Council for Undergraduate Studies

Kalyani University

Course Curriculum for Physiology Honours under Choice Based Credit System (CBCS)

Submitted by

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UGBOS in Physiology

Introduction

The syllabus for Physiology at undergraduate level using the Choice Based Credit System has been framed in compliance with UGC CBCS Guidelines and adhering the model syllabus in Physiology framed by WBSCHE.

The purpose of the course is to standardize physiology teaching at undergraduate level throughout the state. The syllabus will equip all undergraduate students with knowledge on basic physiological mechanisms for the set point control of different physiological variables in healthy human beings with special references to their implications in pathogenesis of disease and the physiological basis of their management.

The ultimate goal of the syllabus is that the students at the end are able to secure a job. The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

The objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Physiology. The course content also lists new practical exercises, so that the students get a hands-on experience of the latest techniques that are in current usage both in the advanced research laboratories and in Industry.

Framework of CBCS in Physiology Honours (B.Sc., Hons. in Physiology)

	Core course (14)	**Ability Enhancement Compulsory Course (AECC) (2)**	**Skill Enhancement Course (SEC) (2)**	**Elective: Discipline Specific (DSE) (4)**	**Elective: Generic (GE) (4)**
I	C1	Environmental Sciences/(English Communication/MIL)			GE-1
	C2				
II	C3	Environmental Science/ (English/ MIL Communication)			GE-2
	C4				
III	C5		SEC-1		GE-3
	C6				
	C7				
IV	C8		SEC-2		GE-4
	C9				
	C10				
V	C11			DSE-1	
	C12			DSE-2	
VI	C13			DSE-3	
	C14			DSE-4	

Implementation

An undergraduate degree with honours in Physiology may be awarded if a student completes 14 Core Courses (CC) or Core Papers in Physiology, 2 Ability Enhancement Compulsory Courses (AECC), minimum 2 Skill Enhancement Courses (SEC) and 4 Courses each from a list of Discipline Specific Elective (DSE) and Generic Elective (GE) Courses, respectively.

Courses of B.Sc. Honours Physiology under 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. Formation and Excretion of Urine
Ability Enhancement Course (AEC) (Compulsory)	1. Environmental Science 2. English/MIL Communication
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
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
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

Summary of the Syllabus

Semester 1

(A) Core Courses (CC)

Theoretical (T)	Practical (P)
CCT1. Cellular Basis of Physiology (4) CCT2. Biological Physics and Enzymes (4)	CCP1.Cellular Basis of Physiology (2) CCP2. Biological Physics and Enzymes (2)

(B) Ability Enhancement Courses (AEC)

AECA1. Environmental Science (1)
AEC A2.English/MIL Communication (1)

(C) Generic Elective (GE)

Theoretical (T)	Practical (P)
GET1 ……(4)	GEP1…… (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
3. Numbers in parentheses indicate value of credit.

Semester II

(A) Core Courses (CC)

Theoretical (T)	Practical (P)
CCT3. Physiology of Nerve and Muscle Cells (4) CCT4. Chemistry of Bio-molecules (4)	CCP3. Physiology of Nerve and Muscle Cells (2) CCP4. Chemistry of Bio-molecules (2)

(B) Ability Enhancement Courses (AEC)

AECB1. Environmental Science (1)
AEC B2.English/MIL Communication (1)

(C) Generic Elective (GE)

Theoretical (T)	Practical (P)
GET2…… (4)	GEP2…… (2)
Total credits: [(4X2)]+(2X2)]+(2X1)+(4+2)=[8+4]+2+6=20	

Semester III

(A) Core Courses (CC)

Theoretical (T)	Practical (P)
CCT5. Circulating Body Fluids (4) CCT6. Circulation (4) CCT7. Functions of Nervous System (4)	CCP5. Circulating Body Fluids (2) CCP6. Circulation (2) CCP7. Functions of Nervous System (2)

(B) Skill Enhancement Courses (SEC)

SECT1. …… (1)
SEC P1……(1)

(C) Generic Elective (GE)

Theoretical (T)	Practical (P)
GET3…… (4)	GEP3…… (2)
Total credits:[12+6]+2+(4+2) =26	

Semester IV

(A) Core Courses (CC)

Theoretical (T)	Practical (P)
CCT8. Energy Balance, Metabolism and Nutrition (4) CCT9. Gastrointestinal Function (4)	CCP8. Energy Balance, Metabolism and Nutrition (2) CCP9. Gastrointestinal Function (2)

CCT10. Respiration (4)	CCP10. Respiration (2)
(B) Skill Enhancement Courses (SEC)	
SECT2. …… (1) SEC P2……(1)	
(C) Generic Elective (GE)	
Theoretical (T)	**Practical (P)**
GET4…… (4)	GEP4…… (2)
Total credits:[12+6]+2+(4+2) =26	

Semester V

(A) Core Courses (CC)	
Theoretical (T)	**Practical (P)**
CCT11. Special Senses (4) CCT12. Endocrinology (4)	CCP11. Special Senses (2) CCP12. Endocrinology (2)
(B) (B)Discipline Specific Electives(DSE)	
Theoretical (T)	**Practical (P)**
DSET1. …… (4) DSET2…… (4)	DSE P1…… (2) DSE P2…… (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)	**Practical (P)**
CCT13. Reproductive Function (4) CCT14. Formation and Excretion of Urine (4)	CCP13. Reproductive Function (2) CCP14. Formation and Excretion of Urine (2)
(B) (B)Discipline Specific Electives(DSE)	
Theoretical (T)	**Practical (P)**
DSET3. …… (4) DSET4…… (4)	DSE P3…… (2) DSE P4…… (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
TOTAL	**26**	**140**

Details of Courses :

Components of Core Courses

CCT1: Cellular Basis of Physiology	4 Credits

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

CCP1: Cellular Basis of Physiology Lab	2 Credits

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.

CCT2: Biological Physics and Enzymes	4 Credits

A study of 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.

CCP2: Biological Physics and Enzymes Lab	2 Credits

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, Transaminases etc.).

CCT3: Physiology of Nerve & Muscle Cells	4 Credits

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.

5. **Clinical Aspect of Nerve and Muscle Physiology**

CCP3: Physiology of Nerves and Muscle Cells Lab	**2 Credits**

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.

CCT4: Chemistry of Biomolecules	**4 Credits**

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

CCP4: Chemistry of Biomolecules Lab	**2 Credits**

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.

CCT5: Circulating Body Fluids	**4 Credits**

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

CCP5: Circulating Body Fluids Lab	**2 Credits**

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 determination.

CCT6: Circulation	**4 Credits**

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.

CCP6: Circulation Lab	**2 Credits**

Cardiovascular Experiments:
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 movement of heart.

CCT7: Functions of the Nervous System	**4 Credits**

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.
9. **Clinical Aspect of Nervous System**

CCP7: Functions of the Nervous System Lab	**2 Credits**
Neurological Experiments:	

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.

CCT8: Energy Balance, Metabolism, and Nutrition	4 Credits

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.

CCP8: Energy Balance, Metabolism, and Nutrition Lab	2 Credits

Biochemical Estimation:
Quantitative 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.

CCT9: Gastrointestinal Function	4 Credits

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, Digestive Function of the Stomach.
   Exocrine Portion of the Pancreas,
   Liver & Biliary System,
   Small Intestine,
   Colon.
3. **Gastrointestinal Dysfunctions**

CCP9: Gastrointestinal Function Lab	2 Credits

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

CCT10: Respiration	4 Credits

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.

CCP10: Respiration Lab	**2 Credits**

Respiratory Human Experiments:
Measurement of peak expiratory flow rate.
Measurement of oxygen saturation by pulse oxymeter before and after exercise.
Measurement of forced expiratory volume (FEV) in first second.

CCT11: Special Senses	**4 Credits**

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.
4. **Clinical Aspect of Special Senses**

CCP11: Special Senses Lab	**2 Credits**

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.

CCT12: Endocrinology	**4 Credits**

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.

CCP12: Endocrinology Lab	**2 Credits**

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.

CCT13: Reproductive Function	**4 Credits**

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,Placenta
Breast development and Lactation,
Physiological concepts for a planned family.

CC13P: Reproductive Function Lab	**2 Credits**

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.

CCT14: Formation and Excretion of Urine	**4 Credits**

1. **Renal Function & Micturition**
   Introduction,
   Juxta Glomerular Apparatus
   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.

CCP14: Formation and Excretion of Urine Lab	2 Credits

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

Ability Enhancement Course (ASE)(Compulsory)

1. Environmental science
2. English/MIL communication

ASET1: Environmental Science
ASET2: English/MIL Communication

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

GE T1 : Developmental Biology / Embryology	4 Credits

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.

GE P1 : Developmental Biology / Embryology Lab	2 Credits

H & E staining of ovarian tissue sections and identification of Graafian follicle, Corpus Luteum.
Demonstration of preserved mammalian embryo.

GE T2 : Instrumentation	4 Credits

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.

GE P2 : Instrumentation Lab	2 Credits

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

GE T3 : Environmental Pollution and Human Health	4 Credits

Air Pollution: definition, sources, air pollutants, effect 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- bioremediation, 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.

GE P3 : Environmental Pollution and Human Health Lab	**2 Credits**

I. Physiological (experimental) Experiments: Kymographic recording of the effects of Hg, Pb and As compounds on: the contraction of perfused heart of toad and on 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.

GE T4 : Biotechnology	**4 Credits**

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.

GE 4P: Biotechnology Lab	**2 Credits**

Measurement of concentration of CT-DNA in a solution.

GE T5 : Plant Physiology / Parasitology	**4 Credits**

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.

GE P5 : Plant Physiology / Parasitology Lab	**2 Credits**

Some experiments on plant growth. Observation on some parasitic organisms.

GE T6 : Community and Public Health	**4 Credits**

Basic idea about community health and public health issues, Malnutrition in a community, over nutrition, 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).

GE P6: Community and Public Health Lab	**2 Credits**

Qualitative assessment of noise, survey on the status of dietary intake in the surrounding area through visits, etc.

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

SEC T1:Detection of Food Additives / Adulterants	**2 Credits**

Qualitative tests for identifying Food Adulterants in some food samples: Metanil yellow, Rhodamin- B, Saccharin, Monosodium glutamate, Aluminum 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.

SEC T2:Histopathological Techniques	**2 Credits**

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.

SEC T3:Clinical Biochemistry	**2 Credits**

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.

SEC T4:Hematological Techniques	**2 Credits**

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.

SEC T5:Pathological Microbiology / Bio-Medical Technology	**2 Credits**

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.

SEC T6:Diet survey and Formulation of diet chart	**2 Credits**

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

Discipline Specific Electives (DSE)(Any Four)

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

11. Research Methodology
12. Environmental Physiology

DSET1 : Biological Statistics	**4 Credits**

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.

DSE P1 : Biological Statistics Lab	**2 Credits**

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 etc.

DSE T2 : Microbiology and Immunology	**4 Credits**

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. Hypersensitivity
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, Rabies through vaccine, AIDS- causative virus, mode of transmission, effects on human body, preventive measures, and principles of diagnostic test for AIDS (ELISA).
Immunopathology - basic principles of autoimmune disease and transplantation immunology.

DSE P2 : Microbiology and Immunology Lab	2 Credits

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

DSE T3 : Ergonomics and Occupational Physiology	4 Credits

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.

DSE P3 : Ergonomics and Occupational Physiology Lab	2 Credits

Measurement of working heart rate by ten beats methods.
Determine cardiac cost of specific work.
Measurement of blood pressure before and after different grades of exercise.
Measurement of Some common anthropometric parameters. Calculation of BSA and BMI from anthropometric data.
Measurement of WBGT indices.
Measurement of noise level by noise level meter.

DSE T4 : Sports and Exercise Physiology	4 Credits

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.

DSE P4 : Sports and Exercise Physiology Lab	2 Credits

Measurement of blood pressure before and after different grades of exercise.
Recording of recovery heart-rate after standard exercise.
Determination of Physical Fitness Index by Harvard Step Test (Modified).
Determination of VO_{2max} by queen college step test.
Measurement of body fat percentage.
Six minute walk test.
Determination of endurance time by hand grip dynamometer.
Pneumographic recording of effect of talking, laughing, coughing, breath holding and hyperventilation.

DSE T5 : Human nutrition and dietetics	4 Credits

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.

DSE P5 : Human nutrition and dietetics Lab	**2 Credits**

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

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

DSE T6: Genetics and Molecular Biology	**4 Credits**

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.

DSE P6: Genetics and Molecular Biology Lab	**2 Credits**

DNA gel electrophoresis (agarose gel).

DSE T7 : Toxicology	**4 Credits**

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.

DSE 7P : Toxicology Lab	**2 Credits**

I. Physiological (experimental) Experiments
Kymographic recording 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.

DSE T8 : Nanobiothechnology and Bioinformatics	**4 Credits**

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 tunnelling 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) – Semiconductors (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.

DSE P8 : Nanobiothechnology and Bioinformatics Lab	**2 Credits**

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

DSE T9 : Research Methodology	**4 Credits**

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 radiolabeling of biomolecules and their detection by autoradiography.
Principles of radioimmunoassay (RIA), ELISA and immunoblotting.
Ethics in research. Planning an experiment.

DSE 9P : Research Methodology Lab	**2 Credits**

Preparation of a standard curve of protein using Lowry's method.
Determination of pH optima of amylase or any other enzyme.

DSE T10 : Environmental Physiology	**4 Credits**

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- bioremediation, 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.

DSE 10P : Environmental Physiology Lab	**2 Credits**

Determination of sound levels by sound level meter and noise index.
Determination of dissolve oxygen in the supplied water samples-supplied water, ground water extracted by shallow and deep tube wells, stream waters, pond water etc.
Detection of food additives in different food samples.
Kymographic recording of the effects of food additives on the movement of perfused heart of toad and intestinal movements of rat in Dale's bath.
Biochemical estimation of serum glucose, total proteins, SGPT and SGOT in chronically exposed rats.

Recommended Text and Reference Books for Physiology (Honours)

- Best and Taylor's Physiological basis of Medical Practices, by B.K. Brobecks. The William and Wilkins Co.
- Review of Medical Physiology, by W.F. Ganong, Lange Medical Book. Pretices- Hall International. Mc Graw Hill.
- Harper's illustrated Biochemistry, by R.K. Murray and others. Lange Medical Book, International edition, Mc Graw Hill.
- Text book of Medical Physiology, by A.C. Guyton. W.B. Saunders Co.
- Lehninger's Principles of Biochemistry, by D.L. Nelson and M.M. Cox, Worth Publishers Inc.
- Text book of Biochemistry, by E.S. West; W.R.Todd; H.S. Mason; J.T Van Bruggen. The Macmillan Company.
- Biochemistry, by D Das. Academic Publishers.
- Biophysics and Biophysical Chemistry, by D.Das. Academic Publishers.
- Physiology, by R.M. Berne and M.N. Levy, C.V Mosby Co.
- Essential Immunology, by I.M. Roitt, Blackwell Scientific Publications.
- Cellular and Molecular Biology, by E.D.P. De Robertis and E.M.F. De Robertis; Lea and Febiger.
- Molecular Biology of gene, by J.D. Watson; H.N. Nancy and other; Benjamin-Cummings.
- Human Physiology, by Rhoades and Pflanger, Saunder College Publishing.
- Neurobiology, by G.M.Shepherd. Oxford University Press.
- Biochemistry, by L. Stryer, W.H. Freeman and Co.
- The Physiological Basis of Physical Education and Athletics, by W.D. McArdle, F. Katch and V.L Katch. Williams and Wilkins.
- The Text Book of Environmental Physiology, by C. Edger Folk Jr. Lea and Febiger.
- The Text Book of Work Physiology by P.O. Astrand and K. Rodhal. McGraw-Hill Books Co.
- Human factors in Engineering and Design, by E.O. McCormick and M. Sanders. Tata McGraw Hill.
- Sports Physiology, by E.L. Fox, Saunders College Publishing Holt-Saunders.
- The Physiology of Reproduction, Volumes I and II, by, E. knobil and J.D. Neil. Raven Press.
- Practice Biochemistry in Medicine, by Srinivas Rao, Academic Publishers.
- Ross and Wilson Anatomy and Physiology in Health and Illness, by A. Waugh and A. Grant. International Edition, Churchill Livigstone Elesvier.
- Human Physiology, by Stuart Ira Fox, McGraw Hill International edition.