Ist M. Sc (2023-2024)

Biochemistry

Title of the Course	**: BASICS OF BIOCHEMISTRY**		
Category of the Course	**: CORE COURSE**	**Semester**	**: I**
Course Code	**: P1R3BCCC1**	**Nature of the Skill**	**: EMPLOYABILITY**
Marks	**: CIA:25+ Ext: 75 = 100**	**Hrs/Week**	**: 6**
Credits	**: 5**	**Total Inst. Hrs**	**: 90**

Course objectives:

The main objectives of this course are to:

1. Students will be introduced to the structure of biomolecules.
2. The significance of carbohydrates in biological processes will be understood.
3. The structure, properties and biological significance of lipids in the biological system will be studied
4. Students will learn about the concepts of protein structure and their significance in biological processes and creatively comprehend the role of membrane components with their biological significance.
5. Students will gain knowledge about the structures and functional roles of nucleic acids in the biological system

Unit I **20 Hours**

CARBOHYDRATES

Monosaccharides & Disaccharides: structure, occurrence, properties and biological functions. Homo and Hetero: Polysaccharides - occurrence, structure, properties and functions of homoglycans - starch, glycogen, cellulose, dextrin, inulin, chitin, xylans and galactans. Occurrence, structure, properties and functions of hetero glycans - hyaluronic acid, keratan sulphate and chondroitin sulphate. Mucopolysaccharides – bacterial cell walls polysaccharides and sialic acid. Blood group substances. Lectins structure and functions.

Unit II **20 Hours**

PROTEINS

Classification, structure and properties of amino acids, Essential and non-essential amino acids. Non protein amino acids. Proteins - Classification based on solubility, shape, composition function & Properties of proteins. Structure of peptide bonds. Chemical synthesis of polypeptides. Physical interactions that determine the properties of proteins – short range

repulsions, electrostatic forces, van der waals interaction, hydrogen bond and hydrophobic interactions. Protein structure - Primary, secondary – α-helix, β-sheet and β-turns, tertiary and quaternary structures of protein. The Ramachandran plot Pauling and Corey model for fibrous proteins. Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (haemoglobin, myoglobin), lipoproteins, metallo proteins, glycoprotein and nucleoproteins.

Unit III **15 Hours**

LIPIDS

Definition and classification of lipids. Fatty acids - classification, nomenclature, structure and properties. Saturated and unsaturated fatty acids. Derived lipids: Phospholipids, glycolipids, structure and function. Cholesterol and Triacylglycerols. Eicosanoids- structure and biological actions of prostaglandins, prosracyclins, thromboxanes, leukotrienes and lipoxins. Lipoproteins- Classification and composition and liposomes.

Unit IV **20 Hours**

NUCLEIC ACIDS

Structure of purines and pyrimidines. Components of nucleic acids - nucleosides, nucleotides, and poly nucleotides. Occurrence and isolation of nucleic acids. Properties of DNA: buoyant density, viscosity, hypochromicity, denaturation and renaturation– the cot curve. DNA: structure of different types (A, B and Z DNA), biological role. DNA binding motifs in proteins – the basic helix loop helix (bHLH) motif, zinc finger, the leucine zipper and helix-loop helix. Structure and role of different types of RNA (mRNA, rRNA, tRNA, sn RNA, hn RNA).

Unit V **15 Hours**

VITAMINS, MINERALS AND PORPHYRINS

Structure and biochemical properties of water soluble and fat soluble vitamins and their coenzyme activity. Macro minerals (Ca, P, Mg, Na, K, Cl) and micro minerals/trace elements (Co, I, Fe, Mn, Zn, and F) - their sources, daily requirements, functions and deficiency diseases symptoms. Porphyrins the porphyrin ring system, chlorophyll, hemoglobin, myoglobin and cytochrome.

Course Outcomes:

Course Name - Basics of Biochemistry		Course Code - P1R3BCCC1	Knowledge Level
After completion of this course, students would be able to			
CO1	Explain the chemical structure and functions of carbohydrates.		K1, K2
CO2	Using the knowledge of lipid structure and function, explain how it plays a role in Signalling pathways.		K3, K4
CO3	Describe the various levels of structural organisation of proteins and the role of proteins in biological system.		K4, K5
CO4	Apply the knowledge of proteins in cell-cellinteractions.		K3, K4
CO5	Applying the knowledge of nucleic acid sequencing in researchand diagnosis.		K2, K3, K4

Reading List

1. https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_(Jakubowski)
2. https://www.thermofisher.com/in/en/home/life-science/protein-biology/protein-biology-learning-center/protein-biology-resource-library/pierce-protein-methods/protein-glycosylation.html
3. https://ocw.mit.edu/courses/biology/7-88j-protein-folding-and- human-disease-spring-2015/study-materials/
4. https://www.open.edu/openlearn/science-maths- technology/science/biology/nucleic-acids-and-chromatin/content-section- 3.4.2
5. https://www.genome.gov/genetics-glossary/Cell-Membrane
6. https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod3.pdf

Recommended Texts

1. David L. Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed) W.H. Freeman.
2. Voet.D & Voet. J.G (2010) Biochemistry, (4th ed), John Wiley & Sons, Inc.
3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
4. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill.
5. Lubert Stryer (2010) Biochemistry, (7th ed), W.H.Freeman

6. Satyanarayan, U (2014) Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.

Relationship Matrix for CO, PO & PSO

Title of the Course: Basics of Biochemistry						**Course Code: P1R3BCCC1**			
Course Outcomes (COs)	**PO**									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	L	M	S	M	M	M	S	M	M
CO2	S	M	L	S	M	M	M	S	M	M
CO3	S	M	M	S	S	M	L	S	M	M
CO4	S	M	M	S	M	M	M	S	M	M
CO5	S	S	M	S	S	M	M	S	M	M

S-Strong (3) M-Medium (2) L-Low (1)

Course objectives:

Biochemical techniques combine various inter-disciplinary methods in biological research and the course aims to provide students with the following objectives:

1. To understand the various techniques used in biochemical investigation and microscopy.
2. To explain chromatographic techniques.\ and their applications
3. To explain electrophoretic techniques.
4. To comprehend the spectroscopic techniques and demonstrate their applications in biochemical investigations.
5. To acquire knowledge of radio labelling techniques and centrifugation.

Unit I **20 Hours**

General approaches to biochemical investigation, cell culture techniques and microscopic techniques. Organ and tissue slice technique, cell distribution and homogenization techniques, cell sorting, and cell counting, tissue Culture techniques. Cryopreservation, Biosensors- principle and applications. Principle, working and applications of light microscope, dark field, phase contrast and fluorescent microscope. Electron microscope- Principle, instrumentation of TEM and SEM, Specimen preparation and applications-shadow casting, negative staining and freeze fracturing.

Unit II **20 Hours**

Chromatographic Techniques:

Basic principles of chromatography- adsorption and partition techniques. Chiral Chromatography and counter current Chromatography. Adsorption Chromatography – Hydroxy apatite chromatography and hydrophobic interaction Chromatography. Affinity chromatography. Gas liquid chromatography- principle, instrumentation, column

development, detectors and applications. Low pressure column chromatography – principle, instrumentation, column packing, detection, quantitation and column efficiency, High pressure liquid chromatography- principle, instrumentation, delivery pump, sample injection unit, column packing, development, detection and application. Reverse HPLC, capillary electro chromatography and perfusion chromatography.

Unit III **20 Hours**

Electrophoretic Techniques:

General principles of electrophoresis, supporting medium, factors affecting electrophoresis, Isoelectric focusing-principle, ampholyte, development of pH gradient and application. PAGE-gel casting-horizontal, vertical, slab gels, sample application, detection-staining using CBB, silver, fluorescent stains. SDS PAGE-principle and application in molecular weight determination principle of disc gel electrophoresis ,2D PAGE. Electrophoresis of nucleic acids-agarose gel electrophoresis of DNA, pulsed field gel electrophoresis- principle, apparatus, application. Electrophoresis of RNA, curve. Microchip electrophoresis and 2D electrophoresis, Capillary electrophoresis.

Unit IV **15 Hours**

Spectroscopic techniques:

Basic laws of light absorption- principle, instrumentation and applications of UV-Visible, IR, ESR, NMR, Mass spectroscopy, Turbidimetry and Nephelometry. Luminometry (Luciferase system, chemiluminescence). X – ray diffraction. Atomic absorption spectroscopy – principle and applications – Determination of trace elements

Unit V **15 Hours**

Radiolabelling Techniques and Centrifugation:

Nature of radioactivity-detection and measurement of radioactivity, methods based upon ionisation (GM counter) and excitation (scintillation counter), autoradiography and applications of radioactive isotopes, Biological hazards of radiation and safety measures in handling radioactive isotopes.

Basic principles of Centrifugation. Preparative ultracentrifugation – Differential centrifugation, Density gradient centrifugation. Analytical ultracentrifugation – Molecular weight determination.

Course Outcomes:

Course Name - Biochemical and Molecular Biology Techniques		Course Code – P1R3BCCC2	Knowledge Level
After completion of this course, students would be able to			
CO1	Attain good knowledge in modern used in biochemical investigation and microscopy and apply the experimental protocols to plan and carry out simple investigations in biological research.		K1, K5
CO2	Demonstrate knowledge to implement the theoretical basis of chromatography in upcoming practical course work.		K3, K5
CO3	Demonstrate knowledge to implement the theoretical basis of electrophoretic techniques in research work.		K3, K5
CO4	Tackle more advanced and specialized spectroscopic techniques that are pertinent to research.		K1, K2 & K5
CO5	Tackle more advanced and specialized radioisotope and centrifugation techniques that are pertinent to research work.		K1, K2 & K5

Reading List

Principles and techniques of biochemistry and molecular biology:

1. https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techiniques%20of%20biochemistry%20and%20molecular%20biology%207th%20ed%

Recommended Texts

1. Keith Wilson, John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th ed) Cambridge University Press
2. David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell
3. David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology,W.H.Freeman
4. Rodney F.Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques,(2nd ed),Prentice Hall
5. Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer

6. Segel I.H (1976) Biochemical Calculations (2nd ed), John Wiley and Sons
7. Robyt JF (2015) Biochemical techniques: Theory and Practice (1st ed), CBS Publishers & Distributors.

Relationship Matrix for CO, PO & PSO

Title of the Course: Biochemical and Molecular Biology Techniques						**Course Code: P1R3BCCC2**			
Course Outcomes (COs)	**PO**								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**L**	**M**	**S**	**S**	**L**	**L**	**S**	**S**	**M**
CO2	**S**	**M**	**M**	**S**	**M**	**L**	**M**	**S**	**S**	**L**
CO3	**S**	**M**	**L**	**S**	**M**	**M**	**M**	**S**	**M**	**L**
CO4	**S**	**S**	**L**	**S**	**S**	**M**	**M**	**S**	**M**	**M**
CO5	**S**	**S**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**

S-Strong (3) M-Medium (2) L-Low (1)

Title of the Course	**: Practical-I Basics of Biochemistry and Biochemical and Molecular Biology Techniques**		
Category of the Course	**: Core Course**	**Semester**	**: I**
Course Code	**: P1R3BCCC3P**	**Nature of the Skill**	**: EMPLOYABILITY**
Marks	**: CIA: 40 + Ext: 60 = 100**	**Hrs/Week**	**: 6**
Credits	**: 4**	**Total Inst. Hrs**	**: 90**

Course objectives:

The main objectives of this course are:

1. To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the biomolecules under investigation.

2.To inculcate the knowledge of various isolation and purification techniques of macromolecules like DNA, RNA, Glycogen and Starch,

3. To perform colorimetric estimations to quantify important metabolites like lactate and tryptophan and minerals like calcium and iron from various sources.

4. To achieve training in subcellular fractionation and to identify them by markers.

5 To achieve training in various chromatographic techniques.

I. Biochemical studies and estimation of macromolecules

1. Isolation and estimation of glycogen from liver.
2. Isolation and estimation of DNA from animal tissue.
3. Isolation and estimation of RNA from yeast.
4. Purification of Polysaccharides –Starch and assessment of its purity.

II. UV absorption

1. Denaturation of DNA and absorption studies at 260nm.
2. Denaturation of Protein and absorption studies at 280nm.

III. Colorimetric estimations

1. Estimation of Pyruvate
2. Estimation of tryptophan.

IV. Estimation of minerals

1. Estimation of calcium

2. Estimation of iron

V. Plant Biochemistry

1. Qualitative analysis Phytochemical screening
2. Estimation of Flavonoids -Quantitative analysis

Group Experiments

1.Fractionation of sub-cellular organelles by differential Centrifugation-Mitochondria and nucleus

2. Identification of the separated sub-cellular fractions using marker enzymes (any one)

3.Separation of identification of lipids by thin layer chromatography.

4.Separation of plant pigments from leaves by column chromatography

5. Identification of Sugars by Paper Chromatography

6.Identification of Amino acids by Paper Chromatography.

Course Outcomes:

Course Name - Practical-I		**Course Code - P1R3BCCC3P**	**Knowledge Level**
After completion of this course, students would be able to			
CO1	The student will be able to acquire knowledge and skill in the techniques used in the isolation, purification and estimation of different biomolecules that are widely employed in research		K1, K2, K4
CO2	The students will get acquainted with Principle, Instrumentation and method of Performing UV absorption studies of DNA, Protein and interpreting the alteration occurred during the process of denaturation		K1, K2, K 3, K4
CO3	The student will be fine-tuning in handling the instruments like colorimeter, spectrophotometer and will be able to estimate the biomolecules and minerals from the given samples.		K1, K2, K4
CO4	The student, in addition to acquiring skill in performing various biochemical techniques can also learn to detect presence of phytochemicals and quantify them in the plant sample.		K1, K2, K3, K4 & K6
CO5	The students will develop skill in analytical techniques like subcellular fractionation, Paper, Column and Thin Layer Chromatography and the group experiments will enable them to build learning skills like team work, Problem solving, Communication ability.		K1, K2, K3, K4 & K6

Reading List

1.https://www.researchgate.net/publication/313745155_Practical_Biochemistry_A_Student_Companion.

2.https://doi.org/10.1186/s13020-018-0177-x

3.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5368116/

4.https://www.life.illinois.edu/biochem/455/Lab%20exercises/2Photometry/spectrophotometry.pdf

5.https://ijpsr.com/bft-article/determination-of-total-flavonoid-and-phenol-content-in-mimusops-elengi-linn/?view=fulltext

6.https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf

Self-Study

1. Laboratory Safety Rules, Requirements and Regulations.
2. Preparation of standard solutions and reagent

Books Recommended

1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd
2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers
3. Varley H (2006) Practical Clinical Biochemistry (6th ed) , CBS Publishers
4. O. Debiyi and F. A. Sofowora, (1978) "Phytochemical screening of medical plants," Iloyidia, vol. 3, pp. 234–246,
5. Prof. Sarin A. Chavhan, Prof. Sushilkumar A. Shinde (2019) A Guide to Chromatography Techniques Edition:1
6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).

Relationship Matrix for CO, PO & PSO

Title of the Course: Practical-I						**Course Code: P1R3BCCC3P**				
Course Outcomes (COs)	**PO**									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	M	S	L	S	M	S
CO2	S	S	S	S	M	S	L	S	M	S
CO3	S	S	S	S	M	S	M	S	M	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S-Strong (3) M-Medium (2) L-Low (1)

Course Objectives:

The main objectives of this course are:

1. To appreciate the classification of microorganisms based on their structure, size and shape with an insight into the ancient scriptures about microbes.
2. To understand the role of microorganisms in environment and also to learn the culture conditions.
3. To recognize the possible contamination of foods by microorganisms, to learn about counteracting preservative measures and to know about probiotic nature of microorganisms.
4. To gain knowledge on pathogenic mediation by microorganisms and preventive measures as well.
5. To comprehend the features of antimicrobial agents, their mechanism of action along with the side effects and also to explore natural remedial measures against microbes.

Unit I **15 Hours**

Taxonomical classification - bacteria, viruses (DNA, RNA), algae, fungi and protozoa. Distribution and role of microorganisms in soil, water and air. Charaka's classification of microbes, lytic cycle and lysogeny. Types of culture media, isolation of pure culture, growth curve and the measurement of microbial growth.

Unit II **20 Hours**

Contamination and spoilage of foods – cereals, cereal products, fruits, vegetables, meat, fish, poultry, eggs, milk and milk products. General principles of traditional and modern methods of food preservation - Removal or inactivation of microorganisms, boiling, steaming, curing, pasteurization, cold processing, freeze drying, irradiation, vacuum packing, control of

oxygen and enzymes. Microbes involved in preparation of fermented foods - cheese, yoghurt, curd, pickles, rice pan cake, appam, ragi porridge (கேழ்வரகு கூழ்) and bread.

Unit III **20 Hours**

Food poisoning- bacterial food poisoning, Salmonella, Clostridium blotulinum (botulism), Staphylococcus aureus, fungal food poisoning – aflatoxin, food infection – Clostridium, Staphylococcus and Salmonella. Pathogenic microorganisms, E. coli, Pseudomonas, Klebsilla, Streptococcus, Haemophilus, & Mycobacterium, causes, control, prevention, cure and safety. Food microbiological screening- Real time PCR, ELISA, Aerobic and anaerobic Plate Count, dye reduction method, anaerobic lactic acid bacteria, anaerobic sporeformers, Hazard analysis critical control point (HACCP)

Unit IV **15 Hours**

Antimicrobial chemotherapy, General characteristics of antimicrobial agents. Mechanism of action – sulfonamides, sulphones and PAS. Penicillin, streptomycin- spectra of activity, mode of administration, mode of action, adverse effects and sensitivity test., Antiviral and antiretroviral agents, Antiviral RNA interference, natural intervention (Natural immunomodulators routinely used in Indian medical philosophy).

Unit V **20 Hours**

Immune system- definition and properties. Cells of the immune system – neutrophils, eosinophils, basophils, mast cells, monocytes, macrophages, dendritic cells, natural killer cells, and lymphocytes (B cells and T cells). Lymphoid organs- Primary and Secondary; structure and functions. Antigens and Complement System: definition, properties- antigenicity and immunogenicity, antigenic determinants and haptens. Antigen - antibody interactions - molecular mechanism of binding. Affinity, avidity, valency, cross reactivity and multivalent binding. Immunoglobulins & Immune Response: Structure, classes and distribution of antibodies. Antibody diversity. Immune system in health & disease, Transplantation immunology- graft rejection and HLA antigens. Immunological techniques, Flow cytometry and its application.

Course Outcomes:

Course Name – Microbiology and Immunology		Course Code – P1R3BCDSE1	Knowledge Level
After completion of this course, students would be able to			
CO1	To classify (by both ancient and modern modes) different types of microorganisms and explain life cycle of the microbes.		K1, K2 & K5
CO2	To recognize the microorganisms involved in decay of foods and will be able to apply various counteracting measures. The students also will be able to relate the role of certain beneficial microbes in day-to- day's food consumption.		K1, K2 & K4
CO3	To understand the common pathogenic bacterial and fungi that cause toxic effects and also will be able to employ curative measures.		K1 & K2
CO4	To analyse various features of wide variety of antimicrobial agents along with their mode of action, in addition, being able to apprehend the valuable potentials of traditional and easily available herbs.		K2, K5 & K6
CO5	To apply knowledge gained in production of industrially important products as both pharmaceutical and nutraceutical.		K2, K4 & K5

Recommended Texts

1. Michael J. Pelczar Jr.(2001) Microbiology (5th ed), McGraw Hill Education (India) Private Limited
2. Frazier WC, Westhoff DC, Vanitha NM (2010) Food Microbiology (5th ed), McGraw Hill Education (India) Private Limited
3. Willey J and Sherwood L (2011), Prescott's Microbiology (8th ed) McGraw Hill Education (India)
4. Anantha narayanan, Paniker and Arti Kapil (2013) Textbook of Microbiology (9th ed) Orient BlackSwan

5. Judy Owen, Jenni Punt Kuby (2013), Immunology (Kindt, Kuby Immunology) (7th ed) W. H. Freeman & Co
6. Brooks GF and Carroll KC (2013) Jawetz Melnick&Adelbergs Medical Microbiology, (26th ed) McGraw Hill Education
7. Greenwood D (2012), Medical Microbiology, Elsevier Health

Relationship Matrix for CO, PO & PSO

Title of the Course: Microbiology and Immunology						**Course Code: P1R3BCDSE1**			
Course Outcomes (COs)	**PO**								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**L**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**S**
CO3	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**M**	**L**	**M**
CO4	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**S**
CO5	**S**	**L**	**S**	**S**	**M**	**L**	**L**	**S**	**S**	**S**

S-Strong (3) M-Medium (2) L-Low (1)

Course Objectives:

The main objectives of this course are:

1. To understand the types and structure of scientific writing.
2. To understand the method of writing and practice writing.
3. To learn to write a paper or article incorporating all necessary components properly.
4. To Understand the ICT for Presentation.
5. To Learn the viva- voce Procedure for Presentation.

Unit I **20 Hours**

Explain the various types of scientific writing: Papers, Reviews Short communications, articles for newspapers, popular science writing, chapters in a text book, thesis writing etc.

Unit II **20 Hours**

Writing main ideas in research paper and arranging details in logical sequence

Evolution and structure of scientific paper-abstract, title, Review of literature Results and Discussion in detail, Conclusion and References.

Unit III **20 Hours**

PPT Presentation - Practice presentations by 4-5 students, randomly selected, evaluation and discussion of positive and negative aspects.

Unit IV **15 Hours**

Poster Presentation -Formal Power Point for Student Submission, Poster presentation of their chosen scientific project.

Unit V **15 Hours**

Oral presentations at Conferences –Preparation, Planning and Delivery, Importance and procedure of viva- voce.

Course Outcomes:

Course Name - Communications & Scientific writing		**Course Code - P1R3BCDSE2**	**Knowledge Level**
After completion of this course, students would be able to			
CO1	Students would have understood the concepts of research methods in Biological Sciences.		K2
CO2	Students would have learnt to design the Research Paper and arranging details in logical sequence		K3
CO3	Students would have become familiar with the Practice presentations		K2
CO4	Students would have learnt to prepare the PowerPoint poster presentation		K3
CO5	Students would have learnt the art of Oral Presentations Preparation.		K2

Text Books Recommended:

1. Kothari C.R., "Research Methodology Methods and Techniques" (New Delhi: New Age International).

2. Krishnaswamy O.R. & Renganathan M. "Methodology of Research in Social Sciences", (New Delhi: Himalaya Publishing House)

3. Ravilochanan P, "Research Methodology" (Chennai: Margham Publications)

4. Pauline V. Young, "Scientific Social Surveys and Research" (New Delhi: Prentice Hall of India P. Ltd)

5. Patten Chetty, "Research Methodology" (Coimbatore: Rainbow Publications).

Relationship Matrix for CO, PO & PSO

Title of the Course: Communications & Scientific writing										**Course Code: P1R3BCDSE2**
Course Outcomes (COs)	**PO**									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	S	M	M	S	S
CO2	L	M	S	L	M	S	M	S	M	S
CO3	S	M	L	S	M	M	S	S	S	M
CO4	M	M	S	M	L	L	M	M	S	M
CO5	S	S	M	S	S	M	M	S	S	S

S-Strong (3) M-Medium (2) L-Low (1)

Title of the Course	**: ENZYMOLOGY**		
Category of the Course	**: CORE COURSE**	**Semester**	**: II**
Course Code	**: P2R3BCCC4**	**Nature of the Skill**	**: EMPLOYABILITY**
Marks	**: CIA:25+ Ext: 75 = 100**	**Hrs/Week**	**: 6**
Credits	**: 5**	**Total Inst. Hrs**	**: 90**

Course objectives:

1. Students will be introduced to the theory and practice of enzymology.

2. Mechanisms of catalysis and factors affecting catalysis will be understood

3. The kinetics of enzyme catalyzed reactions in the absence and presence of inhibitors will be studied and the options for applying enzymes and their inhibitors in medicine will be analyzed.

4. Students will learn about the applications of enzymes in research, medicine, and industry, which will prepare them for careers in industrial and biomedical research.

5. The control of metabolic pathways and cellular responses through enzyme regulation will be emphasized.

Unit I **18Hrs**

Nomenclature and classification

Nomenclature and classification of enzymes: according to IUB-EC,1964 .intracellular localization of enzymes, homogenization techniques, isolation and fractionation of enzymes-classical methods of purification and selective adsorption, criteria of purity, units of enzymes activity, turn over number, specific activity and determination of active site residues.

Unit II **18Hrs**

Enzyme catalysis

Acid base catalysis, electrostatic catalysis, covalent catalysis, enzyme catalysis ,mechanism of reaction catalyzed by enzymes-lysozyme and chymotrypsin. Metal activated enzymes and metalloenzymes. role of metal ions in mechanism-carbonic anhydrase, superoxide dismutase, carboxy pepditase. enzyme regulation-feedback inhibition, feed forward stimulation, sequential feedback, concerted feedback, cumulative feedback and enzyme multiplicity and covalent modification

Unit III **18Hrs**

Enzyme kinetics

Pre steady state and steady state kinetics, factors affecting enzyme activity, michaleis-menten plot, lineweaver-burk plot, eadien-hofstee plot and hanes plot. kinectics of allosteric enzymes-MWC and KNF models, Hills equation and coefficient, K and V series enzymes,

bisubstrate reactions. enzyme inhibition-reversible-competitive, non-competitive, uncompetitive and mixed inhibition and their kinetic diffferentition, irreversible inhibition.

Unit IV **18Hrs**

Clinical applications of enzymes

Enzyme as diagnostic reagents, antibodies as analytical reagents. therapeutic enzymes. determination of enzymes activities for clinical diagnosis-phosphatases, transaminases,LD,CK,amylase,cholinesterase.clinical enzymology of liver and heart diseases, enzyme inhibitors and drug design, enzyme therapy.biosensors-colorimetric,potentiometric,amphometric,optical and immunosensors.

Unit V **18Hrs**

Industrial applications of enzymes

Industrial large scale enzyme extraction, purification and stabilization. industrial applications of carbohydrates, proteolytic enzyme, lignocellulose degrading enzyme, pectin and pectic enzyme. applications of enzymes in food industry, leather industry. additional industrial enzymes-lipase, enzyme in animal nutrition. immobilization of enzymes-methods and applications of enzyme engineering and artificial enzymes.

Course Outcomes:

Course Name- ENZYMOLOGY	**Course Code P2R3BCCC4**	**Knowledge Level**
After completion of this course, students would be able to		
CO1	Describe the catalytic mechanisms employed by enzymes	K1, K2, K5
CO2	Choose and use the appropriate methods to isolate and purify enzymes and check the purity of the enzyme	K1, K2, K3, K4, K5
CO3	Analyze enzyme kinetic data graphically, calculate kinetic parameters, determine the mechanism of inhibition by a drug/chemical and analyse options for applying enzymes and their inhibitors in medicine	(K1,K2, K3,K4)
CO4	Explain allosterism and cooperativity and differentiate Michaelis-Menten kinetics from sigmoidal kinetics. The role played by enzymes in the regulation of vital cellular processes will be appreciated.	K1,K2, K5, K6
CO5	Highlight the use of enzymes in industries and biomedicine	K1, K2, K3

Reading List

1. **Enzymes** | MIT Open Course Ware | Free Online Course Materials https://ocw.mit.edu/high-school/biology/exam-prep/chemistry-of-life/enzymes/
2. **Enzymology**
3. https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
4. https://mooc.es/course/enzymology/
5. **The active site of enzymes**
6. https://dth.ac.in/medical/courses/biochemistry/block-1/1/index.php
7. **Enzymes and Enzyme Kinetics**
8. https://www.lecturio.com/medical-courses/enzymes-and-enzyme kinetics.course#/
9. Mechanistic enzymology in drug discovery: a fresh perspective
10. https://www.nature.com/articles/nrd.2017.219
11. Enzyme Biosensors for Biomedical Applications: Strategies for Safeguarding Analytical Performances in Biological Fluids
12. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934206/

Recommended Texts

1. Enzymes: Biochemistry, Biotechnology and Clinical chemistry, 2nd edition, 2007, Palmer T and Bonner P; Affiliated- East West press private Ltd, New Delhi
2. Fundamentals of Enzymology, 3rd edition, 2003, Price NC and Stevens L; Oxford University Press, New York
3. Voet's Biochemistry, adapted ed, 2011, Voted and Voet JG; Wiley, India
4. Lehninger Principles of Biochemistry, 8th edition, 2021, Nelson DL and Cox MM; WH Freeman & Co, New York
5. Biochemistry, Berg JM, Stryer L, Gatto,G, 8th ed, 2015;WH Freeman & Co., New York.
6. Enzyme Kinetics and Mechanism; Cook PF, Cleland W, ;2007; Garland Science, London

Relationship Matrix for CO, PO and PSO

Title of the Course: ENZYMOLOGY							**Course Code: P2R3BCCC4**			
Course Outcomes (COs)	**PO**									
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	**S**	**M**	**S**	**L**	**M**	**S**	**L**	**S**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**S**	**S**

S-Strong (3) M-Medium (2) L-Low (1)

Title of the Course	**: CELLULAR METABOLISM**		
Category of the Course	**: CORE COURSE**	**Semester**	**: II**
Course Code	**: P2R3BCCC5**	**Nature of the Skill**	**: EMPLOYABILITY**
Marks	**: CIA:25+ Ext: 75 = 100**	**Hrs/Week**	**: 6**
Credits	**: 5**	**Total Inst. Hrs**	**: 90**

Course objectives:

1. Familiarize on blood glucose homeostasis
2. Provide an insight into the metabolic path way of glycogen, glycoprotein, mucopolysaccharide and peptidoglycan with clinical correlation wherever required
3. Inculcate knowledge on nucleotide metabolism and disorders associated with it
4. Provide a platform to understand the versatile role of PLP in amino acid degradation, formation of specialized products and disorders associated with ammonia detoxification
5. Educate on heme and Sulphur metabolism with associated clinical manifestation

Unit I **18Hrs**

METABOLISM INTRODUCTION

High energy compounds, standard free energy. Mitochondrial electron transport chain, proton exchange during electron transport. Energetics of electron transport. Coupling of electron transport to oxidative phosphorylation. Inhibitors of electron transport chain.

Unit II **18Hrs**

METABOLISM OF CARBOHYDRATES

An overview & energetics of glycolysis and gluconeogenesis. Regulation of glycolysis and gluconeogenesis - phosphofructokinase, hexokinase and pyruvate kinase as regulatory enzymes in glycolysis; hormone regulation (ICT). Anaphlerotic reactions 'filling up reactions Gluconeogensis: Regulation by allosteric and substrate level control mechanisms. TCA - cycle - steps: Regulation at branch points: -Pyruvate dehydrogenase. alpha - keto glutarate dehydrogenase, and citrate synthase. Glycogen metabolism - Regulation of glycogen phosphorylase; glycogen synthase by effectors, covalent modification and hormones. Uronic acid pathway (Assignment).

Unit III **18Hrs**

METABOLISM OF LIPIDS

Fatty acid synthesis and its regulation. Fatty acid oxidation – β-oxidation, α- oxidation & ω- oxidation (ICT). Phospholipids and Triacylglycerol -Synthesis, degradation and regulation. Lipoproteins - classification, metabolism and importance. Cholesterol - Biosynthesis, regulation and degradation. ketone bodies – pathway, utilization and regulation.

Unit IV **18Hrs**

METABOLISM OF AMINO ACIDS

Biosynthesis and degradation of amino acids and their regulation. Transamination and deamination, ammonia formation. The urea cycle and regulation of ureogenesis (Seminar).

Unit V **18Hrs**

NUCLEIC ACID METABOLISM

Biosynthesis and catabolism of purines and pyrimidines and their regulation. PRPP aminotransferase & Aspartate carbamoyl transferase. Integration of metabolism-Metabolic integration of the liver, adipose tissue and brain. Altered metabolism in starvation.

Course Outcomes:

Course Name- CELLULAR METABOLISM	**Course Code P2R3BCCC5**	**Knowledge Level**
After completion of this course, students would be able to		
CO1	Appreciate the modes of synthesis and degradation of glucose and will be able to justify the pros and cons of maintain the blood sugar level	K1, K2, K5
CO2	Gain knowledge on polysaccharide metabolism and glycogen storage disease	K1, K2, K5
CO3	Acquaint with the making and braking of nucleotides	K1,K2,K4
CO4	Differentiate the diverse reaction a particular amino acid can experience	K1,K2, K3
CO5	Correlate the disturbance of metabolic reactions to clinical manifestations with reference to heme and sulphur metabolism	K1, K2, K3

Reading List

1. https://www.embopress.org/doi/full/10.1038/msb.2013.19
2. https://people.wou.edu/~guralnl/450Glycogen%20metabolism.pdf
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243375/
4. https://www.researchgate.net/publication/334458898_Urea_Cycle
5. https://www.researchgate.net/publication/51233381_Heme_biosynthesis_and_its_regulation_Towards_understanding_and_improvement_of_heme_biosynthesis_in_filamentous_fungi
6. https://www.researchgate.net/publication/349746691_Microbial_Sulfur_Metabolism_and_Environmental_Implications

Recommended Texts

1. David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed), W.H.Freeman
2. Voet.D and Voet. J.G (2010) Biochemistry, (4th ed), John Wiley & Sons, Inc.
3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
4. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill.
5. Textbook of Biochemistry with Clinical Correlations, 7th Edition,Thomas M. Devlin (Editor), Wiley
6. Human Biochemistry – James M.Orten & Otto.W.Neuhan- 10th edn- The C.V.Mosby Company

Relationship Matrix for CO, PO and PSO

Title of the Course: CELLULAR METABOLISM							**Course Code: P2R3BCCC5**			
Course Outcomes (COs)	**PO**									
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 2	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**M**
CO 3	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 4	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO5	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong (3) M-Medium (2) L-Low (1)

Title of the Course	**: PRACTICAL II**		
Category of the Course	**: CORE COURSE**	**Semester**	**: II**
Course Code	**: P2R3BCCC6P**	**Nature of the Skill**	**: EMPLOYABILITY**
Marks	**: CIA:40+ Ext: 60 = 100**	**Hrs/Week**	**: 6**
Credits	**: 4**	**Total Inst. Hrs**	**: 90**

Course objectives:

1. To inculcate skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the assayof enzymes under investigation.
2. To inculcate the knowledge of isolation and purification techniques ofenzymes using alkaline phosphatase as an example
3. To perform experiments to study the factors affecting enzyme activity
4. To achieve training in assay of enzymes
5. To achieve training in basic microbiological techniques – preparation of culture, sterilization and staining methods.
6. To perform the blood grouping test and to prepare blood smear to studydifferent types of blood cells
7. To learn molecular biology techniques like Gel electrophoresis andBlotting techniques
8. To introduce industrial visit so that students may be aware of actualneed of the industry and various opportunities available

Unit

1. Media Preparation, culturing and plating techniques
2. Determination of bacterial growth curve
3. Assessment of antimicrobial activity by tube dilution, phenol coefficient test,diffusion method
4. Preparation of Competent cell
5. Isolation of Plasmid DNA and estimations by DNP methods
6. Isolation and purification mitochondrial DNA and assay by Marker enzymes
7. Isolation and Purification of proteinEnzyme Kinetics
8. Determination of total and specific activity amylase
9. Effect of pH on enzyme activity (acid phosphatase)
10. Effect of temperature on enzyme activity (ALT/ALP) and determination of activation energy.
11. Effect of substrate concentration on enzyme activity (salivary amylase) and determination of km value.
12. Effect of inhibitor on activity of salivary amylase/urese.
13. Effect of activator on activity of salivary amylase/urease

Course Outcomes:

Course Name- PRACTICAL II		**Course Code P2R3BCCC6P**	**Knowledge Level**
After completion of this course, students would be able to			
CO1	The student will be able to employ the relevant techniques for isolation and purification of enzymes and gain skill in kinetic studies which is essential for research activity		K1, K2, K4
CO2	Student will acquire ability in performing enzyme assay, and explicate the methods that form the basis of enzyme characterization		K1, K2, K4
CO3	Learn the Basic concepts in microbiology and cell biology which will be helpful for interdisciplinary research work.		K1,K3,K4
CO4	Students will be trained in separation techniques used in molecular Biology which will be supportive in their future research		K1,K3, K4 K6
CO5	Industrial visits will provide the students with an opportunity to learn practically through interaction, working methods and employment practices. Students will have an exposure to Industrial standard and current work practices		K1, K2, K3 K4,K6

Reading List

1. https://www.researchgate.net/publication/337146254_Kinetic_studies_with_alkaline_phosphatase
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4846332/
3. https://www.ijsr.net/archive/v3i8/MDIwMTU0MDk=.pdf
4. https://www.researchgate.net/publication/349318898_ABC_of_
5. Periheral_smear
6. https://ncdc.gov.in/WriteReadData/l892s/File608.pdf
7. https://www.ncbi.nlm.nih.gov/books/NBK562156/

Self-Study

1. Preparation of Buffers and pH measurement
2. Michaelis-Menten equation and Lineweaver Burk plot

Recommended Texts

1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd
2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers
3. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
4. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley-VCH Publishers (2000).
5. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, Pearson Education Inc
6. Practical Enzymology, Second Revised Edtion: Hans Bisswanger, Wiley – Blackwell; 2 edition (2011)

Relationship Matrix for CO, PO and PSO

Title of the Course: PRACTICAL II							**Course Code: P2R3BCCC6P**			
Course Outcomes (COs)	**PO**									
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**
CO 2	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong (3) M-Medium (2) L-Low (1)

Title of the Course : BIOSTATISTICS & DATA SCIENCE
Category of the Course: DISCIPLINE SPECIFIC ELECTIVE Semester: II
Course Code : P2R3BCDSE3 Nature of the Skill : EMPLOYABILITY
Marks : CIA:25+ Ext: 75 = 100 Hrs/Week : 4
Credits : 3 Total Inst. Hrs : 60

Course objectives:

1. To summarize the data and to obtain its salient features from the
2. vast mass of original data.
3. To understand the concept of various measures of dispersion.
4. To understand the concepts of sampling and learning test
5. of significance.
6. To understand the concept of various attributes and relate to
7. biological studies.
8. To gain knowledge in SPSS, a software package which gives a
9. perfect graphical representation and appropriate result for the data that has been entered

Unit I **12Hrs**

Nature of biological and clinical experiments

Collection of data in experiment- Primary and secondary data. Methods of data collection. Classification and tabulation. Different forms of diagrams and graphs related to biological studies. Measures of Averages- Mean, Median, and mode. Use of these measures in biological studies.

Unit II **12Hrs**

Measures of Dispersion for biological characters

Quartile deviation, deviation, Mean deviation, Standard deviation and coefficient of variation. Measures of skewness and kurtosis. Correlation and regression – Rank correlation – Regression equation. Simple problems based on biochemical data.

Unit III **12Hrs**

Basic concepts of sampling

Simple random sample stratified sample and systemic sampling. Sampling distribution and standard error. Test of significance based on large samples. Test for mean, difference of means, proportions and equality of proportions.

Unit IV **12Hrs**

Small sample tests

Students't' test for mean, difference of two way means, tests for correlation and regression coefficients. Chi-square test for goodness of a non independence of attributes. F test for equality of variances. ANOVA- one way and two way. Basic concept related to biological studies

Unit V **12Hrs**

Introduction to Data Science

Definition of data science, importance, and basic applications, Machine Learning Algorithms, Deep Learning, Artificial Neural Networks and their Application, Reinforcement Learning, Natural Language Processing Artificial Intelligence (AI), Data Visualization, Data Analysis, Optimization Techniques, Big Data, Predictive Analysis. Application of AI in medical, health and pharma industries.

Course Outcomes:

Course Name- BIOSTATISTICS & DATA SCIENCE	**Course Code P2R3BCDSE3**	**Knowledge Level**
After completion of this course, students would be able to		
CO1	Concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables.	K1, K2, K3
CO2	Conditions for the consistency' and criteria for the independence of data based on attributes. Measures of central tendency, Dispersion, Skewness and Kurtosis.	K1, K2, K3
CO3	Learning different sampling methods and analysing statistical significance.	K1,K2,K3,K4
CO4	Understanding students t test, ANOVA, Chi square test to analyse the significance of various research.	K1,K2, K3 K4
CO5	Learning on data science, algorithm for machine learning, artificial intelligence and big data, their applications in clinical and pharma domain.	K1, K2, K3 K4,K6

Reading List

1.https://www.ibm.com/docs/en/SSLVMB_28.0.0/pdf/Accessibility.pdf
2.https://pure.tue.nl/ws/portalfiles/portal/19478370/20160419_CO_Mzolo.pdf
3.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5453888/
4.https://home.ubalt.edu/ntsbarsh/excel/excel.htm
5.https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_spss.pdf

https://www.ibm.com/support/pages/ibm-spss-statistics-28-documentation

Self-Study

1. Simple problems on probability, theoretical distributions, hypothesis testing
2. Relationship between mean, median and mode pros and cons of the measures of central tendency and deviation

Recommended Texts

1. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition
2. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to Biostatistics", 2nd edition,. Prestographik, Vellore, India,.
3. Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition,Springer
4. Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2nd edition ,Mc Graw Hill,
5. Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press
6. Introducing Data Science, Davy Cielen, Anro DB Meysman, Mohamed Ali.

Relationship Matrix for CO, PO and PSO

Title of the Course: BIOSTATISTICS & DATA SCIENCE							**Course Code: P2R3BCDSE3**			
Course Outcomes (COs)	**PO**									
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**

S-Strong (3) M-Medium (2) L-Low (1)

Title of the Course :BIOSAFETY, LAB SAFETY AND IPR
Category of the Course:DISCIPLINE SPECIFIC ELECTIVE Semester: II
Course Code :P2R3BCDSE4 Nature of the Skill: EMPLOYABILITY
Marks :CIA:25+ Ext: 75 = 100 Hrs/Week : 4
Credits :3 Total Inst. Hrs : 60

Course objectives:

1. To assimilate the hazards associated with the handling of biological and chemical agents.
2. To understand how to protect from the hazards by the implementation of various safety measures in biochemical laboratories.
3. To implicate the importance of protecting the scientific intellect by filing patent and understand the various offices for filing and maintaining patents
4. To understand the scope of patenting in biological research.
5. To create an awareness of ethics associated with used of genetically modified organisms/cells and its rationale for use in living organisms.

Unit I **12Hrs**

Biosafety

Historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; recommended biosafety levels for infectious agents and infected animals; biosafety guidelines - government of India, roles of IBSC, RCGM, GEAC etc. for GMO applications in food and agriculture; environmental release of GMOs; risk assessment; risk management and communication; national regulations and international agreements.

Unit II **12Hrs**

Laboratory safety

Compliance, Laboratory security and emergency response and administrative controls. Chemical, electrical and fire hazards; handling and manipulating human or animal cells and tissues, toxic, corrosive or mutagenic solvents and reagents; mouth pipetting, and inhalation exposures to infectious aerosols, Safe handling of syringe needles or other contaminated sharps, spills and splashes onto skin and mucous membranes. Health aspects; toxicology, allergenicity, antibiotic resistance. History of biosafety microbiology and molecular biology, Risk assessment, Personal protective equipment, Laboratory facilities and safety equipment, Disinfection, decontamination, and sterilization, Regulatory.

Unit III **12Hrs**

Intellectual Property Rights (IPR)

Introduction to patents, types of patents, process involved in patenting in India, trademarks, copyright, industrial design, trade secrets, traditional knowledge, geographical indications, history of national and international treaties and conventions on patents, WTO, GATT, WIPO, Budapest Treaty, Patent Cooperation Treaty (PCT) and TRIPS. Patent databases: Searching international databases; analysis and report formation. Indian Patent Act 1970; recent amendments; filing of a patent application; precautions before patenting disclosure/non-disclosure; procedure for filing a PCT application. The patentability of microorganisms-claims, Characterization and repeatability disposition in the culture collections, legal protection for plants and other higher organisms, new plant varieties by rights, tissue culture protocols.

Unit IV **12Hrs**

Patent filing and infringement

Patent application- forms and guidelines, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and convention patent applications, International patenting-requirement, financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US. Research Patenting: Patenting by researchers and scientists-University/organizational rules in India and abroad. Detailed information on patenting biological products, Case studies on patents (basmati rice, turmeric, neem etc.), and patent infringement.

Unit V **12Hrs**

Bioethics

Introduction to bioethics, human genome project and its ethical issues, genetic manipulations and their ethical issues, ethical issues in GMOs, foods and crops in developed and developing countries, environmental release of GMOs, ethical issues involved in stem cell research and use, use of animals in research experiments, animal cloning, human cloning and their ethical aspects, testing of drugs on human volunteers.

Course Outcomes:

Course Name- BIOSAFETY, LAB SAFETY AND IPR	**Course Code P2R3BCDSE4**	**Knowledge Level**
After completion of this course, students would be able to		
CO1	To understand and implement various aspects of biosafety and carry out risk assessment of products in biological research	K1, K2, K4
CO2	Student **U**nderstand the basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights	K1, K2, K4
CO3	To appreciate the intellectual property rights and its implementation of on the invention related to biological research	K1,K3,K4

CO4	To understand the statutory bodies that regulate the property rights and its validity in various countries.	K1,K3, K4 K6
CO5	Critique the ethical concerns associated with modern biotechnology processes and plan accordingly	K1, K2, K3 K4,K6

Reading List

1. V. Shree Krishna, (2007). Bioethics and Biosafety in Biotechnology, New Age International Pvt. Ltd. Publishers. (Unit III, Unit IV and Unit V)
2. Deepa Goel, Shomini Parashar, (2013). IPR, Biosafety and Bioethics, Pearson. (Unit II)
3. R. Ian Freshney, 2016. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, John Wiley & Blackwell.
4. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007. (Unit I)

Self-Study

1. Review of drug patent documents
2. Safety in biological research laboratories

Recommended Texts

1. Biosafety in Microbiological and Biomedical Laboratories, (2020) 6th Ed. (https://www.cdc.gov/labs/pdf/SF__19_308133-A_BMBL6_00-BOOK-WEB-final3.pdf)

2. Kankanala C., (2007), Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd.,

Relationship Matrix for CO, PO and PSO

Title of the Course: BIOSAFETY, LAB SAFETY AND IPR							**Course Code: P2R3BCDSE4**			
Course Outcomes (COs)	**PO**									
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**L**	**M**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 4	**S**	**M**	**M**	**L**	**S**	**L**	**S**	**S**	**S**	**M**
CO5	**S**	**S**	**S**	**L**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong (3) M-Medium (2) L-Low (1)

Title of the Course : BIOINFORMATICS

Category of the Course : SKILL ENHANCEMENT COURSE Semester: II

Course Code : P2R3BCSEC1 Nature of the Skill : EMPLOYABILITY

Marks : CIA:25+ Ext: 75 = 100 Hrs/Week : 4
Credits : 2 Total Inst. Hrs : 60

Course objectives:

1. A student completing a major in Bioinformatics shall be able to apply: knowledge and awareness of the basic principles and concepts of biology,
2. To apply Computer science and mathematics. existing software effectively
3. To extract information from large databases and to use this information in computer modeling.
4. To understand the concept of Sequence alignment & gene prediction.
5. To enable students, understand protein structural organization, prediction and visualization.

Unit I **12Hrs**

Introduction bioinformatics

Definition, Scope, importance and applications of bioinformatics. Emerging areas of bioinformatics. An introduction to Servers-World Wide Web (www). internet and intranet packages. Biological databases and its Types-Nucleic acid databases (NCBI, DDB and EMBL) **(ICT)**, Protein databases (primary, composite and secondary). Specialized Genome databases (SGD, TIGR), Structural databases (CATH, SCOP and PDB sum).

Unit II **12Hrs**

Sequence alignment

Dot matrix, local alignment (Smith and Watermen algorithm), Global alignment (Needleman and wunsch algorithm), similarity searching using BLAST and FASTA **(ICT)** Crustal-W- Multiple sequence alignment and methods and application.

Unit III **12Hrs**

Phylogenetic analysis

phylogenetic trees, Distance based and character based methods, automated tools for phylogenetic analysis. **(ASSINGMENT)**.

Unit IV **12Hrs**

Basic concepts and perspectives of Systems Biology

Introduction to Modelling in Systems Biology and some biological models: Population Ecology and Epidemiological models. Biological Networks: Representation, Network visualization and structural analysis of Biological Networks – Metabolic Networks **(ICT)**; Transcription Regulation Networks and Protein-protein Interaction Networks.

Unit V **12Hrs**

Metabolome

Interact me and Transcriptome (basic concepts), Protein- Protein Interaction Databases **(ASSINGMENT),** Systems Biology databases. Software for Systems Biology.

Course Outcomes:

Course Name- BIOINFORMATICS	**Course Code P2R3BCSEC1**	**Knowledge Level**
After completion of this course, students would be able to		
CO1	A student completing a major in Bioinformatics shall be able to apply: knowledge and awareness of the basic principles and concepts of biology	K1, K2, K4
CO2	To apply Computer science and mathematics. existing software effectively	K1, K2, K4
CO3	To extract information from large databases and to use this information in computer modelling.	K1,K3,K4
CO4	To understand the concept of Sequence alignment & gene prediction.	K1,K3, K4 K6
CO5	To enable students, understand protein structural organization, prediction and visualization.	K1, K2, K3 K4,K6

Reading List

1. Attwood, T.K. and Parry – Smith, D.J. (1999). Introduction to Bio – Informatics, Person Education, Pvt, LTD. Singapore.
2. Gibas, C, Jam beck, P. Developing Bioinformatics Computer Skills, Shroff Publisher Calcutta.

Recommended Texts

1. Kitano H. (ed.), 2001 Foundations of Systems Biology. MIT Press.
2. Bock G. and Goode J.A. (ed.), 2002 In Silico Simulation of Biological Processes, Novartis Foundation Symposium, John Wiley & Sons.
3. Klipp E., Herwig R., Kowald A., Wierling C., and Lehrach H., 2005 Systems Biology in Practice, Wiley-VCH.

4. Sneppen K. and Zocchi G., 2005 Physics in Molecular Biology, Cambridge University Press.
5. Noble D., The Music of Life, 2006 Biology Beyond the Genome Oxford University Press.

Relationship Matrix for CO, PO and PSO

Title of the Course: BIOINFORMATICS							**Course Code: P2R3BCSEC1**			
Course Outcomes (COs)	**PO**									
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**L**	**M**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 4	**S**	**M**	**M**	**L**	**S**	**L**	**S**	**S**	**S**	**M**
CO5	**S**	**S**	**S**	**L**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong (3) M-Medium (2) L-Low (1)

Course Objectives:

1. To understand the need and methods of various biological sample collection.
2. To explicitly understand the etiopathogenesis, symptoms and complications of metabolic and hormonal disorders and the relevant diagnostic markers
3. To emphasize the diagnostic significance of serum enzymes in different pathologies and other Laboratory investigations of diagnostic importance so as to differentiate normal from disease
4. To conceive the role of inherited genes in inborn errors of metabolism and methodologies pertaining to *in utero* diagnosis and post-natal screening.
5. To get updated about electrolyte and hormonal imbalances and the biochemical tests to diagnose them.

Unit I **(14 Hours)**

Basic understanding of clinical samples - Blood, urine, stool, bile. Methods for collection (anticoagulants) and preservation of samples. Clinical significance of urinary compounds with reference to sugars, proteins, ketone bodies, bilirubin and porphyrins. CSF-composition, collection, chemical examination for infections. Amniotic fluid: origin, collection, composition and analysis of amniotic fluid. Instruments used in an automated Biochemistry laboratory: Auto-Analyzers, spectrophotometer, colorimeter, haematology counter, Blood gas analyzers; ELISA reader (ICT).

Unit II **(14 Hours)**

Diagnostic Enzymology: Clinically Important Enzymes and Isoezyme as diagnostic markers: Clinical significance of AST, ALT, ALP, ACP, CK, γ-GT, amylase, pseudocholinesterase and their pattern in. Myocardial infarction; Liver disease, Bone disease, Muscle disease, Cancer (tumor markers), GI tract pancreatitis); Enzymes as therapeutic agents.

Pre- and post-natal testing: Amniocentesis, prenatal detection of inborn errors of metabolism in developing fetus- Autosomal recessive mode of inheritance- cystic fibrosis, X linked recessive

inheritance-Duchenne muscular dystrophy. New born screening (NBS) for In born errors of metabolism, Tandem mass spectrometry application in NBS

Unit III **(14 Hours)**

Organ function tests (Lab Oriented Learning)

Liver function test: Clinical features (pathogenesis, biochemical findings) and test based on bile pigments level, plasma changes, prothrombin time and consequences of jaundice, cirrhosis, hepatitis and gall stones. Kidney function test: Renal function tests, Clinical features and consequences of glomerulonephritis, acute and chronic renal failure renal failure, nephrotic syndrome and nephrolithiasis (ICT). Gastric function test: Pathogenesis, management of peptic ulcer and gastritis. Pancreatic function test: Causes, Biochemical findings, consequences of pancreatitis and cystic fibrosis.

Unit IV **(14 Hours)**

Inborn Errors Metabolism

Disorders of carbohydrate metabolism: Glycogen storage diseases (Seminar), Diabetes mellitus; Galactosemia and lactose intolerance. Mucopolysaccharides and Glucose tolerance tests. Disorders of lipid metabolism: Hyperlipidemia, Hyper cholesterolemia;, sphingolipidosis; diseases associated with lipoprotein metabolism - Atherosclerosis and coronary artery diseases; fatty liver, and lipotrophic factors. Disorders of protein metabolism: Phenylketonuria, hartnup's disease, alkaptonuria, albinism, maple syrup urine diseases. Disorders of purine and pyrimidine metabolism: Gout, orotic aciduria. Disorders of porphyrin metabolism - porphyrias.

Unit V **(14 Hours)**

Molecular diagnosis of genetic defects and cancer

Diagnosis of genetic diseases by molecular biology techniques:

Hemachromatosis, thalassemias, sickle cell diseases, DNA probes; restriction fragment length polymorphism (RFLP); polymerase chain reaction (PCR) (ICT). amplification of mRNA. AIDS: Clinical diagnosis. Cancer: Types, invasion and metastasis (ICT). Tumor markers-neuron specific enolase, prostate specific antigen, on cofetal antigen, AFP, CEA. Carbohydrate markers, genetic marker, p53 gene, Ras gene. Free radicals in diseases and its management.

Text Books:

1. Thomas M. Devlin (2014) Textbook of Biochemistry with Clinical Correlations (7th ed). John Wiley & Sons
2. Montgomery R, Conway TW, Spector AA (1996), Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA.
3. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2018) (8th ed), Saunders
4. Dinesh Puri, (2020) Text book of Biochemistry: A clinically oriented approach – 4th Edition, Elsevier.

5. 5. M. N. Chatterjee and Rana Shinde (2012). Textbook of Medical Biochemistry (8th ed), Jaypee Brothers Medical Publishers.
6. Clinical Case Discussion in Biochemistry a Book On Early Clinical Exposure (ECE), Poonam Agrawal, 2021, CBS Publishers & distributors pvt. Ltd

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**S**
CO 2	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**	**M**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**M**	**M**
CO 4	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 5	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	To appreciate the biological significance of sample collection and awareness of the diagnostic/screening tests to detect common non-communicable diseases so as to understand role of laboratory investigations for biochemical parameters and understand the disorders associated with blood cells	K4
CO2	To understand the etiology of metabolic diseases like diabetes and atherosclerosis and avoid such lifestyle disorders by healthy eating and correlate the symptoms with underlying pathology based on diagnostic and prognostic markers.	K3
CO3	To understand the diagnostic application of serum/plasma enzymes to correlate their levels with the organ pathologies associated with specific diseases.	K3
CO4	To appreciate the role of pre and post-natal diagnosis leading to healthy progeny.	K4
CO5	To link the serum hormone levels and clinical symptoms with underlying hormonal disturbances. To review the onward transmission of signal via downstream signalling molecules from cell surface to the nucleus by different pathways by comparing and contrasting them and critically evaluate the network between them resulting in the biological outcome.	K3

Course Objectives:

1. To introduce the students to the process of inheritance, concepts of genes, genome, chromatin and chromosomes.
2. To impart a thorough understanding of the key events of molecular biology, including the mechanisms of DNA replication, transcription and translation along with DNA repair mechanisms.
3. To provide a detailed understanding of post transcriptional and posttranslational modifications and processing of eukaryotic RNA and proteins
4. To give a detailed explanation of transcriptional regulation with lac operon and tryptophan operon as examples
5. To impart adequate information of the types of regulatory RNAs along with key concepts of gene silencing

Unit I **(14 Hours)**

Mendelian Inheritance-Laws of inheritance. Mendelian traits in man. Gene interaction - codominance, incomplete dominance, Epistasis. – Multiple alleles (Blood group inheritance in human) – crossing over – cytological proof for crossing over – significance of crossing over - chromosome mapping

Unit II **(14 Hours)**

DNA replication and repair: Enzymes of replication, prokaryotic replication mechanisms, primosome & replisomes, eukaryotic DNA replication, the role of topoisomerases and telomerase, regulation of replication, difference between prokaryotic and eukaryotic replication. Mutations - Types of mutations, mechanisms of mutations, mutagenic agents. DNA repair mechanisms – Direct repair, excision repair, mismatch repair, recombination repair, SOS response, eukaryotic repair systems. Recombination and mobile genetic elements- the Holliday model, the general recombination in *E.coli*, site specific recombination, transposons and retroposons.

Unit III **(14 Hours)**

Transcription – Prokaryotic transcription-subunits of RNA polymerase, E. coli promoters, sigma factor and promoter recognition, alternative sigma factors, initiation, elongation, Rho-dependent and independent termination of transcription. Eukaryotic transcription- Initiation, promoter elements, RNA polymerases, transcription factors, regulatory sequences in eukaryotic protein – coding genes, CpG islands, enhancers. Post transcriptional modifications in eukaryotes- RNA processing- mRNA 5' capping and 3'poly-adenylation, introns and exons, RNA splicing, - spliceosome assembly, alternative splicing, processing of tRNA and rRNA, self-splicing, ribozymes, RNA editing- substitution and insertion/deletion editing, Genome editing-CRISPR-Cas technology.

Unit IV **(14 Hours)**

Translation – organization of the ribosome, the genetic code, evidence for a triplet code, deciphering the genetic code, wobble hypothesis, deviation in the genetic code, unusual codons. activation, initiation, elongation and termination of translation in E. coli. The role of tRNA and rRNA, suppressor tRNAs and inhibitors of protein synthesis., Comparison of prokaryotic translation with eukaryotic translation. Post translational modification of proteins- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation, Protein sorting – signal peptides, transport of secretory proteins, Golgi and post-golgi sorting, coated vesicles, targeting of mitochondrial, lysosomal and nuclear proteins, Protein Degradation-Ubiquitination of proteins, Protein folding-chaperones

Unit V **(14 Hours)**

Regulation of gene expression in prokaryotes-– Positive and negative control, the lac operon, identification of operator and regulator sequences by mutations, induction and repression, Foot-printing and gel-shift assays for identification of protein-DNA interactions. Catabolite repression. *Trp* operon – Attenuation, alternative secondary structures of *trp* mRNA.
Regulation of gene expression in eukaryotes- Response elements, DNA-binding motifs, steroid receptors, association of methylation and histone acetylation with gene expression.

Recommended Texts

1. Lewin's Genes XII : 12th edition, Krebs JE, Goldstein ES, Kilpatrick ST ;Prentice Hall, Delhi
2. Molecular Biology of the Gene : 6th edition, Watson JD , Baker TA, Bell S, Gann A, Levine M, Losick R; Cold Spring Harbor Laboratory Press, New York
3. Essential Cell Biology :3rd edition, Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P ; Garland Science, New York
4. Molecular Cell Biology : 8th edition , Lodish H, Arnold Berk; W.H.Freeman & Co, New York
5. Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition; Wiley, India

An Introduction to Genetic Analysis 12th edition,, Griffith A. F, Doebley J, Peichel C, David A, Wassarman DA; Albion Press.W.H.Freeman & Co ,New York

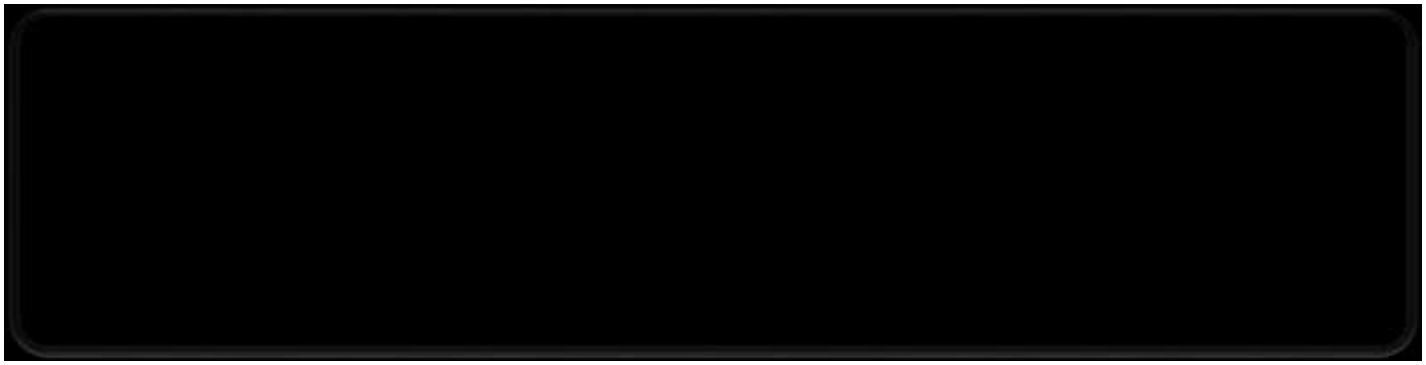
Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**L**	**M**	**L**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**M**	**M**	**L**	**M**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**L**	**M**	**L**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	Comprehend the organization of genomes, the molecular basis of DNA replication, recombination and transposition, the significance of these processes, the various ways in which the DNA can be damaged leading to mutations and lesions and the different ways in which they are repaired. (K1, K2, K3, K5)	K4
CO2	Gain knowledge about how genes are transcribed and translated in prokaryotes and eukaryotes and how these processes are regulated, recognize the nature of the genetic code and the various experimental approaches used to crack the code (K1, K2, K3, K4, K5)	K3
CO3	Acquire knowledge of the molecular basis of RNA processing and RNA splicing and the various human pathologies that can result from defects of RNA modification. (K1, K2, K4, K5)	K3
CO4	Comprehend the techniques of gene silencing and its applications. (K1, K2, K3, K4, K5, K6)	K4
CO5	Apply the knowledge they have gained in understanding the above vital life processes to enhancing their analytical and problem-solving skills and develop an interest to pursue high quality research. (K2, K3, K4, K5, K6)	K3



Course Objectives

CO1: To Understand the knowledge about Role of immunologically important organs and cells

CO2: To know outline the antigen and Antibodies

CO3: To Impart Knowledge about Major histocompatibility complex (MHC) genes

CO4: To understand the Immunization

CO5: To gain knowledge about the Types of hypersensitivity

Unit I **(12 Hours)**

Immunity:

Historical Perspective, Cellular and humoral immunity. Role of immunologically important organs and cells, bone marrow, thymus, spleen and lymphocytes. Formation and functions of T and B Lymphocytes. Helper T-cells and killer T-cells. Macrophages. Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies.

Unit II **(12 Hours)**

Antigens:

Definition, epitopes, haptens, carriers, adjuvants, antigenicity. Antibodies: Definition, types and structure of immunoglobulin's (IgG – light chain, heavy chain, hyper variable region, constant domains, Fab and Fc). Effector functions of antibody, antigenic determinants on Ig, Ig super family. Monoclonal antibodies production and applications.

Unit III **(12 Hours)**

Major histocompatibility complex (MHC)

Major histocompatibility complex (MHC) genes and products – Polymorphism of MHC genes, role of MHC antigens in immune responses, MHC antigens in transplantation. Antigen–antibody reaction in vitro: Formation of antigen-antibody complex. Application of immunodiffusion, RIA, ELISA (Basic principles only).

Unit IV **(12 Hours)**

Immunization:

Vaccination – vaccines and their preparations, primary and secondary immune response, active and passive immunization, types of vaccines, immunosuppressive therapy.

Unit V (12 Hours)

Autoimmunity and hypersensitivity:

Self-tolerance and possible mechanisms of induction of autoimmunity, Organ specific and systemic autoimmune diseases, Types of hypersensitivity. Immunological disorders: Allergy and AIDS. Structure of HIV, mode of transmission.

Text Books

1. Immunology – Janis Kuby – W. H. Freeman and Co. 7th edition (2019)

2. Richard Coico, Geoffrey Sunshine, Eli Benjamini. Immunology – A Short Course. Wiley-Liss, New York. 5th ed., 2003

3. Janeway Travers, Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd ed., 1997.

Reference Books

1. I.M. Riott, J. Brostoff, D. Male “Immunology” 3rd edn. W.H. Freeman and Pub. Company, USA.

2. J. Kuby “Immunology” 3rd edn., Mosby Year Book Co., England Introduction to Immunology –NandiniShetty (2003)

3. Janeway’sImmunobiology 2012 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN:978-0-8153-4243-4

e - Learning Resources

1. https://onlinelearning.hms.harvard.edu/hmx/courses/hmx-immunology/

2. https://www.coursera.org/courses?query=immunology

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**L**	**M**	**S**	**M**	**M**	**M**	**M**	**M**	**M**
CO 2	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**M**	**M**	**S**
CO 3	**S**	**M**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**L**	**M**	**M**	**M**	**M**	**S**	**M**	**M**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	**Significant knowledge on immunologically important organs and cells**	K4
CO2	**Understand the Helper T-cells and killer T-cells. Macrophages**	K3
CO3	**To outline the antigen and Antibodies**	K3
CO4	**Understand genes and products – Polymorphism of MHC genes**	K4
CO5	**Gaining Knowledge about Immunological disorders**	K3

Course objectives:

CO1: Explain the clinical significance of the laboratory tests

CO2: Diagnosis of clinical disorders by estimating biomarkers

CO3: Determine various substances including substrates, enzymes, hormones, etc and their use in Diagnosis and monitoring of disease are applied

CO4: Evaluate the abnormalities which commonly occur in the clinical field

CO5**:** Review the information from each category of tests and develop a protocol for Disease diagnosis

Course content

1. Qualitative analysis of abnormal constituents in urine - glucose, albumin, bile pigments,
2. bile salts and ketone bodies.
3. Estimation of serum calcium by Clark and Collips method.
4. Determination of A/G ratio by Biuret method.
5. Analysis of SGOT-SGPT (AST, ALT) / creatine kinase / acid or alkaline phosphatase.
6. Qualitative analysis of Urine sample for normal and abnormal constituents.
7. Determination of titrable acidity of urine.
8. Estimation of uric acid in serum and urine by Caraway's method
9. Estimation of creatinine and creatine in serum and urine by Zaffe's method.
10. Estimation of urea in urine by Nesslerization method (Urease method).
11. Determination of urine Chloride by Volhard-Arnold method.
12. Estimation of 17-ketosteroid by Zimmerman's method.
13. Estimation of urine Bilirubin.Estimation of serum enzymes - Creatine phosphokinase (CPK), ALP, AST, SGPT and SGOT

Text Books:

1. Joshi SA. (2010). Nutrition and Dietetics. 3rd Ed. New Delhi: McGraw Hill Education
2. (India) Put Ltd.
3. Raut SK., Mitra K and Chowdhury P., AdhunikPustibigyan, Academic Publishers.

Reference Books:

1. Practical Biochemistry- Keith Wilson and John Walker, Cambridge University Press, 1997
2. R. Boyer, Modern Experimental Biochemistry, 3rd., Pearson Education (Singapore) Pvt. Ltd.,2001.
3. D.T. Plummer, Practical Biochemistry - TATA McGraw-Hill education; 3rd edition,2006
4. Wilson and J. Walker, Practical Biochemistry, Principles and Techniques, Cambridge University Press, eighth edition 2018.

Course Outcomes

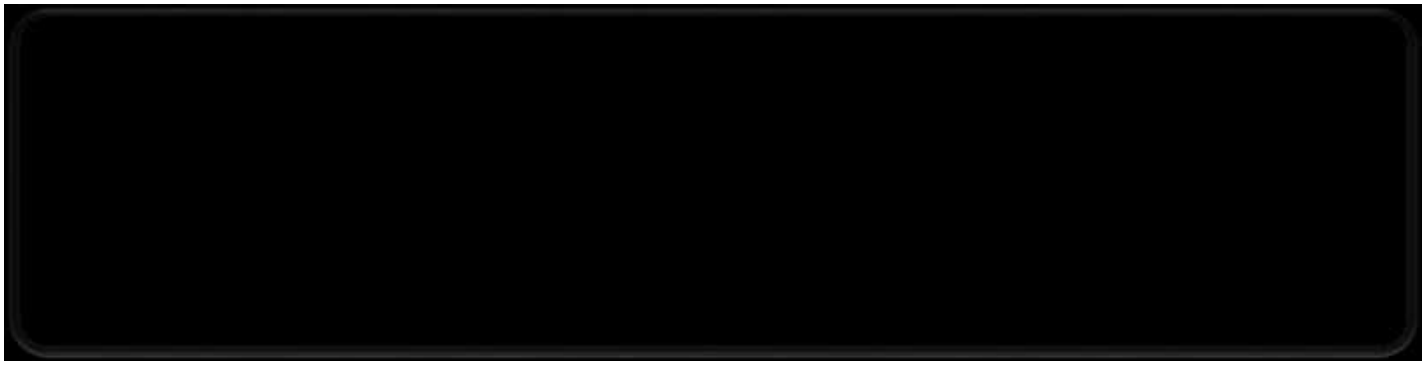
After the successful completion of the course the students shall be able to

CO. NO	**CO STATEMENT**	**KNOWLEDGE LEVEL**
CO 1	Apply and practice the methods to improve blood typing	K1, K2
CO 2	Analyse the isolation of blood cells.	K2, K3
CO3	Helps the students to understand, evaluate and analysis the abnormal constitutes in various serum biological profile	K3, K4
CO4	Create awareness of different lifestyle diseases increasingly found in present day	K2, K3
CO5	Understand and familiarize in the modern clinical Laboratory techniques and its applications	K3, K4

Relationship Matrix for CO, PO and PSO:

Course Outcome (CO)	**Programme Outcome (PO)**					**Programme Specific Outcome (PSO)**					**Average**
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	1	3	3	3	3	2	3	2.5
CO2	1	2	2	3	3	2	3	3	3	3	2.5
CO3	2	3	3	3	2	3	3	3	3	3	2.8
CO4	3	2	3	2	2	3	2	3	2	2	2.4
CO5	2	3	3	1	2	2	2	3	3	3	2.4
											2.52

Mean Overall Relationship is **2.52** which is **High**



Course Objectives

1. To understand basic concepts involved in growth, health, nutrition, physiology and metabolism

2. To discuss the concepts and applications of nutrition in correlation with biochemistry

3.To define nutritional needs in healthy individuals and modification of diet during illness

Unit I **(9 Hours)**

Basic concepts - Nutrition - Food groups and balanced diet. Novel Foods. Calorific value of foods: Direct and indirect calorimetry. Empty calories. Basal metabolic rate: Factors affecting BMR. SDA and physical activity. Calculation of day's energy requirement. Assessment of nutritional status. Lactose intolerance. Nutritional requirement and biochemical changes in different physiological states -infancy, childhood, pregnancy, lactation, and ageing. Sports nutrition.

Unit II **(10 Hours)**

Elements of nutrition - Plant and animal sources of simple and complex carbohydrates, fats and proteins and their requirement. Biological significance, deficiency and toxicity of macronutrients and micronutrients. Role of dietary fibre. Protein sparing action of carbohydrates and fats. Essential amino acids. Essential fatty acids. Effects of naturally occurring food toxins, preservatives, additives, alcohol and tobacco on health.

Unit III **(8 Hours)**

Vitamins and Minerals- Dietary sources, classification, biochemical functions, requirements, absorption, metabolism and excretion. Vitamin B complex as coenzyme. Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

Unit IV **(10 Hours)**

Malnutrition - Diseases arising due to Protein - Calorie Malnutrition and undernutrition (Kwashiorkor and Marasmus), Prevention of malnutrition. Deficiency diseases associated with vitamin B complex, vitamin C and A, D, E & K vitamins - Mineral deficiency diseases - aetiology, sign and symptoms and dietary supplementation. Enrichment and fortification (vitamins and minerals)

Unit V **(8 Hours)**

Nutrition in diseases - Aetiology, signs and symptoms, treatment and dietary management during fever(Typhoid and Malaria) and infectious diseases(COVID-19), Jaundice, hyper acidity (Ulcer), Atherosclerosis, Hypertension, kidney diseases and diabetes in adults. Starvation and Obesity. Inter-relationship of nutrition, infection, immunity and poverty

Recommended Texts

1. Srilakshmi. E .(2016) Nutrition Science, New Age International Publishers.
2. Mahan, Kathleen L. (2004) Krause's Food, Nutrition and Diet Therapy, W.B.Saunder's 11th Edition
3. Andreas M. Papas (1998). Antioxidant Status, Diet, Nutrition, and Health (1st ed) CRC Press.
4. M. Swaminathan (1995) Principles of Nutrition and Dietetics. Bappco
5. Margaret Mc Williams (2012). Food Fundamentals (10th ed) Prentice Hall
6. Tom Brody (1998) Nutritional Biochemistry (2nd ed). Academic Press, USA

Course Outcomes

CO No.	CO Statement	Knowledge level
CO1	Plan a balanced diet based on an individual's energy requirement, Assess nutritional status of an individual (K3, K4, K5)	K4
CO2	Describe the biochemical, physiological and nutritional functions of macronutrients and their integrated role. Understand the role played by antinutritional factors (k1 to K6)	K3
CO3	Evaluate the functions of vitamins and minerals, and fluids and electrolyte balance in different physiological states and in sports persons (K1 to K6)	K3
CO4	Identify nutritional deficiency conditions, its prevention and dietary management ((K3, K4)	K4
CO5	Acquire knowledge about the importance of balanced diet and diet therapy (k5,K6)	K3

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**L**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**

S-Strong M-Medium L-Low

Course Objectives

1. To understand the detailed study of biochemical basis of drugs and its toxicity, particularly their actions on living systems.
2. To understand the relevance and methods to identify the chemotherapeutic value of drug.
3. To understand the fundamentals of toxicology and dose- response relationships.
4. To understand the toxicological drug testing procedures based on in vitro and animal studies
5. To understand biochemical pathways of drug toxicity and its manifestation on vital organs.

Unit I **(10 Hours)**

Fundamentals of Toxicology and dose-Response Relationships:
Introduction Biomarkers Criteria of Toxicity New Technologies Evaluation of Toxicity Interactions; Dose Response; Measurement of Dose-Response; Relationships Linear Dose Response Hormesis; Hazard and Risk Assessment Duration and Frequency of Exposure and Effect

Unit II **(9 Hours)**

Factors Affecting Toxic Responses: Disposition: Absorption, Sites of absorption, distribution, Excretion; Metabolism: types of Metabolic change phase I reactions; Phase 2 reactions; control of Metabolism, Toxication vs. Detoxication

Unit III **(8 Hours)**

Toxicity testing; Test protocol, Genetic toxicity testing & Mutagenesis assay: In vitro test systems: bacterial mutation tests-Reversion test, Ames test, Fluctuation test, and Eukaryotic mutation test. In vivo test system Mammalian mutation test-Host mediated assay and Dominant Lethal test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules & genotoxicity, Tissue specific toxicity

Unit IV **(10 Hours)**

Toxic Responses to Foreign Compounds: Direct Toxic Action: Tissue Lesions; Mechanism and response in cellular toxicity, pharmacological, physiological and Biochemical effects; Developmental Toxicology- Teratogenesis; Immunotoxicity Genetic Toxicity; Chemical Carcinogenesis

Unit V **(9 Hours)**

Biochemical Mechanisms of Toxicity: Tissue Lesions: Liver Necrosis; kidney Damage; Lung Damage, Liver damage, Cardiac damage; Neurotoxicity; Exaggerated and Unwanted pharmacological effects; Physiological effects; Biochemical Effects: Lethal Synthesis and Incorporation, Interaction with specific Protein Receptors; Teratogenesis; Immunotoxicity; multi-Organ Toxicity

Recommended Texts

1. Principles Of Toxicology by: Karen E Stine, Thomas M Brown 2006 Publisher. Crc Press
2. Principles of Biochemical Toxicology by John A. Timbrell Publisher: Informa Healthcare
3. Environmental Toxicology by Sigmund F. Zakrzewski, (2002)
4. Publisher: Oxford University Press, USA

Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	To appreciate and understand the role of toxicological biomarkers to assess drug toxicities	K4
CO2	To conceive the role of disposition of drug in human system and their metabolism and methodologies pertaining to toxicological studies	K3
CO3	To understand and evaluate the functions of different organs on drug disposition and associated drug toxicities.	K3
CO4	To understand the toxicological response to foreign compounds and their pharmacological, physiological and biochemical effects.	K4
CO5	To link the mechanism of toxicity and clinical symptoms with underlying physiological disturbances.	K3

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**L**	**S**	**L**	**M**	**M**	**M**	**M**
CO 2	**M**	**M**	**S**	**M**	**M**	**L**	**M**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**M**	**M**
CO 4	**S**	**M**	**S**	**M**	**M**	**M**	**S**	**S**	**M**	**M**
CO 5	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**

S-Strong M-Medium L-Low

Course Objectives

1.To understand the concepts of the mechanisms involved in regulation of blood sugar and management of diabetes mellitus

2.To gain in-depth knowledge of the mechanisms of cancer and of tumor metastasis

3.The student will review the basic organization of the central and peripheral nervous system that coordinate the sensory and motor functions of the body. In addition, the student will explore impaired features underlying the major neuropathological complications.

4.To gain knowledge in renal diseases

5.To understand the mechanisms involved in cardiac disorders

Unit I **(9 Hours)**

Mechanism of blood sugar regulation in human body. Pathophysiology of Type I and II diabetes, Diabetes – investigation methods for the diagnosis of diabetes. Nutritional care. Complications related to diabetes – Diabetic cardiovascular disease, retinopathy, neuropathy and nephropathy. Cellular and molecular mechanism of development of diabetes- Management of Type I and Type II diabetes, drugs for the treatment of diabetes.

Unit II **(8 Hours)**

Biology of cancer: Overview of hallmarks of cancer. Tumorigenesis, Tumor progression and mechanism of Metastasis. Proto-oncogene to oncogene. Oncogene- myc and src family. Tumor suppressor gene-Rb and p53 pathway in cancer. Diagnosis- Non-invasive imaging techniques, Tumor diagnosis, Interventional radiology, New imaging technique, Molecular techniques in cancer diagnosis.- treatment of cancer- surgery, radiotherapy, chemotherapy, hormonal treatment, and biological therapy. Introduction to personalized medicine.

Unit III **(9 Hours)**

Brain- neuronal network- memory- Neurogenerative diseases- Parkinson and Alzheimer Disease- molecular understanding of the neurodegenerative diseases- treatment modalities.

Unit IV **(9 Hours)**

Acute and chronic renal failure, glomerular diseases–glomerulonephritis, nephritic syndrome, diabetes insipidus, diagnosis of kidney disease.

Unit V **(10 Hours)**

Introduction to cardiovascular diseases, Lipids and lipoproteins in coronary heart disease-cardiac enzymes, Molecular changes during cardiac remodeling – hypertrophy of hearts – heart failure-treatment modalities.

Recommended Texts

1. Wills' Biochemical Basis of Medicine: 2nd edition, Thomas H, Gillham B;Elsevier
2. Molecular Biochemistry of Human Diseases,2021, Feuer G ,de la Iglesia F; CRC Press

Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	Overall view about the complications of diabetes mellitus and its management.	K4
CO2	Comprehensive understanding of the concepts of cancer biology and implicating the theoretical concepts for further research	K3
CO3	Understand and appreciate the pathophysiology of conditions affecting the nervous system	K3
CO4	A thorough knowledge of renal and cardiac diseases with emphasis related to mechanistic aspects and therapeutic interventions.	K4
CO5	A thorough knowledge on the experimental models of non-communicable diseases that will be applied for future research or project dissertation. An in-depth knowledge on development of drugs against non-communicable diseases.	K3

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**	**S**	**S**
CO 2	**S**	**M**	**S**	**L**	**M**	**M**	**M**	**M**	**M**	**S**
CO 3	**S**	**S**	**M**	**L**	**S**	**S**	**M**	**M**	**S**	**M**
CO 4	**S**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**M**	**S**
CO 5	**S**	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**S**	**S**

S-Strong M-Medium L-Low

Course Objectives

1. To understand the background of developmental biology
2. To gain in-depth knowledge of various model organisms
3. To gain insight into aspects of stem cell technology
4. To gain insights into morphogenesis and organogenesis
5. To acquire in-depth understanding of cell death mechanisms and cell fate decision

Unit I **(9 Hours)**

Overview of Developmental biology: Background of Developmental biology - Principles of developmental biology –Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Unit II **(10 Hours)**

Gametogenesis – production of gametes, Formation of zygote, fertilization and early development: molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants;cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. Drosophila Developmental biology- Axis formation, Genes & mutation. *C.elegans* – Vulva formation, Axis formation.

Unit III **(8 Hours)**

Stem cells – Definition, Classification, Embryonic and adult stem cells, properties, identification, Culture of stem cells, Differentiation and dedifferentiation, Stem cellmarkers, techniques and their applications in modern clinical sciences. Three- dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.

Unit IV **(8 Hours)**

Morphogenesis & Organogenesis:Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens formation, limb development and regeneration in vertebrates;

differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Unit V **(10 Hours)**

Cellular senescence and Cell fate decision

Cellular senescence – concepts & Frizzled receptor in Development and disease. Diabetes and developmental biology, Cell death pathways in developments. Markers of important diseases.

Recommended Texts

Developmental biology: VIII edition, **Gilbert, S**F; Sinauer Associates, Inc

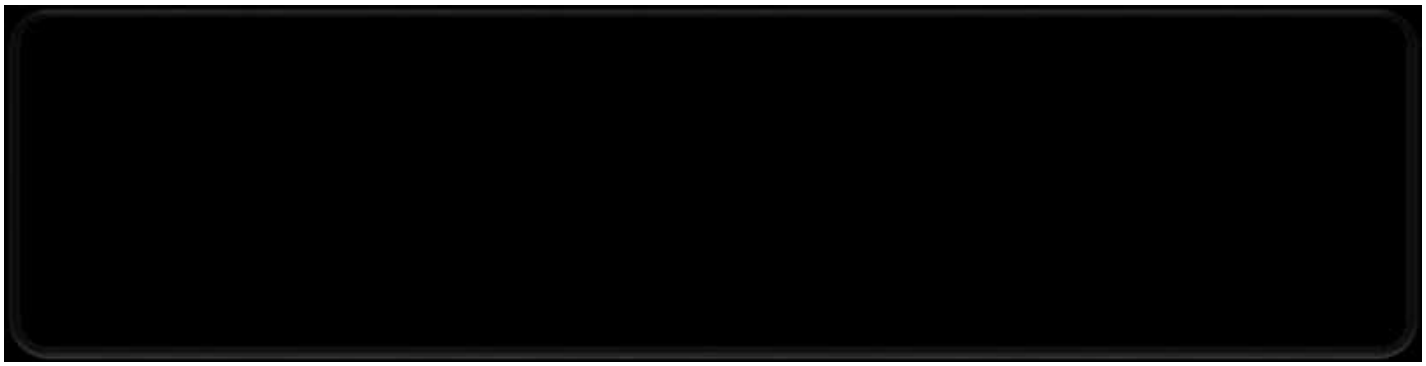
Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	Grasp knowledge about the background of developmental biology	K4
CO2	Gain abundant knowledge about model oraganisms and gametogenesis	K3
CO3	Gain knowledge about stem cells and their applications in regenerative therapy	K3
CO4	Good knowledge about organogenesis	K4
CO5	Learn the basics of cell death mechanisms and cell fate decision	K3

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**M**	**M**	**S**	**S**	**M**	**L**	**S**	**S**	**M**
CO 2	**M**	**M**	**M**	**M**	**M**	**S**	**M**	**S**	**M**	**M**
CO 3	**M**	**M**	**L**	**M**	**M**	**S**	**L**	**S**	**L**	**L**
CO 4	**S**	**M**	**L**	**S**	**S**	**M**	**S**	**S**	**M**	**M**
CO 5	**S**	**S**	**M**	**S**	**L**	**M**	**M**	**S**	**M**	**M**

S-Strong **M-Medium**



Course Objectives

1. To gain knowledge of the structure, classification and use of microorganisms in various industries.
2. To know various fermenter designs, culture systems and the application of fermentation process in industry.
3. To understand the production and purification of fermented products and their industrial applications.
4. Understand the basic concepts of food and agricultural microbiology.

Unit I **(18 Hours)**

Structure of bacteria, fungi and viruses and their classification. Types and characteristics of microorganisms used in Industry (a) Food Industry (b) Chemical Industry (c) Pharmaceutical Industry

Unit II **(18 Hours)**

Fundamentals and principles of microbial fermentation techniques – application in industry and pharmaceutical Biochemistry. Fermentation – types, techniques, design and operation of fermenters including addition of medium. Types and characteristics of microorganisms, environmental conditions required for the growth and metabolism of industrially and pharmaceutically important microbes. Sterilization methods in fermentation techniques, air, gas, culture medium sterilization. Steam-filtration and chemicals. Types and constituents of fermentative culture medium and conditions of fermentations, Antifoaming devices.

Unit III **(18 Hours)**

Recovery and estimation of products of fermentation- Production of ethanol, acetic acid, glycerol, acetone, butanol and citric acid by fermentation. Production of Enzymes- amylase, protease, lipase,Production of pharmaceuticals by fermentation– penicillin, streptomycin, tetracycline, riboflavin, vitamin B12.Beverages-wine, beer and malt beverages.

Unit IV **(18 Hours)**

Food Microbiology: Production of dairy products-bread, cheese and yoghurt (preparation and their types). Food borne diseases- Bacterial and Non- Bacterial. Food preservation - Principles–Physical methods: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, Chemical methods - salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit V **(18 Hours)**

Agricultural Microbiology: General Properties of soil, microorganisms in soil – decomposition of organic matter in soil. Biogeochemical cycles, nitrogen fixation, Production of bio fertilizers and its field applications – Rhizobium, azotobacter, blue green algae, mycorrhizae, azospirilium, Production of biofuels (biogas- methane), soil inoculants.

Recommended Texts

1. Food Microbiology: An Introduction: 4th edition,**Matthews KR, Kniel KE, Montville TJ;** American Society for Microbiology
2. Food, Fermentation and Micro-Organisms,2nd edition, **Charles, BW;** Blackwell Science Ltd
3. Microbiology. 5th edition , **Pelczar MJ, Chan ECS and Krieg NR**; McGraw Hill Book Company.
4. Text book of Microbiology:11th edition, **Ananthanarayanan R and Paniker CKJ;** Universities Press (India) Pvt. Ltd.
5. Food Microbiology, 3rd edition, **Frazier WC and Westhoff DC;**Tata McGrawHill Publishing Company Ltd, New Delhi
6. New Methods of Food Preservation:1st edition, **Gould GW**; Springer Manual of Industrial Microbiology and Biotechnology**:** 3rd edition, **Baltz**

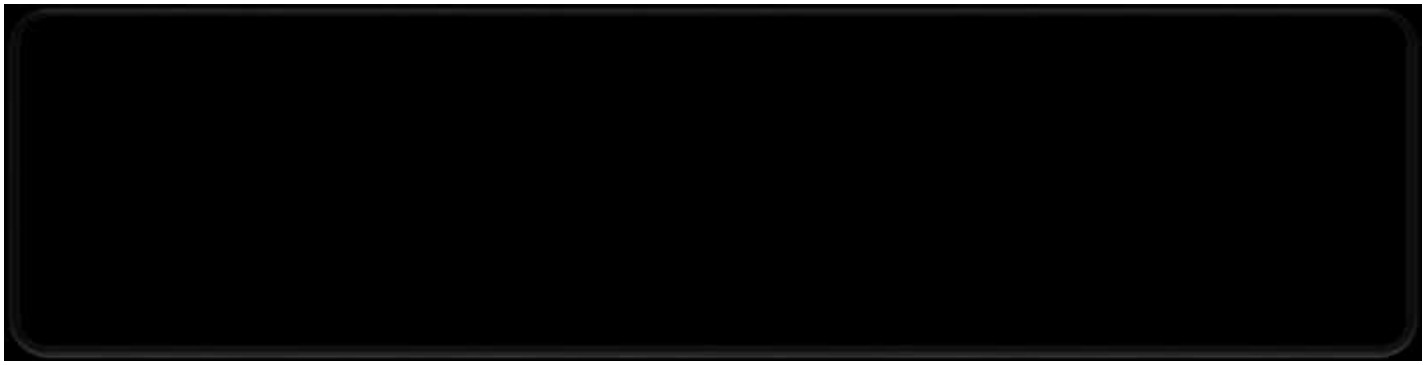
Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	Students will be able to understand the structure and classification of microorganisms (K2 , K4)	K4
CO2	Gain knowledge of the uses of microorganisms in various industrial applications (K3 , K4)	K3
CO3	Understand the concepts of fermentation process, harvest and recovery. (K1 , K5)	K3
CO4	Students will know the types of microbial fermentation processes and their applications in pharmaceutical industry. (K2 , K3)	K4
CO5	Students will learn about the use of microorganisms in beverages, diary and food industries. (K3 , K6)	K3

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	S	S	M	S	S	S	M	M	S	S
CO 2	S	M	S	S	M	S	S	M	M	M
CO 3	S	M	L	S	M	M	S	S	M	S
CO 4	M	S	S	S	L	M	S	M	S	M
CO 5	S	S	M	S	S	M	M	S	S	S

S-Strong M-Medium L-Low



Course Objectives:

1. To understand the different types of bioinformatic tools for drug discovery.
2. To get an overview of how different bioinformatic tools aid in the process of target identification, drug screening and quantitative structure activity relationship.
3. To assimilate the involvement of different metabolic pathways involved in drug metabolism and correlate their involvement in elimination process
4. To understand the biochemical basis of drug action at the target tissue.
5. To understand different phases in drug clinical trials and its assessment.

Unit I **(18 Hours)**

Drug discovery and development, drug target identification and validation, Hit identification, General principles of screening, correlations between various animal models and human situations, Correlation between in-vitro and in-vivo screens; Special emphasis on cell-based assay, biochemical assay, radiological binding assay, Pharmacological assay, In vitro, In vivo & Ex-vivo experiments, lead optimization, preclinical studies.

Unit II **(18 Hours)**

Identification of potential molecules, chemical compound library preparation, Identification of target in pathogen, Ligand & protein preparation, Molecular docking, Binding free energy estimation, High throughput virtual screening, Docking protocol validation and enrichment analysis, Single point energy calculation, Pharmacokinetics and Pharmacodynamics, ADME & toxicity prediction, Molecular dynamic simulation, Rule of three and five, Lipinsky rule, Pharmacophore development, Quantitative structure activity relationship, 3D-QSAR, Techniques of developing a pharmacophore map covering both ligand based and receptor based approaches.

Unit III **(18 Hours)**

Drug-receptor interactions, receptor theories and drug action, Xenobiotics, xenobiotics phases (Phase-I, Phase-II and Phase-III), role of cytochrome P450 oxidases and glutathione S-transferases in drug metabolism, factors affecting drug metabolism, Enzymes as a drug target, Kinase inhibitors, ATPase inhibitors, drug protein interaction, DrugDNA interaction. Basic ligand concepts-agonist, antagonist, partial agonist, inverse agonist, efficiency and potency. Forces involved in drug-receptor complexes. Receptor classification – the four super families. Receptor binding assays- measurement of Kd, Bmax and IC_{50}.

Unit IV **(18 Hours)**

Biochemical mode of action of antibiotics- penicillin and chloramphenicol, actions of alkaloids, antiviral and antimalarial substances. Biochemical mechanism of drug resistance-sulphonamides. Drug potency and drug efficacy. General principles of chemotherapy: chemotherapy of parasitic infections, fungal infections, viral diseases. Introduction to immunomodulators and chemotherapy of cancer.

Unit V **(18 Hours)**

Clinical trials (Phase-I, Phase-II, Phase-III and Phase-IV clinical trial). Main features of clinical trials, including methodological and organizational considerations and the principles of trial conduct and reporting. Key designs surrounding design, sample size, delivery and assessment of clinical trials.

Recommended Texts

1. Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc.
2. 3D QSAR in Drug Design: Theory, Methods and Applications, Ed. Kubinyi H., Ledien
3. Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns, EH, Lipinski CA, Thakker DR and Wang B, AAPS Press, 2004
4. Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1st edition 2006.
5. Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1st Edition 2012.

Course Out Comes

CO No.	CO Statement	Knowledge level
CO1	To understand and explain the basic concepts of drug discovery and drug development process.	K4
CO2	To review the different software and computational tools which aid in the design of drugs and its rationalization.	K3
CO3	To analyze the different stages of the drug discovery process with the target & hit identification, assays for drug screening and preclinical studies.	K3
CO4	To understand the various phases of the clinical trails and the method of conduct of clinical trails.	K4

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**M**	**S**	**M**	**S**	**M**	**M**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**L**	**S**	**M**	**M**	**S**	**S**	**M**
CO 4	**S**	**M**	**S**	**L**	**S**	**L**	**M**	**S**	**S**	**M**
CO 5	**S**	**S**	**S**	**L**	**S**	**M**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low