

National Curriculum and Credit Framework (NCCF)

Syllabus

for

Major Courses in Physiology

w.e.f. Academic Session 2023-24



Kazi Nazrul University

Asansol, Paschim
Bardhaman West Bengal
713340

Basic Structural Framework of the Syllabus:

SEMESTER I:

SEMESTER	COURSE TYPE	PAPER CODE	PAPER NAME	CREDIT	MARKS
1	MAJOR- (MJC-1)	BSCPHYMJ101	CELL BIOLOGY AND BIOCHEMISTRY	05	100
1	MINOR- (MNC-1)	BSCPHYMN101	CELL BIOLOGY AND BIOCHEMISTRY	05	100
1	MD (MDC-1)	See Pool	See Pool	3	50
1	SKILL ENHANCEMENT COURSES (SEC-1)	BSCPHYSE101	HUMAN EXPERIMENT	03	50
1	Ability Enhancement (AE)	AEC-1	English/MIL Communication	04	50

MAJOR COURSE (MJC)

SEMESTER I

Course Name: CELL BIOLOGY AND BIOCHEMISTRY

Course Code: BSCPHYMJ101

Course Type: Core (Theory + Practical)	Course Details: MJC-1		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning outcomes:

- *Students will understand the structures and purposes of basic components prokaryotic and eukaryotic cells will especially macromolecules membrane and organelle student will understand how these cellular components are used to generate and utilized energy in cells.*
- *Students will understand the cellular components underline mitotic cell division. Students will apply their knowledge of cell biology to selected example of changes or loses in cell function.*
- *This can include responses to environment or physiological changes or alteration of cell function brought about by mutation and also can acquire knowledge through cell apoptosis.*
- *Understand the principles of various fields of biochemistry and genetics.*
- *Develop transferable quantities skill apply modern instrumentation theory and practice to biochemical problem.*
- *The student will be able to correlate the various metabolites of carbohydrate, protein and fat.*
- *The learning outcomes are designed to help learners understands the objectives of studying B.Sc Honours physiology.*

THEORY (MJC-1)

Paper Name (Theory): Cell Biology and Biochemistry

Unit I: Brief Overview of Physiological Systems [5 Marks]

- Brief Overview of Physiological Systems: Basics of anatomy, functional organization and physiological functions of Cardiovascular system, Respiratory system, Digestive system, Endocrine system, Nervous system, Reproductive system, Excretory system and Blood and Immune system.

Unit II: Cellular Basis of Physiology [10 Marks]

- General concept of structure and functions of animal tissues and cells: Anatomy, electron microscopic structure and functions of animal tissues, eukaryotic cells and cell organelles (Nucleus, endoplasmic reticulum, ribosomes, Golgi bodies, mitochondria) lysosomes, peroxisomes, cytoskeletal elements, centrosomes and plasma membrane.
- Cellular transport: Passive and active transport. Ion channels, ionophores. Intercellular communication: Basic idea of tight junctions, gap junctions, adherens junctions, desmosomes and cell adhesion molecules, Extracellular matrix components.

Unit III: Chemistry of Biomolecules [20 Marks]

- **Carbohydrates:** Definition and classification. Monosaccharides – Classification, structure, stereoisomerism, optical isomerism, optical activity, epimerism. Cyclic structures- Pyranose and furanose forms, anomerism, mutarotation and its mechanism. Chemical reactions of monosaccharides (Glucose & Fructose) -Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance. Derivatives of monosaccharides -Amino sugars, deoxy sugars, sugar alcohols, sugar acids, sugar esters, their biochemical and physiological importance. Disaccharides – Maltose, Lactose and Sucrose: Structure, Occurrence and Physiological importance. Polysaccharides – Starch, Glycogen, dextrin, Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids.
- **Lipids:** Definition and classification. Fatty acids - Classification, systemic nomenclature and structure. Mono-, Di- and Triglycerides. Properties of Fat and Fatty acids Hydrolysis, saponification number, Iodine number, Acetyl number, Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Steroids and sterols, Cholesterol & its ester -their structure

and physiological importance. Lipoproteins - Structure and classification. Micelle, bilayer, Liposome.

- **Proteins:** Amino acids: Classification, Structure, Nomenclature and Optical properties. Protonic equilibria of amino acids – Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde. Structure and properties of peptide bonds – Phi and Psi angles. Reactions with Sanger's and Edman's reagent. Biuret reaction. Different levels of protein structure: Primary, Secondary (α -helix and β -pleated sheet), Tertiary and Quaternary. Forces stabilizing the structures. Denaturation and Renaturation.
- **Nucleic Acids:** Purine and Pyrimidine bases: Structure, nomenclature and tautomerism. Nucleic acids: Nucleosides and Nucleotides-structure. Polynucleotides. DNA double helix, Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. RNA - Structure, types, features. Denaturation and annealing of DNA. Hyperchromicity, melting temperature and half Cot value.

PRACTICAL (MJC-1)

Paper Name (Practical): Cell Biology and Biochemistry

1. Qualitative analysis for the identification of physiologically important substances: Starch, Dextrin, Glucose, Fructose, Lactose, Maltose, Sucrose, Albumin, Gelatine, Peptone, Hydrochloric acid, Lactic Acid, Uric Acid, Urea, Acetone, Glycerol and Bile salts.

Recommended readings:

1. *Best and Taylor's Physiological basis of Medical Practices*, by B.K. Brobecks. The William and Wilkins Co.
2. *Review of Medical Physiology*, by W.F. Ganong, Lange Medical Book. Pretices- Hall International. Mc Graw Hill.
3. *Text book of Medical Physiology*, by A.C. Guyton. W.B. Saunders Co.
4. *Molecular Biology of the Gene*, by J.D.Watson; H.H.Nancy & others; Benjamin Cummings.
5. *Molecular Biology of the Cell*, by B. Alberts and others, Garland
6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. Scientific American Book.

7. *Harper's Illustrated Biochemistry*, by R. K. Murray & others. Lange Medical Book, International Edition, McGraw Hill.
8. *Lehninger's Principles of Biochemistry*. By D. L. Nelson and M.M. Cox, Worth Publishers Inc.
9. *Text Book of Biochemistry*, by E.S. West; W. R. Todd.; H. S. Mason; J. T. VanBruggen. The Macmillan Company.
10. *Biochemistry*. By D. Das. Academic Publishers.
11. *Biochemistry*, by L. Stryer, W.H. Freeman and Co. 23. *Text Book of Physiology* by G.H.Bell: J.N.Davidson and H.Scarborougl. ELBS.
12. *Practical Biochemistry in Medicine* by SrinivasRao., Academic Publishers.
13. *Note Books on Practical Biochemistry*. (Published by the Physiological Society of India, Kolkata.)

SKILL ENHANCEMENT COURSES (SEC)

SEMESTER I

Course Name: **HUMAN EXPERIMENT**

Course Code: **BSCPHYSE101**

Course Type: Core (Practical)	Course Details: SEC-1		L-T-P: 0-0-6		
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	...	20	...

Learning outcomes:

- *At the end of this course, students will be provided with useful information about the health and well-being*
- *This course will help them to evaluate the impact and effectiveness of public health interventions, policies, and programs on human populations and communities.*
- *Knowing the exact principles and procedures of measurement of physical fitness, BMI, BSA, body fat, etc. will help them in the understanding of injury management and disease prevention.*

PRACTICAL (SEC-1)

Paper Name (Practical): Human Experiment

Unit I: Determination of BMI, BSA, PI, CI, waist-hip ratio, MUAC, body fat percentage. Determination of physical fitness by Harvard and modified Harvard Step Tests, Measurement of systolic and diastolic arterial blood pressure by sphygmomanometer and determination of pulse and mean pressure. Determination of heart rate by palpation.

Recommended readings:

1. *Physiology, by R.M. Berne and M.N. Levy, C.V Mosby Co.*
2. *The Physiological Basis of Physical Education and Athletics, by W.D. McArdle, F. Katch and V.L Katch. Williams and Wilkins.*

3. *The Text Book of Work Physiology* by P.O. Astrand and K. Rodhal. McGraw-Hill Books Co.
4. *Human factors in Engineering and Design*, by E.O. McCormick and M. Sanders. Tata McGraw Hill.
5. *Sports Physiology*, by E.L. Fox, Saunders College Publishing Holt-Saunders.
6. *Ross and Wilson Anatomy and Physiology in Health and Illness*, by A. Waugh and A. Grant. International Edition, Churchill Livigstone Elesvier.
7. *Ergonomics in Sport and Physical Activity, Enhancing performance and improving safety* by Thomas Reilly, Publisher:- Human Kinetics.
8. *Exercise Physiology and Ergonomics* by Asis Goswami, Academic Publishers.

MINOR COURSE (MNC)

SEMESTER I

Course Name: CELL BIOLOGY AND BIOCHEMISTRY

Course Code: BSCPHYMN101

Course Type: Core (Theory + Practical)	Course Details: MJC-1		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning outcomes:

- *Students will understand the structures and purposes of basic components prokaryotic and eukaryotic cells will especially macromolecules membrane and organelle student will understand how these cellular components are used to generate and utilized energy in cells.*
- *Students will understand the cellular components underline mitotic cell division. Students will apply their knowledge of cell biology to selected example of changes or loses in cell function.*
- *This can include responses to environment or physiological changes or alteration of cell function brought about by mutation and also can acquire knowledge through cell apoptosis.*
- *Understand the principles of various fields of biochemistry and genetics.*
- *Develop transferable quantities skill apply modern instrumentation theory and practice to biochemical problem.*
- *The student will be able to correlate the various metabolites of carbohydrate, protein and fat.*
- *The learning outcomes are designed to help learners understands the objectives of studying B.Sc Honours physiology.*

THEORY (MNC-1)

Paper Name (Theory): Cell Biology and Biochemistry

Unit I: Brief Overview of Physiological Systems [5 Marks]

- Brief Overview of Physiological Systems: Basics of anatomy, functional organization and physiological functions of Cardiovascular system, Respiratory system, Digestive system, Endocrine system, Nervous system, Reproductive system, Excretory system and Blood and Immune system.

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- General concept of structure and functions of animal tissues and cells: Anatomy, electron microscopic structure and functions of animal tissues, eukaryotic cells and cell organelles (Nucleus, endoplasmic reticulum, ribosomes, Golgi bodies, mitochondria) lysosomes, peroxisomes, cytoskeletal elements, centrosomes and plasma membrane.
- Cellular transport: Passive and active transport. Ion channels, ionophores. Intercellular communication: Basic idea of tight junctions, gap junctions, adherens junctions, desmosomes and cell adhesion molecules, Extracellular matrix components.

Unit III: Chemistry of Biomolecules [20 Marks]

- **Carbohydrates:** Definition and classification. Monosaccharides – Classification, structure, stereoisomerism, optical isomerism, optical activity, epimerism. Cyclic structures- Pyranose and furanose forms, anomerism, mutarotation and its mechanism. Chemical reactions of monosaccharides (Glucose & Fructose) -Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance. Derivatives of monosaccharides -Amino sugars, deoxy sugars, sugar alcohols, sugar acids, sugar esters, their biochemical and physiological importance. Disaccharides – Maltose, Lactose and Sucrose: Structure, Occurrence and Physiological importance. Polysaccharides – Starch, Glycogen, dextrin, Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids.
- **Lipids:** Definition and classification. Fatty acids - Classification, systemic nomenclature and structure. Mono-, Di- and Triglycerides. Properties of Fat and Fatty acids Hydrolysis, saponification number, Iodine number, Acetyl number, Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Steroids and sterols, Cholesterol & its ester -their structure

and physiological importance. Lipoproteins - Structure and classification. Micelle, bilayer, Liposome.

- **Proteins:** Amino acids: Classification, Structure, Nomenclature and Optical properties. Protonic equilibria of amino acids – Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde. Structure and properties of peptide bonds – Phi and Psi angles. Reactions with Sanger's and Edman's reagent. Biuret reaction. Different levels of protein structure: Primary, Secondary (α -helix and β -pleated sheet), Tertiary and Quaternary. Forces stabilizing the structures. Denaturation and Renaturation.
- **Nucleic Acids:** Purine and Pyrimidine bases: Structure, nomenclature and tautomerism. Nucleic acids: Nucleosides and Nucleotides-structure. Polynucleotides. DNA double helix, Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. RNA - Structure, types, features. Denaturation and annealing of DNA. Hyperchromicity, melting temperature and half Cot value.

PRACTICAL (MNC-1)

Paper Name (Practical): Cell Biology and Biochemistry

1. Qualitative analysis for the identification of physiologically important substances: Starch, Dextrin, Glucose, Fructose, Lactose, Maltose, Sucrose, Albumin, Gelatine, Peptone, Hydrochloric acid, Lactic Acid, Uric Acid, Urea, Acetone, Glycerol and Bile salts.

Recommended readings:

1. *Best and Taylor's Physiological basis of Medical Practices*, by B.K. Brobecks. The William and Wilkins Co.
2. *Review of Medical Physiology*, by W.F. Ganong, Lange Medical Book. Pretices- Hall International. Mc Graw Hill.
3. *Text book of Medical Physiology*, by A.C. Guyton. W.B. Saunders Co.
4. *Molecular Biology of the Gene*, by J.D.Watson; H.H.Nancy & others; Benjamin Cummings.
5. *Molecular Biology of the Cell*, by B. Alberts and others, Garland
6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. Scientific American Book.

7. *Harper's Illustrated Biochemistry*, by R. K. Murray & others. Lange Medical Book, International Edition, McGraw Hill.
8. *Lehninger's Principles of Biochemistry*. By D. L. Nelson and M.M. Cox, Worth Publishers Inc.
9. *Text Book of Biochemistry*, by E.S. West; W. R. Todd.; H. S. Mason; J. T. VanBruggen. The Macmillan Company.
10. *Biochemistry*. By D. Das. Academic Publishers.
11. *Biochemistry*, by L. Stryer, W.H. Freeman and Co. 23. *Text Book of Physiology* by G.H.Bell: J.N.Davidson and H.Scarborougl. ELBS.
12. *Practical Biochemistry in Medicine* by SrinivasRao., Academic Publishers.
13. *Note Books on Practical Biochemistry*. (Published by the Physiological Society of India, Kolkata.)

Basic Structural Framework of the Syllabus:

SEMESTER II:

SEMESTER	COURSE TYPE	PAPER CODE	PAPER NAME	CREDIT	MARKS
2	MAJOR-(MJC-2)	BSCPHYMJ201	CELL SIGNALLING, ENZYMES AND BIOPHYSICS	05	100
2	MINOR-(MNC-2)	BSCPHYMN201	CELL SIGNALLING, ENZYMES AND BIOPHYSICS	05	100
2	MD (MDC-2)	See Pool	See Pool	03	50
2	VA	(VAC-1)	Environmental Studies	04	50
2	SKILL ENHANCEMENT COURSES (SEC-2)	BSCPHYSE201	APPLIED WORK AND EXERCISE PHYSIOLOGY	03	50

MAJOR COUSES (MJC-2)

SEMESTER II

Course Name: **CELL SIGNALLING, ENZYMES AND BIOPHYSICS**

Course Code: **BSCPHYMJ201**

Course Type: Core (Theory + Practical)	Course Details: CC-2		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning outcomes:

- *Students will be able to understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location, give examples of different types of extracellular signals and receptors, and explain their functional significance, describe the mechanisms by which different receptors may be activated by their respective ligands, describe and give examples of the structure and properties of the major components of signal transduction pathways.*
- *Enzymes are bio-catalyst which are highly specific and help to accelerate reactions taking place in organisms. After interacting with this the students will be able to:*
 - Describe enzymes and their components*
 - Recall energetic enzymatic reactions*
 - List out models for enzyme substrate binding*
 - The students will acquire knowledge of kinetics of enzymatic reaction and enzyme inhibition.*
- *The student will be able to demonstrate a thorough comprehension of core concept of bio physics including osmosis, diffusion, plasmolysis, Donnan membrane equilibrium. Therefore, the behaviors of biological systems can be predicted from physical principle.*

THEORY (MJC-2)

Paper Name (Theory): Cell Signalling, Enzymes and Biophysics

Unit I: Cell signalling [10 Marks]

- **Cell signalling:** Definition, Types (Autocrine, Endocrine, Paracrine and signalling by direct contact), Stages of cell signalling (Reception, Transduction and Response), Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme-coupled. Intracellular messengers – cAMP, cGMP, IP₃, DAG, Protein kinases, Ca²⁺, CO, NO.
- **Signal transduction pathways:** Phosphatidyl inositides, MAP kinase, JAK-STAT, Raf-Ras, SMAD.

Unit II: Enzyme [15 Marks]

- Definition, Chemical nature of enzymes, comparison between enzymes and inorganic catalyst, Classification, EC. Nomenclature, Concept of apoenzyme, holoenzyme, coenzyme, cofactors, and prosthetic group. Metals in enzyme activity, Enzyme - Substrate complex, Active site, Binding site.
- Models for Enzyme – Substrate interactions (Fischer's template of Lock and Key model and Koshland's induced fit model), Enzyme specificity, Concept of initial rate, maximum velocity and steady-state kinetics. Michaelis-Menten constant (K_m), Derivation of Michaelis-Menten equation, Graphical representation of hyperbolic kinetics, Linear transformation of Michaelis-Menten equation: Lineweaver-Burk double reciprocal plot, *Eadie-Hofstee plot*, *Wolf-Hanes plot*, Significance of K_m and V_{max}.
- Factors influencing enzyme-catalyzed reactions: substrate concentration, enzyme concentration, pH, temperature. Competitive, noncompetitive, and uncompetitive inhibitions. Regulation of enzyme activities — Irreversible covalent activation, Reversible covalent modifications, Allosteric modulation, Sigmoid Kinetics and Hill equation, K and M series of enzymes. Feedback inhibition. Rate-limiting enzymes and its features, multi-enzymes, Isozymes, Ribozymes and Abzymes.

Unit III: Biophysics and Biophysical Principle [10 Marks]

- Diffusion: Its characteristics, factors influencing and physiological applications. Osmosis: Osmotic pressure – laws, determination – freezing point depression method and physiological applications.
- Surface tension & viscosity: Physiological applications. pH & Buffer, Henderson Hasselbach – equation (quantitative problems). Determination of pH.
- Colloids: Classification, properties (optical, electrical, electrokinetic), Physiological importance of colloids. Definition and physiological importance of Dialysis, adsorption, Gibbs-Donnan membrane equilibrium, endocytosis.
- Thermodynamics: Type of surroundings and systems. First Law– Internal energy, enthalpy. Second Law – Entropy, Free energy change, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system.

PRACTICAL (MJC-2)

Paper Name (Practical): Cell Signalling, Enzymes and Biophysics

- 1. Study and identification of stained section of different mammalian tissues and organs:** Parotid gland, Submaxillary gland, Sublingual gland, Tongue, Oesophagus, Stomach, Duodenum, Jejunum, Ileum, Large intestine, Liver, Kidney, Ureter, Pancreas, Spleen, Lymph gland, Lung, Trachea, Thyroid gland, Adrenal gland, Ureter, Kidney, Skin, Ovary, Testis, Uterus, Spinal Cord, Cerebellum, Cerebrum, Cardiac muscle, Skeletal Muscle, Smooth muscle, Artery, Vein, Bone, Cartilage.
- 2. Permanent Slide Preparation and Staining**
- 3. Study of charts on Cell signalling**
- 4. Demonstration: Preparation of Buffer and pH measurement.**

Recommended readings:

- 1. Biomedical Instrumentation & Measurements, by L. Cromwell, F. J. Weibell & E. A. Pfeiffer; Prentice-Hall of India Pvt Ltd.*
- 2. Biophysics and Biophysical Chemistry, by D. Das. Academic Publishers*
- 3. Molecular Biology of the Gene, by J. D. Watson; H. H. Nancy & others; Benjamin-Cummings.*
- 4. Molecular Biology of the Cell, by B. Alberts and others, Garland.*
- 5. Neurobiology, by G.M. Shepherd. Oxford University Press*

6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. *Scientific American Book*.
7. Mescher A.L. (2013). *Junqueira's Basic Histology Text and Atlas. Thirteenth Edition. The Tata McGraw Hill Companies*.
8. Ross M.H and Reith, E.J. (2011). *Histology - A Text and Atlas. Sixth Edition. The Williams and Wilkins Company*.
9. *Bailey's Text Book of Histology*, revised by W.M. Copenhaver; *The Williams and Wilkins Company*.
10. Eroschenko V.P. (2012). *Difiore's Atlas of Histology: With Functional Correlations. Twelfth Edition. Lippincott Williams Wilkins Company*.

MINOR COURSE (MNC-2)

SEMESTER II

Course Name: **CELL SIGNALLING, ENZYMES AND BIOPHYSICS**

Course Code: **BSCPHYMN201**

Course Type: Core (Theory + Practical)	Course Details: CC-2		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning outcomes:

- *Students will be able to understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location, give examples of different types of extracellular signals and receptors, and explain their functional significance, describe the mechanisms by which different receptors may be activated by their respective ligands, describe and give examples of the structure and properties of the major components of signal transduction pathways.*
- *Enzymes are bio-catalyst which are highly specific and help to accelerate reactions taking place in organisms. After interacting with this the students will be able to:*
 - e. Describe enzymes and their components*
 - f. Recall energetic enzymatic reactions*
 - g. List out models for enzyme substrate binding*
 - h. The students will acquire knowledge of kinetics of enzymatic reaction and enzyme inhibition.*
- *The student will be able to demonstrate a thorough comprehension of core concept of bio physics including osmosis, diffusion, plasmolysis, Donnan membrane equilibrium. Therefore, the behaviors of biological systems can be predicted from physical principle.*

THEORY (MNC-2)

Paper Name (Theory): Cell Signalling, Enzymes and Biophysics

Unit I: Cell Signalling [10 Marks]

- **Cell signalling:** Definition, Types (Autocrine, Endocrine, Paracrine and signalling by direct contact), Stages of cell signalling (Reception, Transduction and Response), Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme-coupled. Intracellular messengers – cAMP, cGMP, IP₃, DAG, Protein kinases, Ca²⁺, CO, NO.
- **Signal transduction pathways:** Phosphatidylinositides, MAP kinase, JAK-STAT, Raf-Ras, SMAD.

Unit II: Enzyme [15 Marks]

- Definition, Chemical nature of enzymes, comparison between enzymes and inorganic catalyst, Classification, EC. Nomenclature, Concept of apoenzyme, holoenzyme, coenzyme, cofactors, and prosthetic group. Metals in enzyme activity, Enzyme - Substrate complex, Active site, Binding site.
- Models for Enzyme – Substrate interactions (Fischer's template of Lock and Key model and Koshland's induced fit model), Enzyme specificity, Concept of initial rate, maximum velocity and steady-state kinetics. Michaelis-Menten constant (K_m), Derivation of Michaelis-Menten equation, Graphical representation of hyperbolic kinetics, Linear transformation of Michaelis-Menten equation: Lineweaver-Burk double reciprocal plot, *Eadie-Hofstee plot*, *Wolf-Hanes plot*, Significance of K_m and V_{max} .
- Factors influencing enzyme-catalyzed reactions: substrate concentration, enzyme concentration, pH, temperature. Competitive, noncompetitive, and uncompetitive inhibitions. Regulation of enzyme activities — Irreversible covalent activation, Reversible covalent modifications, Allosteric modulation, Sigmoid Kinetics and Hill equation, K and M series of enzymes. Feedback inhibition. Rate-limiting enzymes and its features, multi-enzymes, Isozymes, Ribozymes and Abzymes.

Unit III: Biophysics and Biophysical Principle [10 Marks]

- Diffusion: Its characteristics, factors influencing and physiological applications. Osmosis: Osmotic pressure – laws, determination – freezing point depression method and physiological applications.
- Surface tension & viscosity: Physiological applications. pH & Buffer, Henderson Hasselbach – equation (quantitative problems). Determination of pH.
- Colloids: Classification, properties (optical, electrical, electrokinetic), Physiological importance of colloids. Definition and physiological importance of Dialysis, adsorption, Gibbs-Donnan membrane equilibrium, endocytosis.
- Thermodynamics: Type of surroundings and systems. First Law– Internal energy, enthalpy. Second Law – Entropy, Free energy change, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system.

PRACTICAL (MNC-2)

Paper Name (Practical): Cell Signalling, Enzymes and Biophysics

- 1. Study and identification of stained section of different mammalian tissues and organs:** Parotid gland, Submaxillary gland, Sublingual gland, Tongue, Oesophagus, Stomach, Duodenum, Jejunum, Ileum, Large intestine, Liver, Kidney, Ureter, Pancreas, Spleen, Lymph gland, Lung, Trachea, Thyroid gland, Adrenal gland, Ureter, Kidney, Skin, Ovary, Testis, Uterus, Spinal Cord, Cerebellum, Cerebrum, Cardiac muscle, Skeletal Muscle, Smooth muscle, Artery, Vein, Bone, Cartilage.
- 2. Permanent Slide Preparation and Staining**
- 3. Study of charts on Cell signalling**
- 4. Demonstration: Preparation of Buffer and pH measurement.**

Recommended readings:

- 1. Biomedical Instrumentation & Measurements, by L. Cromwell, F. J. Weibell & E. A. Pfeiffer; Prentice-Hall of India Pvt Ltd.*
- 2. Biophysics and Biophysical Chemistry, by D. Das. Academic Publishers*
- 3. Molecular Biology of the Gene, by J. D. Watson; H. H. Nancy & others; Benjamin-Cummings.*
- 4. Molecular Biology of the Cell, by B. Alberts and others, Garland.*
- 5. Neurobiology, by G.M. Shepherd. Oxford University Press*

6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. *Scientific American Book*.
7. Mescher A.L. (2013). *Junqueira's Basic Histology Text and Atlas. Thirteenth Edition. The Tata McGraw Hill Companies*.
8. Ross M.H and Reith, E.J. (2011). *Histology - A Text and Atlas. Sixth Edition. The Williams and Wilkins Company*.
9. *Bailey's Text Book of Histology*, revised by W.M. Copenhaver; *The Williams and Wilkins Company*.
10. Eroschenko V.P. (2012). *Difiore's Atlas of Histology: With Functional Correlations. Twelfth Edition. Lippincott Williams Wilkins Company*.

SKILL ENHANCEMENT COURSES (SEC)

SEMESTER II

Course Name: **APPLIED WORK AND EXERCISE PHYSIOLOGY**

Course Code: **BSCPHYSE201**

Course Type: Core (Practical)	Course Details: SEC-2		L-T-P: 3-0-0		
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		---	15	---	35

Learning outcomes:

- *This course will provide a wide knowledge about structural and functional organization of different body systems.*
- *The students will have gain detailed knowledge about the principles of exercise and training.*
- *They acquire a concept about the importance of physical activity, exercise, yoga and meditation on health.*
- *From this course students will gather the knowledge about the muscle physiology and their involvement in different types of exercise.*
- *The course would fortify to the students to acquire the knowledge about injury management.*

THEORY (SEC-2)

Paper Name (Theory): Applied Work and Exercise Physiology

Unit I: Definitions of work and exercise Physiology, Fundamental concepts of work, different categories of work. Physical work—its definition and nature—isotonic, isometric and isokinetic, positive and negative work.

Physiological basis of work: Concept of physiological work. Power and capacity relation. Workload light, moderate (submaximal) and heavy (maximal) depending on intensity and duration of work. Changes in heart rate, oxygen consumption and blood pressure to assess

person's ability to withstand work load. Effect of heat stress on physiological responses to work load, Aerobic and anaerobic capacity, EPOC, OBLA, lactate threshold and lactate tolerance and their usefulness. Athletic performance based on aerobic and anaerobic capacity. Brief general idea about nutritional aspects of sports.

Recommended readings:

1. *Physiology*, by R.M. Berne and M.N. Levy, C.V Mosby Co.
2. *The Physiological Basis of Physical Education and Athletics*, by W.D. McArdle, F. Katch and V.L Katch. Williams and Wilkins.
3. *The Text Book of Work Physiology* by P.O. Astrand and K. Rodhal. McGraw-Hill Books Co.
4. *Human factors in Engineering and Design*, by E.O. McCormick and M. Sanders. Tata McGraw Hill.
5. *Sports Physiology*, by E.L. Fox, Saunders College Publishing Holt-Saunders.
6. *Ross and Wilson Anatomy and Physiology in Health and Illness*, by A. Waugh and A. Grant. International Edition, Churchill Livigstone Elesvier.
7. *Ergonomics in Sport and Physical Activity, Enhancing performance and improving safety* by Thomas Reilly, Publisher:- Human Kinetics.
8. *Exercise Physiology and Ergonomics* by Asis Goswami, Academic Publishers.

Basic Structural Framework of the Syllabus:

SEMESTER III:

SEMESTER	COURSE TYPE	PAPER CODE	PAPER NAME	CREDIT	MARKS
III	MAJOR- MJC-3	BSCPHYMJ301	Haematology and Cardiovascular System	5	100
III	MAJOR- MJC-4	BSCPHYMJ302	Respiration and Circulation	5	100
III	MINOR- MNC-3	BSCPHYMN301	Haematology and Cardiovascular System	5	100
III	MD-MDC-3	BSCPHYMD301	Multidisciplinary Courses offered in 3rd Semester across the faculties	3	50
III	AEC-2	AEC-2	English Communication	4	50

MAJOR COURSES (MJC)

SEMESTER III

Course Name: Haematology and Cardiovascular System

Course Code: **BSCPHYMJ301**

Course Type: Core (Theory + Practical)	Course Details: MJC-3		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning outcomes:

- *Describe the various constituents of blood, haematopoiesis, function and maturation of red cells, white cells and platelets, blood types, transfusion, tissue, and organ transplantation.*
- *Describe endothelial function, blood coagulation and discuss the most common abnormalities and complications relating to endothelial dysfunction and failure of haemostasis.*
- *Discuss the general characteristics of leukocytes (neutrophils and macrophages) and their roles in defending the host against infection, including the monocyte-macrophage system and inflammation*
- *Explain the relationship between the structure and function of the arteries, veins and capillaries.*
- *Identify and describe the interior and exterior parts of the human heart*
- *Describe the path of blood through the cardiac circuits*
- *Describe the size, shape, and location of the heart*
- *Compare cardiac muscle to skeletal and smooth muscle*
- *Explain the cardiac conduction system*
- *Describe the process and purpose of an electrocardiogram*
- *Explain the cardiac cycle*
- *Calculate cardiac output*
- *Describe the effects of exercise on cardiac output and heart rate*
- *Name the centres of the brain that control heart rate and describe their function*

- *Identify other factors affecting heart rate*
- *Explain and classify common cardiovascular conditions.*
- *Analyse factors leading to hypertension, as well as approaches useful in preventing and treating the condition*

THEORY (MJC-3)

Paper Name (Theory): Haematology and Cardiovascular System

Unit 1: Blood [15 Marks]

- 1.1. Blood- properties & composition
- 1.2. Plasma proteins-Classification, Values & Functions, Plasmapheresis
- 1.3. Bone Marrow-Classification & Functions
- 1.4. White Blood Cells-types, characters, shape & size, Functions
- 1.5. Immune activities of blood Platelets
- 1.6. Red Blood Cells-Biosynthesis & Factors affecting it
- 1.7. Haemoglobin – Structure, compounds and derivatives, biosynthesis, and catabolism.
Foetal haemoglobin, Embryonic haemoglobin.
- 1.8. Haemoglobinopathies- Thalassemia, Sickle-cell anaemia. Anaemia-different types and their causes
- 1.9. Blood volume –regulation and determination by dye and radioisotope methods
- 1.10. Haemostasis–factors, mechanism, anti-clotting mechanism, anticoagulants, procoagulants. Disorders of haemostasis-Haemophilia, Thrombosis and Embolism
- 1.11. Blood grouping – ABO and Rh systems, H- antigen. Erythroblastosis fetalis and Rh antigens. Bombay type blood group
- 1.12. Blood transfusion and its hazards. Red cell fragility
- 1.13. TC, DC, ESR, MCH, MCHC, PCV, Leukaemia, Leucocytosis, Leukopenia, Purpura, Arneeth count
- 1.14. Blood Volume- Values, physiological variations, measurements, and regulations
- 1.15. Spleen- Structure & function
- 1.16. Lymph-Lymphatic system, Source, Composition, circulation, and functions. Edema.

Unit 2: Cardiovascular System – I (Anatomy and Electrical Activity of the Heart) [10 Marks]

- 2.1 Histology of Heart- Nodal tissues, ventricles, and valves.
- 2.2 Properties of cardiac muscle.
- 2.3 Origin and propagation of cardiac impulse-action potential in nodal and ventricular muscles.
- 2.4 The cardiac cycle- events, pressure, and volume changes. Heart sounds. Murmurs. Cardiac output – measurement by application of Fick’s principle and dye dilution method, factors affecting. Starling’s law of heart.

- 2.5 Electrocardiography – the normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vector cardiogram, the mean electrical axis of heart. The His bundle electrogram.
- 2.6 Principles of Echocardiography. Cardiac Arrhythmias. Myocardial Infarction.

Unit 3: Cardiovascular System – II (Regulation of Cardiovascular functions) [10 Marks]

- 3.1 Functional morphology of arteries, arterioles, capillaries, venules and veins, sinusoids.
- 3.2 General pattern of circulation and significance of branching of blood vessels. The pulse – arterial and venous.
- 3.3 Haemodynamic of blood flow.
- 3.4 Blood pressure– its measurement and factors affecting.
- 3.5 Cardiovascular homeostasis – neural and chemical control of cardiac functions and blood vessels.
- 3.6 Cardiac and vasomotor centres, baroreceptors and chemoreceptors, innervation of the heart and blood vessels, cardiac and vasomotor reflexes.
- 3.7 Cardiovascular adjustment after haemorrhage.

PRACTICAL (MJC-3)

Paper Name (Practical): Haematology and Cardiovascular System

- 1.1 Haematological experiments: Preparation and staining of blood film with Leishman's stain.
- 1.2 Identification of blood corpuscles.
- 1.3 Differential count of WBC.
- 1.4 Total count of RBC and WBC.
- 1.5 Haemoglobin estimation by Shali's hemoglobinometer method.
- 1.6 Preparation of haemin crystals.
- 1.7 Preparation and staining of bone marrow smear.
- 1.8 Measurement of diameter of megakaryocyte.
- 1.9 Reticulocyte staining.
- 1.10 Blood group determination.
- 1.11 Demonstration: Haematocrit, MCV, MCH and MCHC. Bleeding time, Clotting time, ESR.
- 1.12 Effect of adrenaline, acetyl choline, temperature, load on cardiac muscle contraction of toad heart
- 1.13 Measurement of electrical activity of heart by ECG
- 1.14 Measurement of blood pressure.

Recommended readings:

1. *Best and Taylor's Physiological basis of Medical Practices*, by B.K. Brobecks. The William and Wilkins Co.
2. *Review of Medical Physiology*, by W.F. Ganong, Lange Medical Book. Prentices- Hall International. Mc Graw Hill.
3. *Text book of Medical Physiology*, by A.C. Guyton. W.B. Saunders Co.
4. *Molecular Biology of the Gene*, by J.D.Watson; H. H. Nancy & others; Benjamin Cummings.
5. *Molecular Biology of the Cell*, by B. Alberts and others, Garland
6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. Scientific American Book.
7. *Harper's Illustrated Biochemistry*, by R. K. Murray & others. Lange Medical Book, International Edition, McGraw Hill.
8. *Lehninger's Principles of Biochemistry*. By D. L. Nelson and M.M. Cox, Worth Publishers Inc.
9. *Text Book of Biochemistry*, by E.S. West; W. R. Todd.; H. S. Mason; J. T. VanBruggen. The Macmillan Company.
10. *Biochemistry*. By D. Das. Academic Publishers.
11. *Biochemistry*, by L. Stryer, W.H. Freeman and Co. 23. *Text Book of Physiology* by G.H.Bell: J.N.Davidson and H. Scarborough. ELBS.
12. *Practical Biochemistry in Medicine* by Srinivas Rao., Academic Publishers.
13. *Note Books on Practical Biochemistry*. (Published by the Physiological Society of India, Kolkata.)

MAJOR COURSES (MJC)

SEMESTER III

Course Name: **Respiration and Circulation**

Course Code: **BSCPHYMJ302**

Course Type: Core (Theory + Practical)	Course Details: MJC-3		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning Outcomes:

After the completion of course, the students will have ability to:

- *Describe and illustrate the main anatomical structures of the respiratory system and the mechanics of inspiration and expiration*
- *List the major functions of the respiratory system*
- *Outline the forces that allow for air movement into and out of the lungs*
- *Outline the process of gas exchange*
- *Discuss the factors that affect pulmonary ventilation*
- *Outline the mechanisms of O₂ and CO₂ transport in the blood*
- *Describe diseases resulting from mutations in haemoglobin*
- *Demonstrate an understanding of the control of the respiration rate.*
- *Create a flowchart illustrating how respiration is controlled*
- *Discuss how the respiratory system responds to exercise*
- *Explain the importance of water in the body*
- *Contrast the composition of the intracellular fluid with that of the extracellular fluid*
- *Explain the importance of protein channels in the movement of solutes*
- *Identify the causes and symptoms of edema*
- *Explain how water and solutes traverse the capillary wall. Use Fick's equation for diffusion to identify the factors that will affect the diffusion mediated delivery of nutrients from the capillaries to the tissues. Define and give examples of diffusion-limited and flow-limited exchange.*

- Describe the phasic flow of blood to the ventricular myocardium through an entire cardiac cycle.
- Contrast the local and neural control of cerebral blood flow. Discuss the relative importance of O₂, CO₂, and pH in regulating cerebral blood flow.
- Describe the structural components of the blood brain barrier and how this barrier impedes the movement of gases, proteins, and lipids from the blood to neurons. Identify the differences in cerebrospinal fluid and plasma relative to protein concentration, and describe the function of cerebrospinal fluid.
- Contrast the local and neural control of the splanchnic circulation. Describe the role of the hepatic portal system and the hepatic artery in providing flow and oxygen to the liver. CV 122: Describe the blood pressure in the hepatic portal vein, hepatic sinusoids, and the vena cava.
- Contrast local and neural control of cutaneous blood flow.
- Discuss the unique characteristics of skin blood flow that are adaptive for body temperature regulation.

THEORY (MJC-4)

Paper Name (Theory): Respiration and Circulation

Unit 1: Respiratory System [20 Marks]

- 1.1 Anatomy and histology of the lung and airways
- 1.2 Non-respiratory functions of lung
- 1.3 Pulmonary ventilation- Spirometer, Douglas bag
- 1.4 The ventilation boundaries of the Lung- TV, IRV, ERV, RV, FRC, IC, TLC, VC, MVV etc.
- 1.5 Dead Space, Ventilation- perfusion ratio and alveolar ventilation
- 1.6 Pulmonary Gas Exchange- Oxygen transport, blood-Oxygen dissociation curve of haemoglobin and myoglobin – factors affecting it, Carbon dioxide transport, Carbon dioxide dissociation curve.
- 1.7 Haldane Effect, Bohr Effect, Chloride shift
- 1.8 Mechanics of breathing -- Role of respiratory muscles, glottis. Lung volumes and capacities.
- 1.9 Compliance of lungs and chest wall, pressure-volume relationship, alveolar surface tension and surfactant, work of breathing.
- 1.10 Regulation of respiration -- neural and chemical, respiratory centres, chemoreceptors, baroreceptors, pulmonary receptors.
- 1.11 Hypoxia – types, effects. Asphyxia, Voluntary hyperpnoea, Apnoea, Cyanosis, Periodic breathing, Asthma, Emphysema.
- 1.12 Lung function tests. Artificial respiration. Concept of non-respiratory functions of lung.

Unit 2: Regional Circulation [15 Marks]

- 2.1 Microcirculation- Anatomy and regulation of blood flow through micro circulation
- 2.2 Vasoactive chemicals, Oedema
- 2.3 Cerebral Circulation- Anatomy, Mechanisms, Peculiarities and Regulation
- 2.4 Coronary Circulation- Anatomy, Mechanisms, Peculiarities and Regulation
- 2.5 Cutaneous Circulation and Circulation through Skeletal Muscle
- 2.6 Placental and Foetal Circulation

PRACTICAL (MJC-4)

Paper Name (Practical): Respiration and Circulation

- 1.1 Pneumographic recording of effects of talking, drinking, laughing, coughing, exercise, hyperventilation, and breath-holding
- 1.2 Body Surface Area and Spirometric measurement of VC, TV, IRV, ERV, FEV₁ etc.
- 1.3 Measurement of changes in respiratory rate during pre- and post-exercise
- 1.4 Effect of graded exercise on respiratory rate
- 1.5 Measurement of oxygen saturation by pulse oximeter before and after exercise
- 1.6 Determination of Physical Fitness Index by Harvard Step Test (Modified).

References/ Suggested Readings

1. Barman, S (23rd Edition): *Ganong's Review of Medical Physiology*, McGraw Hill Lange.
2. Guyton and Hall (11th Edition): *Textbook of Medical Physiology*, Elsevier Saunders.
3. *Human Physiology*, by R.F. Schmidt & G. Thews, Springer-Verlag.
4. *Physiology of Respiration* by J.H. Comroe. Year Book Medical Publishers.
5. *Best and Taylor's Physiological basis of Medical Practices*, by B.K. Brobecks. The William and Wilkins Co.
6. *Review of Medical Physiology*, by W.F. Ganong, Lange Medical Book. Prentices- Hall International. Mc Graw Hill.
7. *Text book of Medical Physiology*, by A.C. Guyton. W.B. Saunders Co.

MAJOR COURSES (MJC)

SEMESTER III

Course Name: **Community Health Care**

Course Code: **BSCPHYMD301**

Course Type: Core (Theory)	Course Details: MDC-3		L-T-P: 2-1-0		
Credit: 3	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		35

Learning Outcomes:

- *After the completion of course, the students will have ability to:*
- *Understand and appreciate the diverse socioeconomic, behavioural, sociocultural, biological, environmental, philosophical, and historical factors that influence health, rehabilitation, and human movement*
- *Comprehend the significant theories, models, themes, and ideas in the biomechanical, physiological, behavioural, pedagogical, biological, socioeconomic, environmental, and sociocultural correlations of Kinesiology and Community Health.*
- *Comprehend and demonstrate ethical practices and the application of scientific findings and/or critical analysis in order to interpret new ideas related to health, rehabilitation, and/or human movement.*
- *Apply best practices in developing, implementing, assessing, and evaluating programs and interventions related to health promotion, physical activity adoption and adherence, and the prevention and treatment of diseases.*

THEORY (MDC-3)

Paper Name (Theory): Community Health Care

- 1.1 Community health and Nutrition** - Definition & concept of health and diseases, dimension of health, health system, Diseases: causation and prevention of diseases, mode of intervention, epidemic and endemic forms of diseases, physiologists as health-counsellors.
- 1.2 Nutrition in infancy:** Nutritional requirements of nutrients during infancy. Breast feeding – nutritional and other factors, advantages, problems in breast feeding, infant milk substitute (IMS) act 1992. Formula feeding, Vitamin and mineral supplementation – vit –D, Iron, Fluoride, Supplementary foods of milk, cow's milk,

goat's milk, vegetarian beverages, fruit juice. Nursing caves; solid supplements wearing, Nutritional requirement of pre-term babies; Feeding problems – food allergies, cow's milk protein allergy, lactose intolerance, diarrhoea, constipations, vegetarianism

- 1.3 Nutrition in childhood and adolescence:** Nutritional requirement of pre-school and school children, monitoring growth and development. Nutrition related problems of children- childhood obesity, dental caries, allergies, deficiency of Vitamin A- Etiology, symptoms, prevention. Nutritional requirement and problem of adolescents- Anorexia nervosa, Bulbna nervosa, Binge eating disorder, premenstrual syndrome.
- 1.4 Nutrition in pregnancy:** maternal factors effecting pregnancy outcome: maternal age, pre-pregnant weight, weight gain during pregnancy, life style factors. Birth weight standards, Low birth weight baby. Nutritional requirements during pregnancy. Problems in pregnancy- morning sickness, nausea and vomiting, constipation, edema and leg-cramps, Heart burn, excessive weight gain. Complication- anaemia, toxemia, Diabetes mellitus
- 1.5 Nutrition in lactating women:** Nutritional requirements, Factors affecting the volume and concentration of breastmilk
- 1.6 Protein energy malnutrition:** - PEM- symptoms, nutritional requirement in dietary management.
- 1.7 Nutritional anemia:** -Prevalence, Iron metabolism, Iron absorption enhancers and inhibitors, Clinical features &management of Iron deficiency anemia, Megaloblastic anemia.
- 1.8 Cardiovascular disorders-**coronary heart disease (CHD): food and nutrients in CHD. Cardiovascular risk factors, and nutritional management of CHD
- 1.9 Diabetes mellitus-**Dietary management of Diabetes mellitus – nutritional requirements, glycaemia index, Complication of diabetes – hypoglycaemia and insulin shock.
- 1.10 Nutrition and aging:** Process of aging, changes in organ function with aging, nutritional requirement, nutrition related problems in old age- osteoporosis, anaemia, obesity, constipation, malnutrition. Antioxidants in the health of old age
- 1.11 Overweight and obesity:** - prevalence, factors – environmental and life style factor, food intake, Genetic factors. Obesity management.

References/ Suggested Readings

1. *Essential Food and Nutrition*, by M. Swaminathan. The Bangalore Printing & Publishing Co. Ltd.
2. *Park's Text Book of Preventive and Social Medicine* by K. Park, M/s. Banarsidas Bhanot Publishers.
3. *Concise Medical Physiology* by S.K. Chaudhury; New Central Book Agency.
4. *Medical Physiology* by A.B. Mahapatra, Current Books International.

MINOR COURS (MNC)

SEMESTER III

Course Name: **Haematology and Cardiovascular System**

Course Code: **BSCPHYMN301**

Course Type: Core (Theory + Practical)	Course Details: MNC-3		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning outcomes:

- *Describe the various constituents of blood, haematopoiesis, function and maturation of red cells, white cells and platelets, blood types, transfusion, tissue and organ transplantation.*
- *Describe endothelial function, blood coagulation and discuss the most common abnormalities and complications relating to endothelial dysfunction and failure of haemostasis*
- *Discuss the general characteristics of leukocytes (neutrophils and macrophages) and their roles in defending the host against infection, including the monocyte-macrophage system and inflammation*
- *Explain the relationship between the structure and function of the arteries, veins and capillaries.*
- *Identify and describe the interior and exterior parts of the human heart*
- *Describe the path of blood through the cardiac circuits*
- *Describe the size, shape, and location of the heart*
- *Compare cardiac muscle to skeletal and smooth muscle*
- *Explain the cardiac conduction system*
- *Describe the process and purpose of an electrocardiogram*
- *Explain the cardiac cycle*
- *Calculate cardiac output*
- *Describe the effects of exercise on cardiac output and heart rate*
- *Name the centers of the brain that control heart rate and describe their function*
- *Identify other factors affecting heart rate*
- *Explain and classify common cardiovascular conditions.*

- *Analyse factors leading to hypertension, as well as approaches useful in preventing and treating the condition*

THEORY (MNC-3)

Paper Name (Theory): Haematology and Cardiovascular System

Unit 1: Blood [15 Marks]

- 1.1 Blood- properties & composition
- 1.2 Plasma proteins-Classification, Values & Functions, Plasmapheresis
- 1.3 Bone Marrow-Classification & Functions
- 1.4 White Blood Cells-types, characters, shape & size, Functions
- 1.5 Immune activities of blood Platelets
- 1.6 Red Blood Cells-Biosynthesis & Factors affecting it
- 1.7 Haemoglobin – Structure, compounds and derivatives, biosynthesis, and catabolism. Foetal haemoglobin
- 1.8 Haemoglobinopathies- Thalassemia, Sickle-cell anaemia. Anaemia-different types and their causes
- 1.9 Blood volume –regulation and determination by dye and radioisotope methods
- 1.10 Haemostasis–factors, mechanism, anti-clotting mechanism, anticoagulants, procoagulants. Disorders of haemostasis-Haemophilia, Thrombosis and Embolism
- 1.11 Blood grouping – ABO and Rh systems, H- antigen. Erythroblastosis fetalis and Rh antigens. Bombay type blood group
- 1.12 TC, DC, ESR, MCH, MCHC, PCV, Leukemia, Leukocytosis, Leukopenia, Purpura, Arneht count
- 1.13 Blood transfusion and its hazards. Red cell fragility
- 1.14 Blood Volume- Values, physiological variations, measurements, and regulations
- 1.15 Spleen- Structure & function
- 1.16 Lymph-Lymphatic system, Source, Composition, circulation, and functions. Edema

Unit 2: Cardiovascular System – I (Anatomy and Electrical Activity of the Heart) [10 Marks]

- 2.1 Histology of Heart- Nodal tissues, ventricles, and valves.
- 2.2 Properties of cardiac muscle.
- 2.3 Origin and propagation of cardiac impulse-action potential in nodal and ventricular muscles.
- 2.4 The cardiac cycle- events, pressure and volume changes. Heart sounds. Murmurs. Cardiac output – measurement by application of Fick’s principle and dye dilution method, factors affecting. Starling’s law of heart.
- 2.5 Electrocardiography – the normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vector cardiogram, the mean electrical axis of heart. The His bundle electrogram.
- 2.6 Principles of Echocardiography. Cardiac Arrhythmias. Myocardial Infarction.

Unit 3: Cardiovascular System – II (Regulation of Cardiovascular functions)

[10 Marks]

- 3.1 Functional morphology of arteries, arterioles, capillaries, venules and veins, sinusoids.
- 3.2 General pattern of circulation and significance of branching of blood vessels. The pulse – arterial and venous.
- 3.3 Haemodynamic of blood flow.
- 3.4 Blood pressure– its measurement and factors affecting.
- 3.5 Cardiovascular homeostasis – neural and chemical control of cardiac functions and blood vessels.
- 3.6 Cardiac and vasomotor centres, baroreceptors and chemoreceptors, innervation of the heart and blood vessels, cardiac and vasomotor reflexes.
- 3.7 Cardiovascular adjustment after haemorrhage.

PRACTICAL (MNC-3)

Paper Name (Practical): Haematology & Cardiovascular System

- 1.1 Haematological experiments: Preparation and staining of blood film with Leishman's stain.
- 1.2 Identification of blood corpuscles.
- 1.3 Differential count of WBC.
- 1.4 Total count of RBC and WBC.
- 1.5 Haemoglobin estimation by Shali's hemoglobinometer method.
- 1.6 Preparation of haemin crystals.
- 1.7 Preparation and staining of bone marrow smear.
- 1.8 Measurement of diameter of megakaryocyte.
- 1.9 Reticulocyte staining.
- 1.10 Blood group determination.
- 1.11 Demonstration: Haematocrit, MCV, MCH and MCHC. Bleeding time, Clotting time, ESR.
- 1.12 Effect of adrenaline, acetyl choline, temperature, load on cardiac muscle contraction of toad heart
- 1.13 Measurement of electrical activity of heart by ECG
- 1.14 Measurement of blood pressure.

Recommended readings:

1. *Best and Taylor's Physiological basis of Medical Practices*, by B.K. Brobecks. The William and Wilkins Co.
2. *Review of Medical Physiology*, by W.F. Ganong, Lange Medical Book. Prentices- Hall International. Mc Graw Hill.
3. *Text book of Medical Physiology*, by A.C. Guyton. W.B. Saunders Co.
4. *Molecular Biology of the Gene*, by J.D. Watson; H.H. Nancy & others; Benjamin Cummings.
5. *Molecular Biology of the Cell*, by B. Alberts and others, Garland
6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. Scientific American Book.
7. *Harper's Illustrated Biochemistry*, by R. K. Murray & others. Lange Medical Book, International Edition, McGraw Hill.
8. *Lehninger's Principles of Biochemistry*. By D. L. Nelson and M.M. Cox, Worth Publishers Inc.
9. *Text Book of Biochemistry*, by E.S. West; W. R. Todd.; H. S. Mason; J. T. VanBruggen. The Macmillan Company.
10. *Biochemistry*. By D. Das. Academic Publishers.
11. *Biochemistry*, by L. Stryer, W.H. Freeman and Co. 23. *Text Book of Physiology* by G.H. Bell: J.N. Davidson and H. Scarboroughl. ELBS.
12. *Practical Biochemistry in Medicine* by Srinivas Rao., Academic Publishers.
13. *Note Books on Practical Biochemistry*. (Published by the Physiological Society of India, Kolkata.)

Basic Structural Framework of the Syllabus:

SEMESTER IV:

SEMESTER	COURSE TYPE	PAPER CODE	PAPER NAME	CREDIT	MARKS
IV	MAJOR- MJC-5	BSCPHYMJ401	Muscle and Renal Physiology	5	100
IV	MAJOR- MJC-6	BSCPHYMJ402	Metabolism	5	100
IV	MINOR- MNC-4	BSCPHYMN401	Metabolism	5	100
IV	MAJOR-SEC-3	BSCPHYSE401	Statistical Analysis of Physiological Parameters	3	50
IV	VA	VAC-401	Yoga And Health	4	50

MAJOR COURSES (MJC)

SEMESTER IV

Course Name: Muscle and Renal Physiology

Course Code: **BSCPHYMJ401**

Course Type: Core (Theory + Practical)	Course Details: MJC-5		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning Outcomes:

- After the completion of course, the students will have ability to:
- *Describe the anatomy of structures in posterior abdominal wall in relation to kidneys, ureter, blood supply and venous drainage of kidneys*
- *Describe the structure, functions and regulations of nephrons and tubules*
- *Describe the mechanism of formation and constituents of urine*
- *Describe the acid base balance and its regulation by the kidneys and lungs*
- *Be able to list at least 4 important inorganic ions the concentrations of which the kidneys help regulate.*
- *Be able to name at least 3 important organic wastes that are eliminated by the kidneys.*
- *Be able to name at least 2 hormones normally produced by the kidney*
- *Understand the concept of renal clearance and be able to perform clearance calculations and to interpret the results.*
- *Know how inulin can be used to measure GFR and be able to perform the calculations involved in this measurement.*
- *Know what the filtration fraction is and its typical range of values, be able to calculate the filtered load.*
- *Know what is meant by the terms: tubular transport maximum (T_m), plasma threshold and splay.*
- *Be able to explain the mechanisms by which the kidneys regulated the volume and composition of the extracellular fluid, the causes of ADH (vasopressin), aldosterone, renin-angiotensin and atrial natriuretic hormone release.*
- *Be able to describe the systemic effects of ADH (vasopressin), aldosterone, renin-angiotensin and atrial natriuretic hormone release, the specific sites of ADH (vasopressin), aldosterone, renin-angiotensin and atrial natriuretic hormone release. Effects of sympathetic activity on renal function.*
- *Explain the overall transmembrane signalling steps whereby increases in cytosolic calcium initiate crossbridge cycling.*
- *Identify the multiple sources, localization, and roles of calcium in muscle contraction and relaxation.*
- *Draw a myosin molecule and label the subunits (heavy chains, light chains) and describe the function of the subunits. Diagram the structure of the thick and thin myofilaments and label the constituent proteins.*
- *Diagram the chemical and mechanical steps in the cross-bridge cycle, and explain how the cross-bridge cycle results in shortening of the muscle.*
- *Explain the relationship of preload, afterload and total load in the time course of an isotonic contraction. Distinguish between an isometric and isotonic contraction.*

- *List the steps in excitation-contraction coupling in skeletal muscle, and describe the roles of the sarcolemma, transverse tubules, sarcoplasmic reticulum, thin filaments, and calcium ions.*
- *List in sequence the steps involved in neuromuscular transmission in skeletal muscle and point out the location of each step on a diagram of the neuromuscular junction.*
- *Distinguish between an endplate potential and an action potential in skeletal muscle.*
- *List the possible sites for blocking neuromuscular transmission in skeletal muscle and provide an example of an agent that could cause blockage at each site.*
- *Describe the differences in actomyosin regulation of, respectively, smooth and skeletal muscle and indicate the structural similarities in their respective contractile units. Explain why smooth muscles can develop and maintain force with a much lower rate of ATP hydrolysis than skeletal muscle.*
- *Distinguish between muscle relaxation from the contracted state and the phenomenon of stress relaxation and give examples of each process.*
- *Diagram the relationship between the timing of the action potential and a twitch in cardiac muscle and explain why this prevents tetanic contraction. Diagram the steps in the excitation-contraction coupling mechanism in cardiac muscle and compare with skeletal muscle including different mechanisms for sarcoplasmic reticulum calcium release.*
- *On the length versus force diagram show how an increase in contractility changes the relationship between afterload and amount of shortening. Describe the mechanisms through which inotropic interventions change cardiac contractility. Describe the physiological consequences of the low-resistance, gap junction pathways between cardiac muscle cells.*
- *Acquire an advanced knowledge related to the complex skin structure (epidermis, dermis, hypodermis) and skin appendages.*
- *Discover and understand the multiple functions of skin (i.e. sensory organ, immunological barrier, synthesis of vitamin D, etc).*

THEORY (MJC-5)

Paper Name (Theory): Muscle and Renal Physiology

Unit 1: Muscle Physiology [20 Marks]

- 1.1** Classification of Muscles: Depending upon striation-Striated Muscle, Non-striated Muscle; Depending upon control- Voluntary Muscle, Involuntary Muscle; Depending upon situation- Skeletal, Smooth and Cardiac muscles.

- 1.2 Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles.
- 1.3 Structure of Skeletal Muscle: Muscle mass, Muscle fiber, Myofibrils, Sarcomere, Contractile elements (proteins) of muscle- Actin, Myosin, Troponin, Tropomyosin, Actinin, Nebulin, Titin, Desmin etc. Structure and Function of the sarco-tubular system- T-Tubule, L-Tubule.
- 1.4 Red and white striated muscle fibers. Single-unit and multi-unit smooth muscle.
- 1.5 Muscle groups: antagonists and agonists.
- 1.6 Properties of skeletal muscle: Excitability-Type of stimulus, Quality of stimulus, Excitability Curve or Strength-Duration Curve- Rheobase, Utilization time, Chronaxie; Contractility- Isotonic contraction, Isometric contraction, Contraction time (Red muscle and Pale muscle), Factors affecting force of contraction (Strength of stimulus, Number of stimulus, Temperature, Load), Effects of repeated stimuli, Genesis of tetanus, Onset of fatigue, Summation of stimuli, Summation of contractions, Refractory period, All or None Law; Tonicity; Conductivity; Extensibility; and Elasticity.
- 1.7 Mechanism of skeletal and smooth muscle contraction and relaxation: Excitation-contraction coupling. Dihydropyridine receptors & Ryanodine receptors.
- 1.8 Chemical, thermal, and electrical changes in skeletal muscle during contraction and relaxation. Electromyography

Unit 2: Renal Physiology [15 Marks]

- 2.1 Anatomy of kidney. Histology of nephron.
- 2.2 Renal circulation – peculiarities and autoregulation.
- 2.3 Formation of urine– glomerular function and tubular functions.
- 2.4 Counter-current multiplier and exchanger.
- 2.5 Renal regulation of osmolarity and volume of blood fluids.
- 2.6 Diabetes insipidus. Formation of hypertonic urine.
- 2.7 Renal regulation of acid-base balance, acidification of urine.
- 2.8 Renal function tests – creatinine, inulin, urea, and PAH clearance tests.
- 2.9 9. Physiology of urinary bladder and micturition.
- 2.10 Composition of urine. Abnormal constituents of urine, their detection and significance.
- 2.11 Renal dialysis. Non-excretory functions of kidney.

PRACTICAL (MJC-5)

Paper Name (Theory): Muscle and Renal Physiology

- 1.1 Normal and abnormal constituents of urine
- 1.2 Preparation, staining and Permanent slide identification of Excretory system and Muscle physiology
- 1.3 Hand-grip dynamometer
- 1.4 Staining of Muscle Fibre

MAJOR COURSES (MJC)

SEMESTER IV

Course Name: Metabolism
Course Code: **BSCPHYMJ402**

Course Type: Core (Theory + Practical)	Course Details: MJC-6		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning Outcomes:

- *Gain knowledge of key metabolic pathways involved in carbohydrate, protein, lipid, and nucleic acid metabolism, including their roles in energy production and biosynthesis.*
- *Understand the enzymatic processes that drive the metabolism of carbohydrates, proteins, lipids, and nucleic acids, and how these enzymes are regulated.*
- *Learn how carbohydrate metabolism (e.g., glycolysis, gluconeogenesis) is interconnected with lipid and protein metabolism, allowing cells to adapt to different energy demands.*
- *Comprehend the processes of protein synthesis, degradation, and amino acid metabolism, including their role in maintaining nitrogen balance and producing energy.*
- *Understand lipid metabolism, including fatty acid oxidation, synthesis, and cholesterol metabolism, and their roles in energy storage, membrane structure, and signalling.*
- *Recognize how nucleic acid metabolism, including DNA replication, RNA transcription, and nucleotide synthesis, is crucial for genetic information flow and cellular function.*
- *Explore the regulation of these metabolic pathways by hormones (e.g., insulin, glucagon) and other regulatory mechanisms, ensuring metabolic homeostasis.*
- *Identify how disruptions in carbohydrate, protein, lipid, and nucleic acid metabolism contribute to metabolic disorders such as diabetes, obesity, cardiovascular diseases, and genetic disorders.*
- *Develop the ability to apply knowledge of these metabolic pathways in practical scenarios, such as clinical diagnostics, metabolic engineering, and therapeutic interventions.*

- *Enhance critical thinking and problem-solving skills in analysing metabolic processes, interpreting experimental data, and understanding the integration of metabolism in health and disease contexts.*

THEORY (MJC-6)

Paper Name (Theory): Metabolism

Unit I: Metabolism of Carbohydrate [15 marks]

1.1 Introduction to Carbohydrate Metabolism

- Overview of carbohydrates: Structure and classification
- Importance of carbohydrates in metabolism
- Anabolism vs. catabolism in carbohydrate metabolism

1.2 Glycolysis

- Overview of glycolysis: Pathway and key steps
- Enzymes involved in glycolysis
- Regulation of glycolysis
- Energetics of glycolysis
- Clinical relevance: Glycolysis in cancer (Warburg effect)

1.3 Glycogen Metabolism

- Glycogenesis: Synthesis of glycogen
- Glycogenolysis: Breakdown of glycogen
- Regulation of glycogen metabolism
- Hormonal control (Insulin, Glucagon, Epinephrine)
- Glycogen storage diseases

1.4 Gluconeogenesis

- Overview of gluconeogenesis: Pathway and key steps
- Comparison with glycolysis
- Regulation of gluconeogenesis
- Role in maintaining blood glucose levels
- Clinical implications: Fasting and diabetes

1.5 Pentose Phosphate Pathway (PPP)

- Overview of the pentose phosphate pathway
- Oxidative and non-oxidative phases of PPP
- Role of PPP in NADPH production and ribose synthesis
- Regulation of PPP

- Clinical relevance: Role in oxidative stress and G6PD deficiency

1.6 Citric Acid Cycle (Krebs Cycle)

- Link between glycolysis and the citric acid cycle: Pyruvate dehydrogenase complex
- Overview of the citric acid cycle: Pathway and key steps, R-L cycle, Glucose-Alanine cycle
- Energetics and regulation of the citric acid cycle
- Anaplerotic reactions
- Integration with other metabolic pathways

1.7 Oxidative Phosphorylation and Electron Transport Chain

- Overview of the electron transport chain (ETC)
- Role of oxidative phosphorylation in ATP production
- Coupling of the ETC and ATP synthesis
- Regulation of oxidative phosphorylation, Inhibitors and uncouplers.
- Mitochondrial disorders and reactive oxygen species (ROS)

1.8 Carbohydrate Metabolism in Different Physiological States

- Fed state vs. fasting state: Metabolic shifts
- Carbohydrate metabolism during exercise
- Adaptations during prolonged fasting and starvation
- Metabolic syndrome and insulin resistance
- Carbohydrate metabolism in diabetes mellitus
- Hormonal regulation: Insulin, glucagon, and epinephrine

1.9 Disorders of Carbohydrate Metabolism

- Inborn errors of carbohydrate metabolism (e.g., galactosemia, fructose intolerance)
- Glycogen storage diseases
- Diabetes mellitus: Type 1 and Type 2
- Hypoglycemia: Causes and management
- Metabolic adaptations in obesity

Unit 2: Metabolism of Lipid [10 marks]

2.1 Introduction to Lipids

- Overview of lipids: Structure, classification, and biological importance
- Role of lipids in cell membranes, energy storage, and signaling

2.2 Fatty Acid Oxidation

- Overview of fatty acid oxidation: Beta-oxidation pathway, Alpha-oxidation, Omega-oxidation
- Steps of beta-oxidation: Activation, transport, and breakdown of fatty acids

- Energetics of beta-oxidation: ATP yield
- Regulation of fatty acid oxidation

2.3 Ketogenesis and Ketone Bodies

- Formation of ketone bodies: Ketogenesis in the liver
- Types of ketone bodies: Acetoacetate, β -hydroxybutyrate, and acetone
- Ketone body metabolism: Utilization and excretion
- Physiological role of ketone bodies during fasting and starvation
- Clinical implications: Diabetic ketoacidosis and ketogenic diets

2.4 Fatty Acid Synthesis (Lipogenesis)

- Overview of fatty acid synthesis: De novo lipogenesis
- Enzymes involved: Acetyl-CoA carboxylase, fatty acid synthase
- Regulation of fatty acid synthesis: Hormonal and nutritional control
- Role of the liver and adipose tissue in lipogenesis
- Clinical relevance: Obesity, non-alcoholic fatty liver disease (NAFLD)

2.5 Synthesis and Metabolism of Triglycerides and Phospholipids

- Triglyceride synthesis: Glycerol-3-phosphate pathway
- Storage and mobilization of triglycerides
- Phospholipid synthesis: Role in membrane structure and signaling
- Disorders of triglyceride and phospholipid metabolism

2.6 Cholesterol Metabolism

- Overview of cholesterol synthesis: Mevalonate pathway
- Regulation of cholesterol synthesis: HMG-CoA reductase
- Cholesterol transport: Role of lipoproteins (LDL, HDL, VLDL)
- Clinical relevance: Hypercholesterolemia, atherosclerosis, and statins
- Cholesterol homeostasis: Dietary regulation and bile acid synthesis

2.7 Lipoprotein Metabolism and Transport

- Structure and function of lipoproteins: Chylomicrons, VLDL, LDL, HDL
- Lipoprotein metabolism: Exogenous and endogenous pathways
- Role of apolipoproteins in lipoprotein function
- Disorders of lipoprotein metabolism: Hyperlipidaemia, dyslipidaemia
- Clinical relevance: Cardiovascular diseases

2.8 Lipid Metabolism in Different Physiological States

- Lipid metabolism in the fed state vs. fasting state
- Lipid metabolism during exercise
- Lipid metabolism during pregnancy and lactation
- Metabolic adaptations during prolonged fasting and starvation
- Lipid metabolism in obesity and metabolic syndrome

2.9 Integration of Lipid Metabolism with Other Pathways

- Interaction with carbohydrate metabolism: Cross-talk between glycolysis, gluconeogenesis, and lipogenesis
- Interaction with protein metabolism: Amino acid catabolism and lipid synthesis
- Role of the liver, adipose tissue, and muscle in metabolic homeostasis
- Hormonal regulation: Insulin, glucagon, epinephrine, and cortisol
- Impact of diet and lifestyle on lipid metabolism

2.10 Disorders of Lipid Metabolism

- Inherited disorders of lipid metabolism (e.g., Gaucher's disease, Tay-Sachs disease)
- Lipid storage diseases: Sphingolipidoses, Niemann-Pick disease
- Obesity: Pathophysiology and metabolic complications
- Fatty liver disease: Alcoholic and non-alcoholic fatty liver disease (NAFLD)

Unit 3: Metabolism of Protein and Nucleic acids [10 marks]

3.1 Amino Acid Metabolism

- Amino acid catabolism: Transamination and deamination
- Urea cycle: Conversion of ammonia to urea
- Essential vs. non-essential amino acids
- Amino acid biosynthesis: Pathways and regulation
- Basic idea of glucogenic and ketogenic amino acids. Metabolism of glycine, sulfur-containing amino acids, tryptophan and phenylalanine
- Disorders of amino acid metabolism (e.g., phenylketonuria, alkaptonuria, tyrosinemia etc.)
- Non-protein Amino acids

3.2 Protein Degradation

- Protein turnover: The balance between synthesis and degradation
- Ubiquitin-proteasome system: Marking proteins for degradation
- Role of protein degradation in cellular homeostasis

3.3 Nucleotide Metabolism

- De novo synthesis of purine and pyrimidine nucleotides
- Salvage pathways for nucleotide synthesis
- Regulation of nucleotide biosynthesis
- Catabolism of nucleotides: Uric acid production and excretion
- Clinical relevance: Disorders of nucleotide metabolism (e.g., gout, Lesch-Nyhan syndrome)

PRACTICAL (MJC-6)

Paper Name (Practical): Metabolism

1. Estimation of percentage and total quantity of glucose (Benedict's Method)
2. Estimation of percentage and total quantity of lactose of milk (Benedict's Method)
3. Estimation of percentage and total quantity of sucrose (Benedict's Method)
4. Estimation of percentage and total quantity of amino nitrogen (Formol Titration Method)
5. Estimation of percentage and total quantity of chloride (Mohr's method)

Recommended readings:

1. *Best and Taylor's Physiological basis of Medical Practices*, by B.K. Brobecks. The William and Wilkins Co.
2. *Review of Medical Physiology*, by W.F. Ganong, Lange Medical Book. Pretices- Hall International. Mc Graw Hill.
3. *Text book of Medical Physiology*, by A.C. Guyton. W.B. Saunders Co.
4. *Molecular Biology of the Gene*, by J.D.Watson; H.H.Nancy& others; BenjaminCummings.
5. *Molecular Biology of the Cell*, by B. Alberts and others, Garland
6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. Scientific American Book.
7. *Harper's Illustrated Biochemistry*, by R. K. Murray & others. Lange Medical Book, International Edition, McGraw Hill.
8. *Lehninger's Principles of Biochemistry*. By D. L. Nelson and M.M. Cox, Worth Publishers Inc.
9. *Text Book of Biochemistry*, by E.S. West; W. R. Todd.; H. S. Mason; J. T. VanBruggen. The Macmillan Company.
10. *Biochemistry*. By D. Das. Academic Publishers.
11. *Biochemistry*, by L. Stryer, W.H. Freeman and Co. 23. *Text Book of Physiology* by G.H.Bell: J.N.Davidson and H.Scarborougl. ELBS.
12. *Practical Biochemistry in Medicine* by SrinivasRao., Academic Publishers.
13. *Note Books on Practical Biochemistry*. (Published by the Physiological Society of India, Kolkata.)

MAJOR COURSES (MJC)

SEMESTER IV

Course Name: **Statistical Analysis of Physiological Parameters**

Course Code: **BSCPHYSE401**

Course Type: Core (Theory + Practical)	Course Details: SEC-3		L-T-P: 0-0-3		
Credit: 3	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30		20	

Course Learning Outcomes:

- *After the completion of course, the students will have ability to:*
- *Have a solid foundation of mathematical and statistical processes at a level comparable to that of students graduating with a BA/BS in Statistics at other universities. Processes should include (but are not limited to) a proficiency in collection, organization, design, and drawing inferences from data using appropriate statistical methodology and problem-solving skills.*
- *Demonstrate their ability to apply statistics in other fields at an appropriate level and demonstrate their ability to apply knowledge acquired from their major to real world models.*
- *Demonstrate mastery of data analysis and statistical concepts by communicating critically reasoned analysis through written and oral presentations.*
- *Acquire up-to-date skills and/or applications of computer and statistical programming related to future career choices.*
- *Apply their knowledge of statistics through an in-depth senior project/research experience. Results will be presented in both written (paper, publication, portfolio, etc.) and visual (PowerPoint, poster, portfolio, etc.) formats.*
- *Read, interpret, and critically analyze journal articles directed at undergraduate*

PRACTICAL (SEC-3)

Paper Name (Practical): Statistical Analysis of Physiological Parameters

UNIT-1: Biostatistics

- 1.1 Scope of statistics – utility and misuse.
- 1.2 Principles of statistical analysis of biological data.
- 1.3 Basic concepts – variable, parameter, statistics.
- 1.4 Sampling. Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram. Parameters.
- 1.5 Different classes of statistics- mean, median, mode, mean deviation, variance, standard deviation, standard error of the mean. Standard score.
- 1.6 Degrees of freedom.
- 1.7 Probability. Normal distribution. Student's t-distribution.
- 1.8 Testing of hypothesis - Null hypothesis, errors of inference, levels of significance, t-test and z score for significance of difference. Distribution-free test - Chi-square test, ANOVA test.
- 1.9 Linear correlation and linear regression.

UNIT-2: Data Analysis using Computer software

- 2.1 Elementary ideas about probability,
- 2.2 Discussion of sampling techniques,
- 2.3 Data summarization,
- 2.4 Common sampling distributions,
- 2.5 Statistical inference and hypothesis testing,
- 2.6 Regression and
- 2.7 Nonparametric inference
- 2.8 Basic Application of Computer in Physiological data Analysis: M.S. Word and M.S. Excel.

References/ Suggested Readings:

1. *Statistics in Biology and Psychology* by D. Das. Academic Publishers.
2. *An Introduction to Biostatistics (2nd ed.)* by N. Gurumani, M.J.P. Publishers, Chennai.
3. *Medical Statistics* by B.K. Mahajan. Jaypee Brothers, Medical Publishers Pvt. Ltd.

MINOR COURSE (MNC)

SEMESTER IV

Course Name: Metabolism
Course Code: **BSCPHYMN401**

Course Type: Core (Theory + Practical)	Course Details: MNC-4		L-T-P: 3-0-4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Learning Outcomes:

- *Gain knowledge of key metabolic pathways involved in carbohydrate, protein, lipid, and nucleic acid metabolism, including their roles in energy production and biosynthesis.*
- *Understand the enzymatic processes that drive the metabolism of carbohydrates, proteins, lipids, and nucleic acids, and how these enzymes are regulated.*
- *Learn how carbohydrate metabolism (e.g., glycolysis, gluconeogenesis) is interconnected with lipid and protein metabolism, allowing cells to adapt to different energy demands.*
- *Comprehend the processes of protein synthesis, degradation, and amino acid metabolism, including their role in maintaining nitrogen balance and producing energy.*
- *Understand lipid metabolism, including fatty acid oxidation, synthesis, and cholesterol metabolism, and their roles in energy storage, membrane structure, and signaling.*
- *Recognize how nucleic acid metabolism, including DNA replication, RNA transcription, and nucleotide synthesis, is crucial for genetic information flow and cellular function.*
- *Explore the regulation of these metabolic pathways by hormones (e.g., insulin, glucagon) and other regulatory mechanisms, ensuring metabolic homeostasis.*
- *Identify how disruptions in carbohydrate, protein, lipid, and nucleic acid metabolism contribute to metabolic disorders such as diabetes, obesity, cardiovascular diseases, and genetic disorders.*
- *Develop the ability to apply knowledge of these metabolic pathways in practical scenarios, such as clinical diagnostics, metabolic engineering, and therapeutic interventions.*

- *Enhance critical thinking and problem-solving skills in analyzing metabolic processes, interpreting experimental data, and understanding the integration of metabolism in health and disease contexts.*

THEORY (MNC-4)

Paper Name (Theory): Metabolism

Unit I: Metabolism of Carbohydrate [15 marks]

1.1 Introduction to Carbohydrate Metabolism

- Overview of carbohydrates: Structure and classification
- Importance of carbohydrates in metabolism
- Anabolism vs. catabolism in carbohydrate metabolism

1.2 Glycolysis

- Overview of glycolysis: Pathway and key steps
- Enzymes involved in glycolysis
- Regulation of glycolysis
- Energetics of glycolysis
- Clinical relevance: Glycolysis in cancer (Warburg effect)

1.3 Glycogen Metabolism

- Glycogenesis: Synthesis of glycogen
- Glycogenolysis: Breakdown of glycogen
- Regulation of glycogen metabolism
- Hormonal control (Insulin, Glucagon, Epinephrine)
- Glycogen storage diseases

1.4 Gluconeogenesis

- Overview of gluconeogenesis: Pathway and key steps
- Comparison with glycolysis
- Regulation of gluconeogenesis
- Role in maintaining blood glucose levels
- Clinical implications: Fasting and diabetes

1.5 Pentose Phosphate Pathway (PPP)

- Overview of the pentose phosphate pathway
- Oxidative and non-oxidative phases of PPP
- Role of PPP in NADPH production and ribose synthesis
- Regulation of PPP

- Clinical relevance: Role in oxidative stress and G6PD deficiency

1.6 Citric Acid Cycle (Krebs Cycle)

- Link between glycolysis and the citric acid cycle: Pyruvate dehydrogenase complex
- Overview of the citric acid cycle: Pathway and key steps, R-L cycle, Glucose-Alanine cycle
- Energetics and regulation of the citric acid cycle
- Anaplerotic reactions
- Integration with other metabolic pathways

1.7 Oxidative Phosphorylation and Electron Transport Chain

- Overview of the electron transport chain (ETC)
- Role of oxidative phosphorylation in ATP production
- Coupling of the ETC and ATP synthesis
- Regulation of oxidative phosphorylation, Inhibitors and uncouplers.
- Mitochondrial disorders and reactive oxygen species (ROS)

1.8 Carbohydrate Metabolism in Different Physiological States

- Fed state vs. fasting state: Metabolic shifts
- Carbohydrate metabolism during exercise
- Adaptations during prolonged fasting and starvation
- Metabolic syndrome and insulin resistance
- Carbohydrate metabolism in diabetes mellitus
- Hormonal regulation: Insulin, glucagon, and epinephrine

1.9 Disorders of Carbohydrate Metabolism

- Inborn errors of carbohydrate metabolism (e.g., galactosemia, fructose intolerance)
- Glycogen storage diseases
- Diabetes mellitus: Type 1 and Type 2
- Hypoglycemia: Causes and management
- Metabolic adaptations in obesity

Unit 2: Metabolism of Lipid [10 marks]

2.1 Introduction to Lipids

- Overview of lipids: Structure, classification, and biological importance
- Role of lipids in cell membranes, energy storage, and signaling

2.2 Fatty Acid Oxidation

- Overview of fatty acid oxidation: Beta-oxidation pathway, Alpha-oxidation, Omega-oxidation
- Steps of beta-oxidation: Activation, transport, and breakdown of fatty acids

- Energetics of beta-oxidation: ATP yield
- Regulation of fatty acid oxidation

2.3 Ketogenesis and Ketone Bodies

- Formation of ketone bodies: Ketogenesis in the liver
- Types of ketone bodies: Acetoacetate, β -hydroxybutyrate, and acetone
- Ketone body metabolism: Utilization and excretion
- Physiological role of ketone bodies during fasting and starvation
- Clinical implications: Diabetic ketoacidosis and ketogenic diets

2.4 Fatty Acid Synthesis (Lipogenesis)

- Overview of fatty acid synthesis: De novo lipogenesis
- Enzymes involved: Acetyl-CoA carboxylase, fatty acid synthase
- Regulation of fatty acid synthesis: Hormonal and nutritional control
- Role of the liver and adipose tissue in lipogenesis
- Clinical relevance: Obesity, non-alcoholic fatty liver disease (NAFLD)

2.5 Synthesis and Metabolism of Triglycerides and Phospholipids

- Triglyceride synthesis: Glycerol-3-phosphate pathway
- Storage and mobilization of triglycerides
- Phospholipid synthesis: Role in membrane structure and signaling
- Disorders of triglyceride and phospholipid metabolism

2.6 Cholesterol Metabolism

- Overview of cholesterol synthesis: Mevalonate pathway
- Regulation of cholesterol synthesis: HMG-CoA reductase
- Cholesterol transport: Role of lipoproteins (LDL, HDL, VLDL)
- Clinical relevance: Hypercholesterolemia, atherosclerosis, and statins
- Cholesterol homeostasis: Dietary regulation and bile acid synthesis

2.7 Lipoprotein Metabolism and Transport

- Structure and function of lipoproteins: Chylomicrons, VLDL, LDL, HDL
- Lipoprotein metabolism: Exogenous and endogenous pathways
- Role of apolipoproteins in lipoprotein function
- Disorders of lipoprotein metabolism: Hyperlipidemia, dyslipidemia
- Clinical relevance: Cardiovascular diseases

2.8 Lipid Metabolism in Different Physiological States

- Lipid metabolism in the fed state vs. fasting state
- Lipid metabolism during exercise
- Lipid metabolism during pregnancy and lactation
- Metabolic adaptations during prolonged fasting and starvation
- Lipid metabolism in obesity and metabolic syndrome

2.9 Integration of Lipid Metabolism with Other Pathways

- Interaction with carbohydrate metabolism: Cross-talk between glycolysis, gluconeogenesis, and lipogenesis
- Interaction with protein metabolism: Amino acid catabolism and lipid synthesis
- Role of the liver, adipose tissue, and muscle in metabolic homeostasis
- Hormonal regulation: Insulin, glucagon, epinephrine, and cortisol
- Impact of diet and lifestyle on lipid metabolism

2.10 Disorders of Lipid Metabolism

- Inherited disorders of lipid metabolism (e.g., Gaucher's disease, Tay-Sachs disease)
- Lipid storage diseases: Sphingolipidoses, Niemann-Pick disease
- Obesity: Pathophysiology and metabolic complications
- Fatty liver disease: Alcoholic and non-alcoholic fatty liver disease (NAFLD)

Unit 3: Metabolism of Protein and Nucleic acids [10 marks]

3.1 Amino Acid Metabolism

- Amino acid catabolism: Transamination and deamination
- Urea cycle: Conversion of ammonia to urea
- Essential vs. non-essential amino acids
- Amino acid biosynthesis: Pathways and regulation
- Basic idea of glucogenic and ketogenic amino acids. Metabolism of glycine, sulfur-containing amino acids, tryptophan and phenylalanine
- Disorders of amino acid metabolism (e.g., phenylketonuria, alkaptonuria, tyrosinemia etc.)
- Non-protein Amino acids

3.2 Protein Degradation

- Protein turnover: The balance between synthesis and degradation
- Ubiquitin-proteasome system: Marking proteins for degradation
- Role of protein degradation in cellular homeostasis

3.3 Nucleotide Metabolism

- De novo synthesis of purine and pyrimidine nucleotides
- Salvage pathways for nucleotide synthesis
- Regulation of nucleotide biosynthesis
- Catabolism of nucleotides: Uric acid production and excretion
- Clinical relevance: Disorders of nucleotide metabolism (e.g., gout, Lesch-Nyhan syndrome)

PRACTICAL (MNC-4)

Course Name (Practical): Metabolism

1. Estimation of percentage and total quantity of glucose (Benedict's Method)
2. Estimation of percentage and total quantity of lactose of milk (Benedict's Method)
3. Estimation of percentage and total quantity of sucrose (Benedict's Method)
4. Estimation of percentage and total quantity of amino nitrogen (Formol Titration Method)
5. Estimation of percentage and total quantity of chloride (Mohr's method)

Recommended readings:

1. *Best and Taylor's Physiological basis of Medical Practices*, by B.K. Brobecks. The William and Wilkins Co.
2. *Review of Medical Physiology*, by W.F. Ganong, Lange Medical Book. Pretices- Hall International. Mc Graw Hill.
3. *Text book of Medical Physiology*, by A.C. Guyton. W.B. Saunders Co.
4. *Molecular Biology of the Gene*, by J.D.Watson; H.H.Nancy & others; Benjamin Cummings.
5. *Molecular Biology of the Cell*, by B. Alberts and others, Garland
6. *Molecular Cell Biology*, by H. Lodish; D. Baltimore & Others. Scientific American Book.
7. *Harper's Illustrated Biochemistry*, by R. K. Murray & others. Lange Medical Book, International Edition, McGraw Hill.
8. *Lehninger's Principles of Biochemistry*. By D. L. Nelson and M.M. Cox, Worth Publishers Inc.
9. *Text Book of Biochemistry*, by E.S. West; W. R. Todd.; H. S. Mason; J. T. VanBruggen. The Macmillan Company.
10. *Biochemistry*. By D. Das. Academic Publishers.
11. *Biochemistry*, by L. Stryer, W.H. Freeman and Co. 23. *Text Book of Physiology* by G.H.Bell: J.N.Davidson and H.Scarborougl. ELBS.
12. *Practical Biochemistry in Medicine* by SrinivasRao., Academic Publishers.
13. *Note Books on Practical Biochemistry*. (Published by the Physiological Society of India, Kolkata.)

Value Added Courses

SEMESTER IV

Course Name: **Yoga and Health**

Course Code: **VAC401**

L - T - P: 4 - 0 - 0

Learning Outcomes:

1. *Understand the principles and philosophy of yoga*
2. *Learn various yoga techniques for physical, mental, and emotional well-being*
3. *Apply yoga practices for stress management and overall health*
4. *Analyse the scientific basis of yoga and its applications in modern life*

THEORY (VAC-2)

Paper Name (Theory): Yoga and Health

Unit 1: Introduction to Yoga (10 marks)

- 1.1 Definition and history of yoga
- 1.2 Principles and philosophy of yoga
- 1.3 Types of yoga (Hatha, Vinyasa, Ashtanga, etc.)
- 1.4 Physiological effects of yoga on body systems
- 1.5 Neurological and psychological benefits of yoga
- 1.6 Research studies on yoga and health

Unit 2: Yoga Techniques (8 marks)

- 2.1 Asanas (postures) for physical health
- 2.2 Pranayama (breathing techniques) for mental well-being
- 2.3 Mudras (hand gestures) and Bandhas (energy locks)
- 2.4 Relaxation techniques (Savasana, Yoga Nidra)

Unit 3: Yoga for Stress Management (10 marks)

- 3.1 Understanding stress and its effects
- 3.2 Yoga practices for stress relief (asanas, pranayama, meditation)
- 3.3 Mindfulness and self-awareness techniques

Unit 4: Applications of Yoga in Modern Life (7 marks)

- 4.1 Yoga in daily life (workplace, relationships, etc.)
- 4.2 Yoga for specific health conditions (back pain, hypertension, etc.)
- 4.3 Yoga and mental health (anxiety, depression, etc.)

Recommended readings:

1. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health Published by SVYP, Bangalore 4.
2. Gharote, M.M. & others: Therapeutic references in Traditional Yoga Texts, the Lonavla Institute, Lonavla, 2010.
3. Gharote ML: Hatharatnavali, The Lonavala Yoha Institute, Lonavala, Pune, IInd Edition, 2009 4. Swami Kuvalyananda & Shukla, S.A.: Gorakshasatkam, Kaivalyadhama, Lonavla, 2006
4. Dr Nagendra H R : The Secret of Action - Karma Yoga, Published by SVYP, Bangalore, 2003
5. Yoga and Mental Health by Prof. R. S. Bhogal
6. I. K. Taimini : The Science of Yoga, (The Theosophical, Publishing House, Adyar Chennai 2005)
7. Swami Satyananda Saraswati : Hatha Yoga, Pub: BSY Mungher
8. Woods, J.H. : The Yoga System of Patanjali, M.L.B.D., Delhi, 1988
9. Swami Vivekananda: Rajayoga, Advaita Ashram, Calcutta, 2000
10. Iyengar B.K.S. : Light on Patanjali Yoga (New York, Schocken Books, 1994)
11. Burley, Mikel: Hatha Yoga, Its' Context Theory and Practice (M.L.B.D. Delhi, 2000)
12. Ghosh, Shyam: The Original Yoga, Munshiram Manoharlal, New Delhi, 1999
13. Burnier, Radha: Hathayoga Pradipika of Svatmarama, The Adyar Library publications, Chennai. 2000
14. Woodroffe, Sir John: The Serpent power (Ganesh & Company, Madras, 2000)
