food Adulterants
Prevention of Food Adulteration Act, 1954
Other Food Toxicants: BPA, BPS, Pesticides, PAH, Dioxin, PCB,
Heavy Metals: Pb, Hg, Cd, As etc.

Toxicology (DSE 7P):

I. Physiological (experimental) Experiments

Kymographic recordind of the effects of Hg, Pb and As compounds on: the contraction of perfused heart of toad, the intestinal movements of rats in Dale's bath.

II. Histo-chemical Experiments

Histochemical studies: chronic effects of food additives and arsenic compounds on liver, kidney, intestine, brain, muscle and lung tissues in rat.

Nanobiothechnology and Bioinformatics (DSE 8T):

Introduction to nanoscience and nanobiotechnology. Definition of a Nano system. Types of Nanostructures; Types of Nanocrystals-One Dimensional (1D)-Two Dimensional (2D) -Three Dimensional (3D) nanostructured materials - Quantum dots - Quantum wire; Core/Shell structures. Synthesis of Nanomaterials. Characterization techniques for Nanomaterials: X-ray diffraction; Scanning Electron Microscope (SEM); Atomic force microscopy (AFM); scanning tunneling microscopy (STM), scanning near field optical microscopy (SNOM); Transmission Electron Microscopy (TEM); Infrared

spectroscopy (IR). Properties of Nanomaterials: Size dependent properties - Mechanical, Physical and Chemical properties.Types of Nanomaterials: Carbon Nanotubes (CNT) - Metals (Au, Ag) - Metal oxides (TiO2, CeO2, ZnO) – Sem iconductors (Si, Ge, CdS, ZnSe) - Ceramics and Composites . Applications of Nanomaterials in Biology: Biochemical sensors; Imaging; Cancer treatment etc. Toxicity of nanomaterials in the environment – Health threats.

Nanobiothechnology and Bioinformatics (DSE 8P):

To be decided by respective universities board of studies based on the availability of infrastructure.

Research Methodology (DSE 9T)

Microscopy, Spectrophotometry, spectrofluorometry,Chromatography: Principles and uses of paper and thin layer chromatography, Electrophoresis: Principles and method, uses of agarose gel electrophoresis, SDS – PAGE. Affinity and ion-exchange chromatography. Staining of DNA/RNA gel by ethidium bromide. Principles of ultracentrifugation: moving boundary and density gradient ultracentrifugation. Radioactivity – classification and properties. Concept of radiolabelling of biomolecules and their detection by autoradiography. Principles of radioimmunoassay (RIA), ELISA and immunoblotting. Ethics in research. Planning an experiment.

Research Methodology (DSE 9P)

Preparation of a standard curve of protein using Lowry’s method.

Determination of pH optima of amylase or any other enzyme

Environmental Physiology (DSE 10T)

Toxicology

Toxins and Toxicology
Factors Affecting toxicity
LD_{50}, LOD_{50}, ED_{50}, NOEL, LOEL
Concept of Acute and Chronic Effects
Birth defects and Teratogens
Concepts of Biomagnification and Bioconcentration
Popular Food Additives and Food Adulterants
Prevention of Food Adulteration Act, 1954
Other Food Toxicants: BPA, BPS, Pesticides, PAH, Dioxin, PCB,
Heavy Metals: Pb, Hg, Cd, As etc

Environmental Pollutions and Health Hazards

Definition: hygiene, health and public health.
Air, Water, Food Borne Diseases: causes, symptoms and control.
Food Additives and Adulterants: definition, examples and human health hazards.
Vector Borne Epidemic Diseases: Malaria and Plague-etiology and control.

Environmental Pollution and Human Health Hazards

Air Pollution: definition, sources, air pollutants, effects of air pollution on human health, concept of ozone hole, green house effects and global warming.

Water Pollution: definition, types, health hazards, water pollutants, biochemical oxygen demand (BOD), thermal pollution, concept of safe drinking water standards.

Soil Pollution: causes, health hazards, solid waste managements- bioreme- diation, phytoremediation.

Sound Pollution: definition, concept of noise, source of sound pollution, effects of sound pollution on human health, noise index (noise standards).

Radionuclide Pollution: ionizing radiations, effects of ionizing radiation on human health, permissible doses.

Arsenic Pollution: sources, sources of arsenic in ground water, drinking water standard for arsenic (WHO, USEPA), health effects of chronic arsenic poisoning

Environmental management

Environmental ethics

Conservation of topsoil, ground water and wild lives; rain water harvesting; sanctuary, national park, biosphere reserve, wildlife (conservation) Act, 1992.

Generic Elective (GE)(Any Four)

1. Developmental Biology/ Embryology
2. Instrumentation
3. Environmental Pollution and Human Health
4. Biotechnology
5. Plant Physiology/ Parasitology
6. Community and Public Health

Developmental Biology / Embryology (GE 1T): Gametogenesis: Spermatogenesis & Oogenesis. ,Ultra structure: sperm and ovum in mammals. Egg Membranes ,Fertilization: In Sea-urchin and mammals Cleavage: Cleavage plane, types, role of yolk in cleavage; cleavage process in mammals. Blastula formation: mammals Morphogenetic movements: Types and examples. Gastrulation: Mammals Concept of induction, determination, and differentiation. Organogenesis: development of eye as an example of reciprocal and repeated inductive events.

Developmental Biology / Embryology (GE 1P): H & E staining of ovarian tissue sections and identification of Graafian follicle, Corpus Luteum, demonstration of preserved mammalian embryo.

Instrumentation (GE 2T):

Microscopy, Spectrophotometry and Spectrofluorometry. Principles and uses of paper and thin layer chromatography. Electrophoresis: Principles and method, uses of agarose gel electrophoresis, SDS – PAGE. Staining of DNA/RNA gel by ethidium bromide,Ultracentrifugation: moving boundary and density gradient ultracentrifugation. ELISA and immunoblotting.

Instrumentation (GE 2P):

Handling of compound microscope, measurement of protein concentration of a sample using spectrophotometer and separation of amino acids through paper chromatography (demonstration).

Environmental pollution and human health (GE 3T):

Air Pollution: definition, sources, air pollutants, effects of air pollution on human health, concept of ozone hole, green house effects and global warming.

Water Pollution: definition, types, health hazards, water pollutants, biochemical oxygen demand (BOD), thermal pollution, concept of safe drinking water standards.

Soil Pollution: causes, health hazards, solid waste managements- bioreme- diation, phytoremediation.

Sound Pollution: definition, concept of noise, source of sound pollution, effects of sound pollution on human health, noise index (noise standards).

Radionuclide Pollution: ionizing radiations, effects of ionizing radiation on human health, permissible doses.

Arsenic Pollution: sources, sources of arsenic in ground water, drinking water standard for arsenic (WHO, USEPA), health effects of chronic arsenic poisoning.

Environmental pollution and human health (GE 3P):

I. **Physiological (experimental) Experiments:** Kymographic recordind of the effects of Hg, Pb and As compounds on: The contraction of perfused heart of toad. The intestinal movements of rats in Dale's bath.

II. **Histo-chemical Experiments:** Histochemical studies: chronic effects of food additives and arsenic compounds on liver, kidney, intestine, brain, muscle and lung tissues in rat.

Biotechnology (GE 4T): Definition, history of biotechnology, importance of biotechnology, Cloning, Gene therapy, Transgenic animals, hybridoma, monoclonal antibody, DNA finger printing and its application in forensic science, polymerase chain reaction, RT-PCR, enzyme immobilization, basic idea of tissue culture and CO_2-incubators.

Biotechnology (GE 4P): Measurement of concentration of CT-DNA in a solution.

Plant Physiology / Parasitology (GE 5T): Water and Plant cells-Water transport processes in plants, Water balance of plants. The Soil-Plant-Atmosphere continuum. Solute transport: Passive and Active transport, Ion transport in roots. Translocation in the phloem: Pathways, patterns and mechanism of translocation. Mineral nutrition: Essential nutrients, deficiencies and plant disorders. Plant hormones – Strigolactone Biosynthesis, storage, breakdown and transport. Stress Physiology: responses of plants to abiotic stress- osmotic stress, temperature stress, oxidative stress. Photosynthesis:Light and dark phase reaction, photophosphorylation, Calvin Cycle, photorespiration, C4 pathway (tropical plants).

Basic concepts of parasitology. Basic idea on malaria parasite etc.

Plant Physiology / Parasitology (GE 5P): Some experiments on plant growth. Observation on some parasitic organisms.

Community and Public Health (GE 6T): Basic idea about community health and public health issues, Malnutririon in a community, overnutrition, issues of obesity; possible remedial measures. Composition and nutritional value of common Indian foodstuffs, rice, wheat, pulses, egg, meat, fish and milk. Dietary fibers. Calorie requirement. Concept of ACU. Principles of formulation of balanced diets for growing child, adult man and woman, pregnant and lactating woman. Diet management of obese, diabetic, hypertensive person and athlete. Basic idea on PCM, marasmus, kwashiorkor and their prevention. Iron and iodine deficiency.
Sound pollution as a community health issue; definition, concept of noise, source of extraordinary sound, effects of sound pollution on human health, noise index (noise standards).

Community and Public Health (GE 6P): Qualitative assessment of noise, survey on the status of dietary intake in the surrounding area through visits, etc.

Ability Enhancement Course (AEC) (Compulsory)

1. Environmental Science

2. English/MIL Communication

Environmental Science (AEC 1T):

English / MIL Communication (AEC 2T):

Skill Enhancement Course (SEC) (Any two)

1. Detection of Food Additives /Adulterants
2. Histopathological Techniques
3. Clinical Biochemistry
4. Hematological Techniques
5. Pathological Microbiology/Bio-Medical Technology
6. Diet Survey

Detection of Food Additives / Adulterants (SEC 1):

Qualitative tests for identifying Food Adulterants in some food samples:Metanil yellow, Rhodamin B, Saccharin, Monosodium glutamate, Aluminium foil, Chicory, Bisphenol A and Bisphenol S, Chocolate Brown HT, Margarine, Pb, Hg, As, PCB, Dioxin etc in turmeric powder, besan, laddoo, noodles, chocolate and amriti.

Histopathological Techniques (SEC 2):

Preparation of tissue sections, H&E staining of tissue sections,Preparation and staining of bone marrow smear, measurement of diameter of megakaryocyte, reticulocyte staining, staining of collagen in tissue sections.

Clinical Biochemistry (SEC 3):

Photo-colorimetric estimation of blood constituents. Measurement of blood glucose by Nelson-Somogyi method, measurement of blood inorganic phosphate by Fiske - Subbarow method, measurement of serum total protein by Biuret method and determination albumin globulin ratio, determination of serum amylase by iodometric method.

Hematological Techniques (SEC 4)

Preparation of blood smear and identification of blood cells. Determination of haematocrit, MCV, MCH,MCHC, bleeding time, clotting time etc.

Measurement of haemoglobin in blood. Preparation of serum, Estimation of SGOT and SGPT.

Pathological Microbiology / Bio-Medical Technology (SEC 5):

Staining of gram positive and gram negative bacteria. Identification of tubercular bacteria in sputum (demonstration: with utmost precautionary measure taken before students handle the samples). Demonstration of an ECG machine at work. Handling of Doctor's centrifuge. Handling of colorimeter / spectrophotometer.

Diet survey and formulation of diet chart (SEC 6):

Survey of dietary status of people in the nearby area by the students, analysis of survey results, and, formulation of diet chart.