

D.K.M. COLLEGE FOR WOMEN (AUTONOMOUS)

VELLORE -1.



DEPARTMENT OF BIOCHEMISTRY

M.Sc., Biochemistry

Syllabus

With effect from 2024 - 2025

M.Sc. Biochemistry

Programme Educational Objectives (PEOs)

PEO1: Attain Academic and Professional Excellence

Build a strong academic foundation and skill set that will enable success in higher education, competitive examinations, teaching, research, industry, and entrepreneurial ventures.

PEO2: Emerge as Empowered Individuals

Develop into confident, self-reliant, and economically independent women capable of applying scientific knowledge to enhance personal growth, family welfare, and community development.

PEO3: Advance Research and Innovation

Demonstrate the ability to investigate real-world challenges and contribute contextually relevant, research-driven, and innovative solutions across scientific disciplines.

PEO4: Uphold Ethical and Cultural Values

Adhere to high ethical standards, respect cultural diversity, and engage responsibly in scientific practices that contribute to a just and inclusive society.

PEO5: Respond to Societal and National Needs

Utilize scientific understanding to support public health, environmental conservation, and technological advancement, fostering inclusive regional and national progress.

PEO6: Exhibit Leadership and Social Responsibility

Lead scientific and community initiatives with integrity, inspire collaborative action, and actively contribute to positive social transformation at local and global levels.

PEO7: Engage in Lifelong and Global Learning

Pursue continuous personal and professional development while staying abreast of global trends, innovations, and interdisciplinary scientific advancements.

Programme Outcomes (POs)

PO1: Comprehend and Apply Scientific Knowledge

Acquire and apply core knowledge from scientific disciplines to understand natural phenomena, solve complex problems, and support innovation across various domains of life and industry.

PO2: Demonstrate Analytical and Critical Thinking

Develop the ability to think critically and analytically by formulating hypotheses, interpreting experimental results, evaluating scientific literature, and drawing evidence-based conclusions.

PO3: Exhibit Technical and Laboratory Competency

Gain proficiency in laboratory techniques, handling of scientific instruments, and use of software tools, while adhering to safety protocols, accuracy, and reproducibility in experimental work.

PO4: Communicate Effectively

Present scientific concepts and findings clearly and coherently through oral presentations, technical writing, and the use of digital tools, adapting to both academic and professional contexts.

PO5: Uphold Ethical Values and Environmental Consciousness

Integrate ethical principles and environmental awareness into scientific practices, promoting sustainable solutions and a sense of accountability towards society and nature.

PO6: Engage in Lifelong Learning

Cultivate an inquisitive mindset and adaptability to emerging scientific advancements, technologies, and interdisciplinary approaches, thereby remaining relevant and competent throughout life.

PO7: Collaborate and Lead in Scientific and Social Contexts

Participate effectively in collaborative scientific projects and community-based activities, demonstrating leadership, decision-making, and commitment to women's empowerment and societal progress.

Programme Specific Outcomes (PSOs) – M.Sc. Biochemistry (PG)

PSO1: Demonstrate Advanced Biochemical Knowledge

Apply in-depth understanding of biochemical pathways, molecular biology, immunology, genetic engineering, and clinical biochemistry to scientific and industrial contexts.

PSO2: Perform and Interpret Advanced Laboratory Procedures

Operate and troubleshoot sophisticated instruments (e.g., spectrophotometers, electrophoresis units, ELISA readers, PCR machines), and apply GLP and safety norms in experimental work.

PSO3: Engage in Research and Innovation

Design and execute biochemical research projects, analyze experimental data, and contribute original ideas to scientific literature and innovation.

PSO4: Apply Biochemistry in Health, Environment, and Industry

Use biochemical principles to address challenges in disease management, biotechnology, food processing, pharmaceuticals, and environmental biochemistry.

PSO5: Communicate Scientifically and Professionally

Write technical reports, present findings in scientific forums, and collaborate effectively in academic and professional teams.

PSO6: Uphold Ethics and Contribute to Societal Development

Adhere to professional ethics in research and apply biochemistry for community welfare, public health awareness, and sustainable practices.

PSO7: Pursue Doctoral Studies and Professional Growth

Be well-equipped for Ph.D. programmes, teaching positions, competitive exams, and R&D careers in academia, healthcare, or industry.

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework
(LOCF) Guideline Based Credits and Hours Distribution System
for all Post – Graduate Courses including Lab Hours**

First Year – Semester – I

| Part | List of Courses | Credits | No. of Hours |
|-------------|------------------------|----------------|---------------------|
| | Core – I | 5 | 7 |
| | Core – II | 5 | 7 |
| | Core – III | 4 | 6 |
| | Elective – I | 3 | 5 |
| | Elective – II | 3 | 5 |
| | | 20 | 30 |

Semester-II

| Part | List of Courses | Credits | No. of Hours |
|-------------|------------------------------------|----------------|---------------------|
| | Core – IV | 5 | 6 |
| | Core – V | 5 | 6 |
| | Core – VI | 4 | 6 |
| | Elective – III | 3 | 3 |
| | Elective – IV | 3 | 3 |
| | Skill Enhancement Course [SEC] – I | 2 | 4 |
| | Human Rights | 2 | 2 |
| | Self Study | 2 | - |
| | | 26 | 30 |

Second Year – Semester – III

| Part | List of Courses | Credits | No. of Hours |
|-------------|--|----------------|---------------------|
| | Core – VII | 5 | 6 |
| | Core – VIII | 5 | 6 |
| | Core – IX | 5 | 6 |
| | Core (Industry Module) – X | 4 | 6 |
| | Elective – V | 3 | 3 |
| | Skill Enhancement Course – II | 2 | 3 |
| | Internship / Industrial Activity [Credits] | 2 | - |
| | | 26 | 30 |

Semester-IV

| Part | List of Courses | Credits | No. of Hours |
|-------------|--|----------------|---------------------|
| | Core – XI | 5 | 6 |
| | Core – XII | 5 | 6 |
| | Project with VIVA VOCE | 7 | 10 |
| | Elective – VI (Industry Entrepreneurship) | 3 | 4 |
| | Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
| | Extension Activity | 1 | - |
| | | 23 | 30 |

Total 95 Credits for PG Courses

List of Courses:

| Semester | Title of the Course | Core/Elective/ Soft Skill | Credits | Tutorial Hours |
|-----------------|--|---|----------------|---------------------------|
| I | Basics of Biochemistry | 1.1Core – I | 5 | 7 |
| | Biochemical and Molecular Biology Techniques | 1.2Core – II | 5 | 7 |
| | Laboratory course on Biomolecules and Biochemical Techniques | 1.3Core – III | 4 | 6 |
| | Microbiology & Immunology | 1.4 Elective – I | 3 | 5 |
| | Energy and Drug metabolism | 1.5 Elective – II | 3 | 5 |
| | | | 20 | 30 |
| II | Enzymology | 2.1. Core-IV | 5 | 6 |
| | Cellular Metabolism | 2.2 Core-V | 5 | 6 |
| | Laboratory course in Enzymology, Microbiology and Cell Biology | 2.3 Core – VI | 4 | 6 |
| | Elective – III Biostatistics and Data Science | 2.4 Discipline Centric Elective – III | 3 | 3 |
| | Elective - IV : Biosafety, Lab Safety and IPR | 2.5 Generic Elective -IV: | 3 | 3 |
| | (SEC-I) Nutritional Biochemistry | | 2 | 4 |
| | Human Rights | | 2 | 2 |
| | Self Study – Nutraceuticals and Nutrigenomics | | 2 | - |
| | | | 26 | 30 |
| III | Physiology and Cell Biology | 3.1. Core-VII | 5 | 6 |
| | Clinical Biochemistry | 3.2 Core-VIII | 5 | 6 |
| | Laboratory course on Clinical Biochemistry | 3.3 Core – IX | 5 | 6 |
| | Molecular Biology | 3.4 Core – X | 4 | 6 |
| | Biochemical Toxicology | 3.5 Discipline Centric Elective - V | 3 | 3 |
| | (SEC-II) Molecular Basis of Diseases and Therapeutic strategies | | 2 | 3 |
| | Internship/ Industrial Activity | | 2 | - |
| | | | 26 | 30 |

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|-----------|--|--|-----------|------------|
| IV | Gene editing, Cell and Gene therapy | 4.1. Core-XI | 5 | 6 |
| | Pharmaceutical Biochemistry | 4.2 Core-XII | 5 | 6 |
| | Project and viva | 4.3 Project with viva voce | 7 | 10 |
| | Industrial Microbiology | 4.4 Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical | 3 | 4 |
| | Developmental Biology and Endocrinology | 4.5 Skill Enhancement course / Professional Competency Skill | 2 | 4 |
| | Extension Activity | | 1 | - |
| | | | 23 | 30 |
| | | | 95 | 120 |

* Internship will be carried out during the summer vacation of the first year and marks should be sent to the University by the College and the same will be included in the Third Semester Marks Statement.

SEMESTER I

| | |
|--------------------------------|---|
| Course | CORE PAPER I |
| Title of the Course: | BASICS OF BIOCHEMISTRY -24CPBC1A |
| Credits: | 5 |
| Pre-requisites, if any: | Basic Knowledge of Biochemistry and Biomolecules |
| Course Objectives | <p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> 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. |
| Course Outcomes | <p>On successful completion of the course, the students should be able to:</p> <p>CO1 : Explain the chemical structure and functions of carbohydrates. (K1,K2).</p> <p>CO2: Using the knowledge of lipid structure and function, explain how it plays a role in signaling pathways (K3, K4).</p> <p>CO3: Describe the various levels of structural organisation of proteins and the role of proteins in biological system (K4, K5).</p> <p>CO4: Apply the knowledge of proteins in cell-cell interactions.(K3,K4) CO5. Applying the knowledge of nucleic acid sequencing in research and diagnosis (K2, K3,K4)</p> |
| Units | |
| I | Carbohydrates- Classification, structure (configurations and conformations, anomeric forms), function and properties of monosaccharides, mutarotation, disaccharides and oligosaccharides with suitable examples. Polysaccharides - Homopolysaccharides (starch, glycogen, cellulose, etc). Heteropolysaccharides - Glycosaminoglycans—source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, keratan sulphate,. Glycoproteins - proteoglycans. |
| II | Lipids – Classification of lipids, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, sphingolipids and steroids – Biological importance. Eicosanoids- classification, |

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| | structure and functions of prostaglandins. Lipoproteins – Classification, structure, transport and their biological significance. |
| III | Amino acids: Classification, Structure and Physicochemical properties; Peptide bond, Peptides of biological importance; Chemical synthesis of peptides – Solid phase peptide synthesis; Proteins – Classification, Isolation, Purification and Characterization of proteins, Criteria of homogeneity; Protein sequencing; Denaturation of proteins. |
| IV | Membrane Proteins - Types and their significance. Cytoskeleton proteins - actin, tubulin, intermediate filaments. Biological role of cytoskeletal proteins. Membrane structure-fluid mosaic model. |
| V | Nucleic acids – types and forms (A, B, C and Z) of DNA. Watson-Crick model-Primary, secondary and tertiary structures of DNA. Mitochondrial and chloroplast DNA. Determination of nucleic acid sequences by Maxam Gilbert and Sanger’s methods. Forces stabilizing nucleic acid structure. Properties of DNA and RNA. |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 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 https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod3.pdf |
| Self-Study | <ol style="list-style-type: none"> 1. Classification of Sugars 2. Nutritional classification of fatty acids |
| Recommended Texts | <ol style="list-style-type: none"> 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 Graw-Hill. 5. Lubert Stryer (2010) Biochemistry,(7th ed), W.H.Freeman 6. Satyanarayana,U (2014) Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata. |

Method of Evaluation:

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|--------|---------|------------|--------------------------|-------|
| Test I | Test II | Assignment | End Semester Examination | Total |
| 10 | 10 | 5 | 75 | 100 |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, shortsummary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations. Discussion.

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 | S | M | M |
| CO 2 | S | M | L | S | M | M | M | S | M | M |
| CO 3 | S | M | M | S | S | M | L | S | M | M |
| CO 4 | S | M | M | S | M | M | M | S | M | M |
| CO 5 | S | S | M | S | S | M | M | S | M | M |

S- Strong

M-Medium

L-Low

Strong: 18

Medium: 29

Low: 3

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| Course | CORE PAPER II |
| Title of the Course: | BIOCHEMICAL AND MOLECULAR BIOLOGY TECHNIQUES - 24CPBC1B |
| Credits: | 5 |
| Pre-requisites, if any: | Comprehensive Knowledge of Tools of Biochemistry/Molecular Biology |
| Course Objectives | <p>Biochemical techniques combine various inter-disciplinary methods in biological research and the course aims to provide students with the following objectives:</p> <ol style="list-style-type: none"> 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 labeling techniques and centrifugation. |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>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)</p> <p>CO2. Demonstrate knowledge to implement the theoretical basis of chromatography in upcoming practical course work. (K3, K5)</p> <p>CO3. Demonstrate knowledge to implement the theoretical basis of electrophoretic techniques in research work. (K3, K5)</p> <p>CO4. Tackle more advanced and specialized spectroscopic techniques that are pertinent to research. (K1, K2 & K5)</p> <p>CO5. Tackle more advanced and specialized radioisotope and centrifugation techniques that are pertinent to research work. (K1, K2 & K5)</p> |
| Units | |
| I | <p>General approaches to biochemical investigation: Cell culture techniques and microscopic techniques. Organ and tissue slice technique, cell disruption 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.</p> |

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| <p style="text-align: center;">II</p> | <p>Chromatographic Techniques: Basic principles of chromatography- adsorption and partition techniques. Chiral Chromatography and counter current Chromatography. Adsorption Chromatography – Hydroxy apatite 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.</p> |
| <p style="text-align: center;">III</p> | <p>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, Microchip electrophoresis and Capillary electrophoresis.</p> |
| <p style="text-align: center;">IV</p> | <p>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.</p> |
| <p style="text-align: center;">V</p> | <p>Radio labeling 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.</p> |
| <p style="text-align: center;">Reading Li(Print and Online)</p> | <p>Principles and techniques of biochemistry and molecular biology: https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techniques%20of%20biochemistry%20and%20molecular%20biology%207th %20ed%20</p> |

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| Self-Study | <ol style="list-style-type: none"> Types of rotors Colorimetry – principle and applications |
| Recommended Texts | <ol style="list-style-type: none"> Keith Wilson, John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th ed) Cambridge University Press. David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell. David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W. H. Freeman. Rodney F. Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques,(2nd ed),Prentice Hall. Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer. Segel I.H (1976) Biochemical Calculations (2nd ed),John Wiley and Sons. Roby JF (2015) Biochemical techniques: Theory and Practice (1st ed), CBS Publishers & Distributors. |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, shortsummary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse(K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6) – Check knowledge in specific or offbeat situations. Discussion.

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 | S | L | L | S | S | M |
| CO 2 | S | M | M | S | M | L | M | S | S | L |
| CO 3 | S | M | L | S | M | M | M | S | M | L |
| CO 4 | S | S | L | S | S | M | M | S | M | M |
| CO 5 | S | S | M | S | M | M | M | S | M | M |

S- Strong M-Medium L-Low Strong: 21 Medium: 21 Low: 8

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|-----------------------------|--|
| Course | CORE PAPER III (CORE PRACTICAL I) |
| Title of the Course: | LABORATORY COURSE ON BIOMOLECULES AND BIOCHEMICAL TECHNIQUES - 24CPBC11 |
| Credits: | 4 |
| Pre-requisites | Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions |
| Course Objectives | <ol style="list-style-type: none"> 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. 6. To perform the isolation and identification of the organelles of a cell using differential centrifugation. 7. To perform phytochemical screening and quantification enabling them to give an insight on phytochemicals this will be useful for future research. |
| Course Outcomes | <p>On successful completion of this course, students should be able to:</p> <p>After completion of the course, the students should be able to:</p> <p>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)</p> <p>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).</p> <p>CO3.The student will be fine-tune in handling the instruments like colorimeter, spectrophotometer and will be able to estimate the</p> |

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| | <p>biomolecules and minerals from the given samples (K1,K2,K4,)</p> <p>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)</p> <p>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)</p> |
| | Units |
| I | <p>Biochemical studies and estimation of macromolecules</p> <ol style="list-style-type: none"> 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. |
| II | <p>UV absorption</p> <ol style="list-style-type: none"> 1. Denaturation of DNA and absorption studies at 260nm. 2. Denaturation of Protein and absorption studies at 280nm. |
| III | <p>Colorimetric estimations</p> <ol style="list-style-type: none"> 1. Estimation of Pyruvate 2. Estimation of Tryptophan. |
| IV | <p>Estimation of minerals</p> <ol style="list-style-type: none"> 1. Estimation of Calcium 2. Estimation of Iron |
| V | <p>Plant Biochemistry</p> <ol style="list-style-type: none"> 1. Qualitative analysis: Phytochemical screening 2. Estimation of Flavonoids - Quantitative analysis |
| VI | <p>Group Experiments</p> <ol style="list-style-type: none"> 1. Fractionation of sub-cellular organelles by differential centrifugation-Mitochondria and nucleus 2. Identification of the separated sub-cellular fractions using markerenzymes (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 |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 1. https://www.researchgate.net/publication/313745155_Practical_Bio_chemistry_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%20exercise |

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| | <p>s/2Photometry/spectrophotometry.pdf</p> <p>5. https://ijpsr.com/bft-article/determination-of-total-flavonoid-and-phenol-content-in-mimusops-elengi-linn/?view=fulltext</p> <p>6. https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf</p> |
| Self-Study | <p>1. Laboratory Safety Rules, Requirements and Regulations.</p> <p>2. Preparation of standard solutions and reagent</p> |
| Books Recommended | <p>1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd</p> <p>2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers</p> <p>3. Varley H (2006) Practical Clinical Biochemistry (6th ed) , CBS Publishers</p> <p>4. O. Debiyi and F. A. Sofowora, (1978)“Phytochemical screening of medical plants,” Iloyidia, vol. 3, pp. 234–246,</p> <p>5. Prof. Sarin A. Chavhan, Prof. Sushilkumar A. Shinde (2019) A Guide to Chromatography Techniques Edition:1</p> <p>6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)</p> |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

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 | 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 |
| CO 5 | S | S | S | S | S | S | S | S | S | S |

S- Strong M-Medium L-Low Strong: 41 Medium: 7 Low: 2

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|--------------------------------|--|
| Course | CORE ELECTIVE PAPER –I |
| Title of the Course: | MICROBIOLOGY & IMMUNOLOGY- 24CPBC1C |
| Credits: | 3 |
| Pre-requisites, if any: | The student should possess basic knowledge about microorganisms, types and their general characteristics. The students are also expected to possess basic understanding about the process of infection, immunological defence and pathological outcomes, if any. |
| Course Objectives | <ol style="list-style-type: none"> 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. 6. To be able to exploit the various features of microorganisms for the beneficial industrial production. |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1. To classify (by both ancient and modern modes) different types of microorganisms and explain life cycle of the microbes (K1, K2 & K5)</p> <p>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)</p> <p>CO3. To understand the common pathogenic bacteria and fungi that cause toxic effects and also will be able to employ curative measures. (K1 & K2)</p> <p>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)</p> <p>CO5. To apply knowledge gained in production of industrially important products as both pharmaceutical and nutraceutical. (K2, K4 & K5)</p> |

| Units | |
|--------------|---|
| I | Taxonomical classification-bacteria, viruses (DNA, RNA), algae, fungi and protozoa. 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. |
| II | Contamination and spoilage of foods – cereals, cereal products, meat, fish, eggs, milk and milk products. General principles of traditional and modern methods of food preservation -Removal or inactivation of microorganisms, curing, pasteurization, cold processing, freeze drying, irradiation, vacuum packing. Microbes involved in preparation of fermented foods-cheese, curd, pickles, ragi porridge (கேழ்வரகுக் கூழ்) and bread. |
| III | Food poisoning-bacterial food poisoning, <i>Salmonella</i> , <i>Clostridium botulinum</i> (botulism), <i>Staphylococcus aureus</i> , fungal food poisoning –aflatoxin, food infection– <i>Clostridium</i> , <i>Staphylococcus</i> and <i>Salmonella</i> . Pathogenic microorganisms, <i>E.coli</i> , <i>Pseudomonas</i> , <i>Klebsilla</i> , <i>Streptococcus</i> , causes, control, prevention, cure and safety. Food microbiological screening- Realtime PCR, ELISA, Aerobic and anaerobic Plate Count, anaerobic lactic acid bacteria, Hazard analysis critical control point (HACCP). |
| IV | 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. |
| V | Immune system-definition and properties. Cells of the immune system–neutrophils, eosinophils, basophils, mastcells, 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. Transplantation immunology-graft rejection and HLA antigens. Immunological techniques and its application. |

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| Reading List (Print and Online) | <ol style="list-style-type: none"> 1. https://www.ijam.co.in/index.php/ijam/article/view/1326 (Krumi(Microorganisms) in Ayurveda- a critical review) 2. Virtual Lectures in Microbiology and Immunology, University of Rochester https://www.frontiersin.org/articles/10.3389/fphar.2020.578970/full#h9 3. https://www.frontiersin.org/articles/10.3389/fmicb.2018.02151/full 4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7559905/ |
| Self-Study | <ol style="list-style-type: none"> 1. Microbial infections and gut microbiome with relevance to <i>tridoshas</i> 2. Microbial population and pH variations in different dairy products. |
| Recommended Texts | <ol style="list-style-type: none"> 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. Ananthanarayanan, 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 |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Observe, Explain.

Analyse (K4)- Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion, Debating, Presentation

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 | S | S | S | S | M | S | S | S |
| CO 2 | S | S | S | S | S | M | L | M | S | S |
| CO 3 | S | M | M | S | M | M | M | M | L | M |
| CO 4 | S | M | M | M | M | M | M | S | S | S |
| CO 5 | S | L | S | S | M | L | L | S | S | S |

S- Strong M-Medium L-Low Strong: 27 Medium: 17 Low: 6

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|-----------------------------|--|
| Course | CORE ELECTIVE PAPER II |
| Title of the Course: | ENERGY AND DRUG METABOLISM - 24CPBC1D |
| Credits: | 3 |
| Pre-requisites | Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds. |
| Course Objectives | <ol style="list-style-type: none"> 1. Familiarize on concepts of enthalpy, entropy, free energy, redox system, biological oxidation and high energy compounds. 2. Provide an insight into the relationship between electron flow and phosphorylation. 3. Inculcate knowledge on processes involved in converting light energy to chemical energy and associated food production by autotrophs. 4. Provide a platform to understand the versatile role of Krebs cycle, transport of NADH across mitochondrial membrane and energetics. 5. Educate on the various phases xenobiotic metabolism. |
| Course Outcomes | <p>On successful completion of this course, students should be able to:</p> <p>After completion of the course, the students should be able to:</p> <p>CO1. Appreciate the relationship between free energy and redox potential and will be able to justify the role of biological oxidation and energy rich compounds in maintaining the energy level of the system (K1,K2,K3,K4)</p> <p>CO2. Gain knowledge on role of mitochondria in the production of energy currency of the cell (K1, K2, K5, K6)</p> <p>CO3. Acquaint with the process of photosynthesis (K1,K2,K5)</p> <p>CO4. Comprehend on the diverse role of TCA cycle and the energy obtained on complete oxidation of glucose and fatty acid (K1,K2,K4,K5)</p> <p>CO5. Correlate the avenues available to metabolize the xenobiotics (K1, K2,K4,K5)</p> |
| Units | |
| I | Thermodynamic- principles in biology- Concept of entropy, enthalpy and free energy change. Redox systems. Redox potential and calculation of free energy. Biological oxidation – Oxidases, dehydrogenases, hydroperoxidases, oxygenases. Energy rich compounds – phosphorylated and non-phosphorylated. High energy linkages. |

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| II | Electron transport chain-various complexes of ETC, Q-cycle. Inhibitors of ETC. Oxidative phosphorylation-P/O ratio, chemiosmotic theory. Mechanism of ATP synthesis - role of F ₀ -F ₁ ATPase, ATP-ADP cycle. Inhibitors of oxidative phosphorylation ionophores, protonophores. Regulation of oxidative phosphorylation. |
| III | Light reaction-Hills reaction, absorption of light, photochemical event. Photo ETC-cyclic and non-cyclic electron flow. Photophosphorylation- role of CF ₀ -CF ₁ ATPase. Dark reaction-Calvin cycle, control of C ₃ pathway, and Hatch-Slack pathway (C ₄ pathway), Photorespiration. Synthesis and degradation of starch |
| IV | Interconversion of major food stuffs. Energy sources of brain, muscle, liver, kidney and adipose tissue. Amphibolic nature of Citric acid cycle. Anaplerotic reaction. Krebs cycle, Inhibitors and regulation of TCA cycle. Transport of extra mitochondrial NADH – Glycerophosphate shuttle, malate aspartate shuttle. Energetics of metabolic pathways – glycolysis, (aerobic and anaerobic). |
| V | Activation of sulphate ions – PAPS, APS, SAM and their biological role. Metabolism of xenobiotics – Phase I reactions – hydroxylation, oxidation and reduction. Phase II reactions – glucuronidation, sulphation, glutathione conjugation, acetylation and methylation. Factors affecting the activities of xenobiotic enzymes. |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 1. https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch21/gibbs.php. 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7767752/#:~:text=The%20mitochondrial%20electron%20transport%20chain,cellular%20ATP%20through%20oxidative%20phosphorylation. 3. https://www.researchgate.net/figure/Oxidative-phosphorylation-in-mitochondrial-electron-transport-chain-ETC-and-proton_fig1_230798915. 4. https://www.lyndhurstschools.net/userfiles/84/Classes/851/photosynthesis%20light%20&%20dark%20reactions%20ppt.pdf?id=560837. 5. https://bajan.files.wordpress.com/2010/05/amphibolic-nature-of-krebs-cycle.pdf. 6. https://www.sciencedirect.com/topics/medicine-and-dentistry/xenobiotic-metabolism#:~:text=Xenobiotic%20metabolism%20can%20be%20defined,more%20readily%20excreted%20hydrophilic%20metabolites. 7. %20can%20be%20defined,more%20readily%20excreted%20hydrophilic%20metabolites. |

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| Self-Study | <ol style="list-style-type: none"> 1. Calculation of Keq and G 2. Interrelationship of carbohydrate, protein, and fat metabolism- role of acetyl CoA |
| Recommended Texts | <ol style="list-style-type: none"> 1. David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed), W.H.Freeman. 2. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012), Harper's Illustrated Biochemistry, (29th ed), McGraw-Hill Medical. 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. Devlin RM (1983) Plant Physiology (4th ed), PWS publishers 6. Taiz L , Zeiger E (2010), Plant Physiology (5th ed), Sinauer Associates, Inc. |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

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 | S | M | S | S | S | M |
| CO 2 | S | S | S | S | S | S | S | S | S | S |
| CO 3 | S | S | S | S | S | S | S | S | S | S |
| CO 4 | S | M | S | M | S | M | S | S | S | L |
| CO 5 | S | M | S | S | S | M | S | S | S | S |

S-Strong

M-Medium

L-Low

Strong: 41 Medium: 08 Low: 01

SEMESTER II

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| Course | CORE PAPER IV |
| Title of the Course: | ENZYMOLGY -24CPBC2A |
| Credits: | 5 |
| Pre-requisites | Basic knowledge about catalysis, kinetics and chemical reaction mechanisms. |
| Course Objectives | <ol style="list-style-type: none"> 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. |
| Course Outcomes | <p>On successful completion of this course, students should be able to:</p> <p>CO1: Describe the catalytic mechanisms employed by enzymes (K1, K2 & K5)</p> <p>CO2: Choose and use the appropriate methods to isolate and purify enzymes and check the purity of the enzyme .(K1,K2 , K3,K4 & K5)</p> <p>CO3: Analyze enzyme kinetic data graphically, calculate kinetic parameters, determine the mechanism of inhibition by a drug/chemical and analyze options for applying enzymes and their inhibitors in medicine (K1, K2, K3 &K4)</p> <p>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)</p> <p>CO5: Highlight the use of enzymes in industries and biomedicine (K1,K2 & K3)</p> |
| Units | |
| I | Introduction to enzymes and features of catalysis: A short history of the discovery of enzymes and how they became powerful biochemical tools. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, Classification and Nomenclature, Specificity of enzyme action-group specificity, absolute specificity, substrate |

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| | <p>specificity, stereochemical specificity. Active site, Identification of amino acids at the active site- trapping of ES complex, identification using chemical modification of amino acid side chains and by site-directed mutagenesis.</p> <p>Mechanisms of enzyme catalysis: acid-base catalysis, covalent catalysis, electrostatic catalysis, metal ion catalysis, proximity and orientation effects, Low barrier H-bonds, Structural flexibility Mechanism of action of chymotrypsin.</p> |
| II | <p>Enzyme techniques: Isolation and purification of enzymes - Importance of enzyme purification, methods of purification- choice of source , extraction, fractionation methods-based on size or mass (centrifugation, gel filtration); based on polarity (ion-exchange chromatography, electrophoresis, isoelectric focusing, hydrophobic interaction chromatography); based on solubility (change in pH, change in ionic strength); based on specific binding sites (affinity chromatography) ,choice of methods, Criteria of purity of enzymes. Enzyme units - Katal, IU. Measurement of enzyme activity - discontinuous, continuous, coupled assays; stopped flow method and its applications. Isoenzymes and their separation by electrophoresis with special reference to LDH</p> |
| III | <p>Enzyme kinetics I: Thermodynamics of enzyme action, Activation energy, transition-state theory, steady-state kinetics & pre-steady-state kinetics. Single substrate enzyme catalyzed reactions -assumptions, Michaelis-Menten and Briggs-Haldane kinetics, derivation of Michaelis- Menten equation . Double reciprocal (Lineweaver-Burk) and single reciprocal (Eadie -Hofstee) linear plots, their advantages and limitations. Analysis of kinetic data- determination of K_m, V_{max}, k_{cat}, and their physiological significance, Importance of k_{cat}/K_m. Enzyme inhibition: Irreversible inhibition. Reversible inhibition-Competitive, uncompetitive ,noncompetitive, mixed and substrate inhibition. Michaelis -Mentenequation in the presence of competitive, uncompetitive and non- competitive inhibitors. Therapeutic use of enzyme inhibitors-Aspirin, statins (irreversible inhibitors), Methotrexate (competitive inhibitor), Etoposide (non-competitive inhibitor), camptothecin (uncompetitive inhibitor).</p> |
| IV | <p>Enzyme kinetics II: Allosteric enzymes: Cooperativity, Sigmoidal kinetics taking ATCase as an example. Regulation of amount and catalytic activity by - extracellular signal, transcription, stability of mRNA, rate of translation and degradation, compartmentation, pH, temperature, substrate concentration, allosteric effectors, covalent modification. Regulation of glycogen synthase and glycogen phosphorylase. Feedback inhibition-sequential, concerted, cumulative,</p> |

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| | <p>enzyme-multiplicity with examples.</p> <p>Bi - Substrate reactions: Single Displacement reactions (SDR) (Ordered and Random bi bi mechanisms), Double Displacement reactions (DDR) (Ping pong mechanism), Examples, Cleland's representation of bisubstrate reactions.</p> |
| V | <p>Enzyme technology: Immobilization of enzymes – methods - Reversible immobilization (Adsorption, Affinity binding), Irreversible immobilization (Covalent coupling, Entrapment and Microencapsulation, Crosslinking, Advantages and Disadvantages of each method, Properties of immobilized enzymes,. Designer enzymes-ribozymes and deoxyribozymes, abzymes, synzymes. Enzymes as therapeutic agents-therapeutic use of asparaginase and streptokinase. Application of enzymes in industry- Industrial application of rennin, lipases, lactases, invertase, pectinases, papain.</p> |
| Reading List (Print and Online) | <p>Enzymes MIT Open Course Ware Free Online Course Materials https://ocw.mit.edu/high-school/biology/exam-prep/chemistry-of-life/enzymes/</p> <p>Enzymology https://onlinecourses.swayam2.ac.in/cec20_bt20/preview https://mooc.es/course/enzymology/</p> <p>The active site of enzymes https://dth.ac.in/medical/courses/biochemistry/block-1/1/index.php</p> <p>Enzymes and Enzyme Kinetics https://www.lecturio.com/medical-courses/enzymes-and-enzyme-kinetics.course#/</p> <p>Mechanistic enzymology in drug discovery: a fresh perspective https://www.nature.com/articles/nrd.2017.219</p> <p>Enzyme Biosensors for Biomedical Applications: Strategies for Safeguarding Analytical Performances in Biological Fluids https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934206/</p> |
| Self-Study | <ol style="list-style-type: none"> 1. Mechanistic enzymology in drug discovery 2. Enzyme Biosensors for Biomedical Applications |
| Recommended Texts | <ol style="list-style-type: none"> 1. Enzymes: Biochemistry, Biotechnology and Clinical chemistry, 2nd edition, 2007, Palmer T and Bonner P; Affiliated- East West press privateLtd, 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,Voet,D and Voet JG; Wiley,India. 4. Lehninger Principles of Biochemistry, 8th edition, 2021, .Nelson DLand Cox MM; WH Freeman & Co, New York. 5. Biochemistry, Berg JM, Stryer L, Gatto,G, 8th ed, 2015;WH |

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| | Freeman& Co., New York. 6. Enzyme Kinetics and Mechanism; Cook PF, Cleland W, ;2007; Garland Science, London. |
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Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

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 | 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 |
| CO 5 | S | S | S | S | M | L | M | S | S | S |

S-Strong M-Medium L-Low Strong: 33 Medium: 13 Low:04

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|----------------------------|--|
| Course | CORE PAPER V |
| Title of the Course | CELLULAR METABOLISM - 24CPBC2B |
| Credits | 5 |
| Pre-requisites | Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds |
| Course Objectives | <ol style="list-style-type: none"> 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 |
| Course Outcomes | <p>On successful completion of this course, students should be able to: After completion of the course, the students should be able to:</p> <p>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)</p> <p>CO2. Gain knowledge on polysaccharide metabolism and glycogen storage disease (K1, K2, K5)</p> <p>CO3. Acquaint with the making and braking of nucleotides (K1,K2,K4)</p> <p>CO4. Differentiate the diverse reaction a particular amino acid can experience (K1,K2,K3)</p> <p>CO5. Correlate the disturbance of metabolic reactions to clinical manifestations with reference to heme and sulphur metabolism (K1, K2, K4, K5)</p> |
| Units | |
| I | Glycolysis – aerobic and anaerobic, inhibitors, and regulation. Galactosemia, fructosuria, Pyruvate dehydrogenase complex-mechanism and regulation. Glyoxalate cycle and its regulation. Gluconeogenesis- source, key enzymes, reaction sequence and its regulation. Pentose phosphate pathway- significance and its regulation. Metabolism of glycogen – glycogenesis and Glycogenolysis - its regulation. |
| II | Oxidation of fatty acids-oxidation of saturated and unsaturated fatty acids (α , β & ω oxidation). Regulation of β oxidation. Ketogenesis and |

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| | its regulation. Biosynthesis of fatty acid–saturated and unsaturated, chain elongation, regulation. Biosynthesis of prostaglandins and thromboxanes. Biosynthesis and degradation of triacylglycerol, phosphoglycerolipids- lecithin, cephalin, plasmalogens and phosphatidyl inositol, Sphingolipid-sphingomyelin, cerebroside, sulfatides, and gangliosides. Cholesterol biosynthesis and its regulation. Lipoprotein metabolism- chylomicrons, VLDL, HDL and LDL. |
| III | Metabolism of nucleotides- <i>De novo</i> synthesis and salvage pathways of purine and pyrimidine nucleotides. Regulation and inhibitors of nucleotide biosynthesis. Degradation of purine and pyrimidine nucleotides. |
| IV | Biosynthesis of non- essential amino acids- Role and biological significance of glutamate dehydrogenase, asparagine synthetase, and phenylalanine hydroxylase. Interconversion of amino acids - proline to glutamate, methionine to cysteine, serine to glycine. Biosynthesis of spermine and spermidine. Degradation of amino acids –glucogenic and ketogenic amino acids. Formation of acetate from leucine and aromatic amino acid, pyruvate from cysteine, threonine and hydroxy proline, α -keto glutarate from histidine and proline, succinate from methionine, threonine, valine and isoleucine, Oxaloacetate from aspartate, glycine and serine. |
| V | Biosynthesis and degradation of heme. Jaundice-classification, pathology and Differential diagnosis Oxidation and reduction of inorganic sulphur compounds by microbes and plants. Sulpho transferases and their biological role- rhodanases, sulphatases, 3- mercapto pyruvate sulphur transferases. Mucopolysaccharidoses - Hunter syndrome, Sanfilippo syndrome and Maroteaux-Lamysyndrome. |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 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 6. heme_biosynthesis_in_filamentous_fungi 7. https://www.researchgate.net/publication/349746691_Microbial_Sulfur_Metabolism_and_Environmental_Implications |
| Self-Study | <ol style="list-style-type: none"> 1. Cori's Cycle and Glucose- Alanine Cycle 2. Coenzymes involved in Methanogenesis |
| Recommended Texts | <ol style="list-style-type: none"> 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. |

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| | 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 |
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Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

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 | 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 |
| CO 5 | S | M | S | S | S | M | S | S | S | S |

S-Strong M-Medium L-Low Strong: 35 Medium: 15 Low: 00

| | |
|----------------------------|--|
| Course | CORE PAPER VI (CORE PRACTICAL – II) |
| Title of the Course | LABORATORY COURSE IN ENZYMOLOGY, MICROBIOLOGY AND CELL BIOLOGY - 24CPBC21 |
| Credits | 4 |
| Pre-requisites | Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions. |
| Course Objectives | <ol style="list-style-type: none"> 1. To inculcate skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the assay of enzymes under investigation. 2. To inculcate the knowledge of isolation and purification techniques of enzymes using acid 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 study different types of blood cells. 7. To learn molecular biology techniques like Gel electrophoresis and blotting techniques. 8. To introduce industrial visit so that students may be aware of actual need of the industry and various opportunities available. |
| Course Outcomes | <p>On successful completion of this course, students should be able to:</p> <p>After completion of the course, the students should be able to:</p> <p>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).</p> <p>CO2. Student will acquire ability in performing enzyme assay, and explicate the methods that form the basis of enzyme characterization. (K1,K2,K4).</p> <p>CO3. Learn the Basic concepts in microbiology and cell biology which will be helpful for interdisciplinary research work. (K1, K3, K4).</p> <p>CO4. Students will be trained in separation techniques used in molecular Biology which will be supportive in their future research(K1, K3, K4 & K6).</p> <p>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).</p> |

| Units | |
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| I | <p>Enzymology</p> <p>Acid Phosphatase</p> <ol style="list-style-type: none"> Isolation of Acid Phosphatase from potato. Checking the purity using SDS-PAGE. Determination of optimum pH and temperature of acid phosphatase. Determination of specific activity and Km of acid phosphatase. Effect of activators and inhibitors on the activity of acid phosphatase. <p>Assay of enzymes</p> <ol style="list-style-type: none"> Determination of specific activity of Salivary Amylase. Determination of serum Alkaline Phosphatase activity. |
| II | <p>Microbiology</p> <ol style="list-style-type: none"> Safety measures and Good Laboratory Practices in microbiology laboratory. Sterilization, Culture and inoculum preparation. Staining of bacteria – Gram Staining. |
| III | <p>Physiology & Cell Biology</p> <ol style="list-style-type: none"> Test for blood grouping (Haemagglutination). Peripheral Blood smear – Staining and Interpretation. |
| IV | <p>Group Experiments</p> <ol style="list-style-type: none"> Separation of proteins based on molecular weight by SDS PAGE. Agarose gel electrophoresis of genomic DNA |
| V | <p>Industrial visit can be organised to students through Academia – Industry collaborative Program.</p> |
| Reading List (Print and Online) | <ol style="list-style-type: none"> https://www.researchgate.net/publication/337146254_Kinetic_studies_with_acid_phosphatase. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4846332/. https://www.ijsr.net/archive/v3i8/MDIwMTU0MDk=.pdf https://www.researchgate.net/publication/349318898_ABC_of_Peripheral_smear. https://ncdc.gov.in/WriteReadData/1892s/File608.pdf https://www.ncbi.nlm.nih.gov/books/NBK562156/ |
| Self-Study | <ol style="list-style-type: none"> Preparation of Buffers and pH measurement. Michaelis-Menten equation and Lineweaver Burk plot. |
| Recommended Texts | <ol style="list-style-type: none"> David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012). |

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| | <p>4. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).</p> <p>5. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, Pearson Education Inc.</p> <p>6. Practical Enzymology, Second Revised Edition: Hans Bisswanger, Wiley – Blackwell; 2 edition (2011).</p> |
|--|---|

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

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 | 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 |
| CO 5 | S | S | S | S | S | S | S | S | S | S |

S-Strong M-Medium L-Low Strong: 41 Medium: 07 Low: 02

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| Course | CORE ELECTIVE PAPER –III |
| Title of the Course | BIostatistics & Data Science - 24CPBC2C |
| Credits | 3 |
| Pre-requisites | Basic knowledge of Statistics and Computer Applications |
| Course Objectives | <ol style="list-style-type: none"> 1. To summarize the data and to obtain its salient features from the vast mass of original data. 2. To understand the concept of various measures of dispersion. 3. To understand the concepts of sampling and learning test of significance. 4. To understand the concept of various attributes and relate to biological studies. 5. To gain knowledge in SPSS, a software package which gives a perfect graphical representation and appropriate result for the data that has been entered |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1: Concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables.(K1,K2,K3)</p> <p>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)</p> <p>CO3: Learning different sampling methods and analysing statistical significance.(K1,K2,K3,K4)</p> <p>CO4: Understanding students t test, ANOVA , Chi square test to analyse the significance of various research. (K1,K2,K3,K4)</p> <p>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)</p> |
| Units | |
| I | 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. |
| II | Measures of Dispersion for biological characters – Quartile 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. |

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| <p style="text-align: center;">III</p> | <p>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. Small sample tests – Students‘t’ test for mean, difference of two way means, tests for correlation and regression coefficients.</p> |
| <p style="text-align: center;">IV</p> | <p>Introduction and Basics of Data Science, Historical Background of Data Science, Need of Data Science, Basic Components of Data Science, Main processes of Data Science, Tools Required for Data Science.</p> |
| <p style="text-align: center;">V</p> | <p>Algorithms - Machine Learning Deep Learning, Artificial Neural Networks, Artificial Intelligence (AI), Skills Required for Data Science, Applications of Data Science, Big Data and their Application in medical, health and pharma industries. Pros and Cons of Data Science.</p> |
| <p>Reading List (Print and Online)</p> | <ol style="list-style-type: none"> 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_s_pss.pdf 6. https://www.ibm.com/support/pages/ibm-spss-statistics-28-documentation |
| <p>Self-Study</p> | <ol style="list-style-type: none"> 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 |
| <p>Recommended Texts</p> | <ol style="list-style-type: none"> 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 Introducing Data Science, Davy Cielen, Anro DB Meysman, MohamedAli. |

Method of Evaluation:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain

Analyse (K4) - Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) - Check knowledge in specific or off beat situations, Discussion, Presentations

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 | 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 |
| CO 5 | S | S | S | S | S | S | M | S | S | S |

S-Strong

M-Medium

L-Low Strong: 43

Medium: 05

Low: 02

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| Course | ELECTIVE PAPER IV |
| Title of the Course | BIOSAFETY, LAB SAFETY AND IPR -24CPBC2D |
| Credits | 3 |
| Pre-requisites | The student should have a basic knowledge of hazards associated with the handling of biological agents and importance of intellectual property from scientific research. |
| Course Objectives | <ol style="list-style-type: none"> 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. |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1. To understand and implement various aspects of biosafety and carry out risk assessment of products in biological research</p> <p>CO2. Understand 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.</p> <p>CO3. To appreciate the intellectual property rights and its implementation of the invention related to biological research.</p> <p>CO4. To understand the statutory bodies that regulate the property rights and its validity in various countries.</p> <p>CO5. Critique the ethical concerns associated with modern biotechnology processes and plan accordingly.</p> |
| Units | |
| I | 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. |

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| <p style="text-align: center;">II</p> | <p>Laboratory safety - 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 compliance, Laboratory security and emergency response and administrative controls.</p> |
| <p style="text-align: center;">III</p> | <p>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 Coutreaties 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.</p> |
| <p style="text-align: center;">IV</p> | <p>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. Research Patenting: Patenting by researchers and scientists-University/organizational rules in India and abroad. Detailed information on patenting biological products, Case studies on Indian patents (basmati rice, turmeric, neem etc.),and patent infringement..</p> |
| <p style="text-align: center;">V</p> | <p>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.</p> |
| <p>Reading List (Print and</p> | <p>1. V. Shree Krishna, (2007). Bioethics and Biosafety in Biotechnology, New Age International Pvt. Ltd. Publishers. (Unit III, Unit IV and</p> |

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| Online) | 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., |

Method of Evaluation:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations. Discussion.

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 | 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 |
| CO 5 | S | S | S | L | S | M | S | S | S | S |

S-Strong M-Medium L-Low Strong: 33 Medium: 13 Low: 04

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| Course | Skill Enhancement Course [SEC] – I |
| Title of the Course | NUTRITIONAL BIOCHEMISTRY - 24SPBC2A |
| Credits | 2 |
| Pre-requisites, if any : | Basic Knowledge on Food, Nutrition & Dietetics, and metabolism of Nutrients. |
| Course Objectives | <ol style="list-style-type: none"> 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. |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1. Plan a balanced diet based on an individual's energy requirement, Assess nutritional status of an individual(K3, K4, K5)</p> <p>CO2. Describe the biochemical, physiological and nutritional functions of macronutrients and their integrated role. Understand the role played by anti-nutritional factors(K1 to K6)</p> <p>CO3. Evaluate the functions of vitamins and minerals ,and fluids and electrolyte balance in different physiological states and in sports persons(K1 to K6)</p> <p>CO4. Identify nutritional deficiency conditions , its prevention and dietary management((K3,K4)</p> <p>CO5. Acquire knowledge about the importance of balanced diet and diet therapy (k5,K6)</p> |
| Units | |
| I | 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. |
| II | Elements of nutrition - Plant and animal sources of simple and complex carbohydrates, fats and proteins and their requirement. Biological |

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| | 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. |
| III | 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. |
| IV | 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). |
| V | 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. |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 1. https://www.jmedscindmc.com/article.asp?issn=1011-4564;year=2014;volume=34;issue=5;spage=211;epage=213;aulast=Shrivastava 2. https://www.researchgate.net/figure/Relationship-between-malnutrition-infection-and-immunity-Malnutrition-is-considered-the_fig1_280722727 3. https://en.wikipedia.org/wiki/Novel_food 4. https://www.chemicalsafetyfacts.org/preservatives/ 5. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/food-enrichment |
| Self-Study | <ol style="list-style-type: none"> 1. Antabuse drugs and food 2. Selection of foods and market visit, reading and understanding the food labels |
| Recommended Texts | <ol style="list-style-type: none"> 1. Srilakshmi. E .(2016) Nutrition Science, New Age International Publishers. 2. Mahan, Kathleen L. (2004) Krause's Food, Nutrition and Diet Therapy, W.B.Saunders'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) |

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| | Prentice Hall 6. Tom Brody (1998) Nutritional Biochemistry (2nd ed). Academic Press, USA |
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Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) - Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations. Discussion.

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

SELF STUDY
NUTRACEUTICALS AND NUTRIGENOMICS

OBJECTIVES

- To enable the students to Gain knowledge on Nutraceutical and Nutrigenomics.
- To study the applications of Nutrigenomics in health and disease.

UNIT I

NUTRACEUTICALS AND FUNCTIONAL FOODS

Definition of functional and traditional foods, nutraceuticals, designer foods and pharma foods, history of functional foods, components of functional foods, foods containing nutraceuticals and classification of nutraceuticals – based on plant sources, mechanism of action and chemical nature

UNIT II

ROLE OF DIETARY SUPPLEMENTS AND NUTRACEUTICALS IN HEALTH AND DISEASE

Concept of dietary supplements, sources and functions of phytochemicals with suitable examples, FOSHU foods – concepts, regulatory aspects

UNIT III

PROBIOTICS AND PREBIOTICS

Human gastrointestinal tract and its microbiota, functions, concept of probiotic, prebiotics and symbiotics; applications of probiotics in human nutrition

UNIT IV

NUTRIGENOMICS

Definition of nutrigenomics, gene expression– transcription, translation, post translational modification, nutrition in the omics era- elementary concepts on epigenetics, transcriptomics, proteomics, metabolomics; genetic variation and nutritional implications

UNIT V

NUTRITION AND GENE EXPRESSION AND NUTRIGENOMICS AND COMPLEX DISEASES

Nutrient control of gene expression–amino acids, nucleotides, basic concepts of nutrigenomics and complex diseases – diabetes, cancer and obesity

REFERENCES:

1. Mahtab,S,Bamji, Kamala Krishnasamy, G.N.V.Brahmam, Text Book of Human Nutrition, Third Edition, Oxford and IBH Publishing Co. P. Ltd., New Delhi, 2009.
2. Srilakshmi, B. Second Edition, Food Science, New Age International (P) Limited Publishers,NewDelhi,2010.B.Sc.Nutrition, Food Service Management and Dietetics: Syllabus (CBCS)57

3. Simopoulos, A.P. and Ordovas, K.J.M., 2004, Nutrigenetics and Nutrigenomics, Vol. 93, Karger, Switzerland.
 4. Watson, David, H., 2003, Performance Functional Foods, CRC Press, Wood Head Publishing Ltd., England
 5. Tamine, A., 2005, Probiotic Dairy Products, Blackwell Publishing Ltd., UK6.
 6. Narasinga Rao, B.S., 2005, Nutrition Research in India – A Country Report, Published by INSA, New Delhi.
 7. Webb, G.P., 2006, Dietary Supplementations and Functional Foods, Blackwell Publishing Ltd., New York.
 8. Tai, E.S. and Gillies, P.J., 2007, Nutrigenomics– Opportunities in Asia, Karger, Singapore.
- B.Sc. Nutrition, Food Service Management and Dietetics: Syllabus(CBCS)58

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| Course | CORE PAPER – VII |
| Title of the Course: | PHYSIOLOGY AND CELL BIOLOGY |
| Credits: | 5 |
| Pre-requisites, if any: | Anatomy, Cells and Biological Compounds |
| Course Objectives | To understand the functions and activities of organs, tissues or cells and of physical and chemical phenomena involved in the human body |
| Course Outcomes | After completion of the course, the students should be able to: CO1. Specifically understand the biological and chemical processes within a human cell (K1, K2, K5, K6). CO2. Identify and prevent diseases (K2, K3, K4, k5,K6). CO3. Understand defects in digestion, nutritional deficiencies and intolerances, and gastrointestinal pathologies (K1, K2, K3, K4, K5, K6). CO4. Identify general characteristics in individuals with imbalances of acid-base, fluid and electrolytes.(K1 , K2 , K3 , K4, K5, K6). CO5. Process the mechanism: te transmission of biochemical information between cell membrane and nucleus. (K1, K2, K5). |
| Units | |
| I | Major classes of cell junctions- anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs) - cadherins, integrins. Types of tissues. Epithelium- organisation and types. The basement membrane. Cell cycle- mitosis and meiosis, Cell cycle-phases and regulation. Cell death mechanisms-an overview-apoptosis, necrosis. |
| II | Reproductive system- sexual differentiation and development; sperm transport, sperm capacitation, semen analyses and Acrosome reaction. Clinical relevance of female reproductive physiology- menstrual cycle, pregnancy and menopause. Fertilisation and infertility issues. |
| III | Digestive system- structure and functions of different components of digestive system, digestion and absorption of carbohydrates, lipids and proteins, role of bile salts in digestion and absorption, mechanism of HCl formation in stomach, role of various enzymes and hormones involved in digestive system. Composition of blood, lymph and CSF. Blood cells - WBC, RBC and energy metabolism of RBC, Blood clotting mechanism and blood groups- ABO and Rhesus system. |

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| <p>IV</p> | <p>Respiratory system-Gaseous transport and acid-base homeostasis. Mechanism of the movement of O₂ and CO₂ through lungs, arterial and venous circulation. Bohr effect, oxygen and carbon dioxide binding haemoglobin. pH maintenance by cellular and intracellular proteins. Phosphate and bicarbonate buffers, Metabolic acidosis and alkalosis. Respiratory acidosis and alkalosis. Regulation of fluid and electrolyte balance.</p> |
| <p>V</p> | <p>Sensory transduction, Nerve impulse transmission- nerve cells, synapses, reflex arc structure, resting membrane potential, Nernst equation, action potential, voltage gated ion-channels, impulse transmission, neurotransmission, neurotransmitter receptors, synaptosomes, synaptotagmin, rod and cone cells in the retina, changes in the visual cycle, photochemical reaction and regulation of rhodopsin, odour receptors, learning and memory. Chemistry of muscle contraction – actin and myosin filaments, theories involved in muscle contraction, mechanism of muscle contraction, energy sources for muscle contraction.</p> |
| <p>Reading List (Print and online)</p> | <p>https://www.genome.gov/genetics-glossary/Cell Cycle https://my.clevelandclinic.org/health/diseases/16083-infertility-causes https://www.webmd.com/heartburn-gerd/reflux-disease https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5760509/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3249628/</p> |
| <p>Self-Study</p> | <ol style="list-style-type: none"> 1. Variation in cell differentiation and progression 2. Lesch Nyhan syndrome, oroticaciduria and GERD |
| <p>Recommended Texts</p> | <ol style="list-style-type: none"> 1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6th ed). John Wiley & Sons. Inc. 2. Bruce Alberts and Dennis Bray (2013),Essential Cell Biology,(4th ed),Garland Science. 3. De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology.(8th ed). Lippincott Williams and Wilkins, Philadelphia. 4. Cooper,G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. (5th ed). Sunderland, Mass. Sinauer Associates, Inc. 5. Wayne M. Baker (2008) the World of the Cell. (7th ed). Pearson Benjamin Cummings Publishing, San Francisco. Cell Biology 6. John E. Hall (2010). Guyton and Hall Textbook of Medical Physiology (12th ed), Saunders 7. Harrison’s Endocrinology by J. Larry Jameson Series: Harrison’s Specialty, 19th Edition Publisher: McGraw-Hill, Year: 2016. |

Method of Evaluation:

| | | | | | |
|--------|---------|------------|--------------------------|-------|-------|
| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)-Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons.

Create (K6)-Check knowledge in specific or off beat situations, Discussion

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | S | S | S | S | S | M | S | S | S | M |
| CO2 | S | S | S | S | S | L | S | S | S | M |
| CO3 | S | S | S | S | S | M | M | S | S | M |
| CO4 | S | S | S | S | S | M | M | S | S | M |
| CO5 | M | S | L | S | S | L | M | M | L | L |

S-Strong M-Medium L-Low

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| Course | CORE PAPER – VIII |
| Title of the Course: | CLINICAL BIOCHEMISTRY |
| Credits: | 5 |
| Pre-requisites, if any: | The student should have a basic knowledge of body fluids and their composition and metabolism; anatomy and physiology of vital organs. |
| Course Objectives | <ol style="list-style-type: none"> 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 <i>in utero</i> diagnosis and post-natal screening. 5. To getup dated about electrolyte and hormonal imbalances and the biochemical tests to diagnose them. |
| Course Outcomes | <p>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</p> <p>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.</p> <p>CO3. To understand the diagnostic application of serum/plasma enzymes to correlate their levels with the organ pathologies associated with specific diseases.</p> <p>CO4. To appreciate the role of pre and post-natal diagnosis leading to healthy progeny.</p> <p>CO5. To link the serum hormone levels and clinical symptoms with underlying hormonal disturbances. To review the onward transmission of signal via downstream signaling 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</p> |

| | Units |
|------------|--|
| I | <p>Biochemical investigations in diagnosis, prognosis, monitoring, screening: Specimen collection – blood, (primary /Secondary specimen)., urine and CSF. Preservation of biological specimens -blood, urine, CSF and amniotic fluid. ; .Biological reference ranges.</p> <p>Disorders of blood cells: Hemolytic, Iron deficiency and aplastic anemia and diagnosis, sickle cell anaemia, thalassemia HBA1C variants. Porphyrias, Thrombocytopenia, Causes of leucopenia, leukemia and leucocytosis. Disorders of blood clotting mechanism - Von willebrand’s disease, Hemophilia A, B and C, diagnostic test for clotting disorders, D-dimer and its clinical significance.</p> |
| II | <p>Diabetes mellitus: pathology and complications: Acute changes; Chronic complications: Diabetic nephropathy, neuropathy, retinopathy and Diabetic foot ulcers, Random/Fasting/PP glucose testing, Impaired glucose tolerance (IGT), Impaired fasting glucose (IFT), Diagnosis-by GTT, Pre-diabetes, Gestational DM, Glycosylated Haemoglobin (HBA1c);Glycated albumin., Hypoglycaemia and critical alert value for glucose. Markers of complications of Diabetes mellitus: Metabolic syndrome, Lipid profile & Atherosclerosis, Diabetic nephropathy, Micralbuminuria, eGFR.</p> <p>Point of care testing for glucose (Glucometers) and continuous glucose monitoring (CGM): principle and its use. Major groups of anti-diabetic drugs. Diet and life style modifications.</p> |
| III | <p>Diagnostic Enzymology: Clinically Important Enzymes and Isoenzyme 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.</p> <p>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.</p> |
| IV | <p>Liver function tests: Liver function test panel, Fatty liver. Plasma protein changes in liver diseases. Hepatitis A, B and C. Cirrhosis and fibrosis. Portal hypertension and hepatic coma. Acute phase proteins - CRP, Haptoglobins, α-fetoprotein, ferritin and transferrin and their clinical significance, Interpreting serum protein electrophoresis.</p> <p>Inflammatory markers (cytokines such as TNF-αIL6 and others).</p> |
| V | <p>Renal function tests - Tests for glomerular and tubular function-Acute and chronic renal failure-Glomerulo nephritis, Nephrotic syndrome, uraemia-urinary calculi - Nephrocalcinosis and Nephrolithiasis-causes, pathology and symptoms. Chronic kidney disease. Dialysis-Hemodialysis and peritoneal dialysis.</p> <p>Electrolyte disorder: calcium: hypercalcemia and hypocalcemia; Calcium homeostasis in Blood; phosphate: Hyper phosphatemia or</p> |

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| | <p>hypophosphatemia; Clinical significance: Potassium: hyperkalaemia and hypokalaemia, Sodium: hypernatremia and hyponatremia; Chloride: hyperchloremia, hypochloremia. Hormonal disorders and diagnostics: T3, T4 and TSH in the diagnosis of thyroid disorders; Diagnostic methods for disorders associated with adrenal, pituitary and sex hormones - Addison's disease, Cushing's syndrome, pituitary tumour, Hypopituitarism, Hypogonadism.</p> |
| <p>Reading List(Print and Online)</p> | <ol style="list-style-type: none"> 1. Utility of HIL in Clinical Chemistry: https://www.aacc.org/science-and-research/clinical-chemistry-trainee-council/trainee-council-in-english/pearls-of-laboratory-medicine/2018/utility-of-hil-in-clinical-chemistry 2. Pre, Post and Analytical Errors in Clinical Chemistry laboratory DOI:10.7860/NJLM/2016/22587:2173 https://doi.org/10.2147/JMDH.S286679 3. Standards of Medical Care in Diabetes—2022 Abridged for Primary Care Providers https://diabetesjournals.org/clinical/article/40/1/10/139035/Standards-of-Medical-Care-in-Diabetes-2022 https://doi.org/10.2337/diaspect.16.1.32 http://www.ngsp.org/ 4. Quality control in clinical laboratory https://www.researchgate.net/publication/335830829_Quality_Control_in_a_Clinical_Laboratory 5. https://labpedia.net/quality-control-of-the-clinical-laboratory/ https://journals.sagepub.com/doi/full/10.1016/j.jala.2008.12.001 https://doi.org/10.1016/B978-0-12-407821-5.00004-8 https://www.westgard.com/clia.htm https://www.labroots.com/webinar/bio-rad-unity-solution-molecular-quality-control-data-management. |
| <p>Self-Study</p> | <ol style="list-style-type: none"> 1. Potential sources of variability in the estimation of the analytes: Pre-analytical phase: acceptance rejection criteria in terms of haemolysis/icteric/lipemia (HIL) interferences. Analytical phase: Linearity, detection limits precision, accuracy, specificity, sensitivity; Total Allowable Error. (Definitions and examples). 2. Post-analytical phase :Units of reporting of clinical chemistry parameters-Interpretation of results in clinical chemistry based on laboratory investigations and quality control: critical/alert values 3. American Diabetes Association(ADA)Standards of Medical Care in Diabetes(yearly update);HBA1Ctesting:NGSP Case studies to review 4. Quality control for clinical chemistry in laboratory |

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| Recommended Texts | <ol style="list-style-type: none"> 1. Thomas M. Devlin (2014) Textbook of Biochemistry with Clinical Correlations (7th ed). John Wiley & Sons 2. Montgomery R, Conway TW, Spector A A (1996), Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA. 3. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2018) (8th ed), 4. Saunders Dinesh Puri,(2020)Textbook of Biochemistry: Aclinically Oriented approach–4thEdition,Elsevier. 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 |
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Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total |
|--------|---------|------------|--------------------------|-------|
| 10 | 10 | 5 | 75 | 100 |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Observe, Explain.

Analyse (K4)-Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons.

Create (K6)-Check knowledge in specific or off beat situations, Discussion, Debating, Presentation

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | S | S | M | S | S | S | S | M | M | S |
| CO2 | S | M | S | M | S | S | S | M | M | M |
| CO3 | S | S | S | S | S | M | S | S | M | M |
| CO4 | S | M | M | M | S | M | S | S | S | M |
| CO5 | S | M | S | M | S | S | S | S | S | S |

S-Strong M-Medium L-Low

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|--------------------------------|---|
| Course | CORE PAPER–IX (CORE PRACTICAL III) |
| Title of the Course: | LABORATORY COURSE ON CLINICAL BIOCHEMISTRY |
| Credits: | 5 |
| Pre-requisites, if any: | Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions |
| Course Objectives | <ol style="list-style-type: none"> 1. To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the investigation of biological samples, clinical approach, normal values of biochemical constituents and clinical interpretations. 2. To inculcate the knowledge of collection, preservation of blood sample and learning various hematological parameters and their significance. 3. To perform experiments to assess liver functions. And also to study the marker enzymes of liver 4. To evaluate lipid profile and assess the irrelation to cardiac function. 5. To perform experiments to estimate blood glucose and glycosylated hemoglobin. 6. To perform urine analysis, estimate BUN and clearance test to assess renal function. 7. To learn basic immune techniques antigen–antibody reactions. 8. To perform data analysis in using MS Excel 9. To introduce visit to hospital so that students may be aware of Phlebotomy ,Collection and storage of specimen, Good laboratory practices, Automation and current methods adopted in the Diagnostic labs |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1.The student will be able to acquire knowledge and skill in hematology techniques. They will get familiar with methods and knowledge to interpret the electrolyte concentration in serum (K1,K2,K3,K4,K5)</p> <p>CO2.The student will be able to assess the Liver Function and interpret the biochemical investigation in a given clinical situation (K1,K2,K3,K4,K5)</p> <p>CO3.Skill to perform the Renal function test to assess the function of Kidney and report the abnormal parameters with reference range will be achieved by the student (K1,K2,K3,K4,K5)</p> <p>CO4. To estimate the blood glucose content and lipid profile , to evaluate the alterations and record the observation in accordance to reference range will be acquired by the student(K1,K2,K3,K4,K5,K6)</p> <p>CO5: The Group Experiments will support them to acquire practical skills to work in health care sector and assist them to understand the automation process in clinical labs (K1,K2,K3,K4,K5,K6)</p> |

| Units | |
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| I | <p>Haematology:</p> <p>RBC count, WBC count – total and differential count, ESR, PCV, MCV. Bleeding Time, Clotting Time and Estimation of hemoglobin.</p> <p>Determination of Electrolytes: Sodium, Potassium</p> |
| II | <p>Liver function test:</p> <p>Estimation of bilirubin – direct and indirect.</p> <p>Estimation of plasma protein, A/G ratio, Thymol turbidity test, Prothrombin -Time (PT), Assay of serum glutamate oxaloacetate transaminase, alkaline phosphatase.</p> |
| III | <p>Renal function test:</p> <p>Collection and Preservation of Urine sample</p> <p>Qualitative tests for normal and pathological components of urine.</p> <p>Estimation of blood Urea, creatinine, and uric acid.</p> |
| IV | <p>Estimation of blood glucose by orthotoluidine and glucoseoxidase method.</p> <p>Determination of glycosylated Hb - Kit method.</p> <p>Lipid profile:</p> <p>Estimation of cholesterol by Zak's method.</p> |
| V | <p>Group Experiments</p> <ol style="list-style-type: none"> Antigen–Antibody Reaction-HCG kit method, RA kit method Phlebotomy–Venipuncture, Different techniques of venipuncture Collection of blood, Serum or Plasma separation and Storage Automation in Clinical Biochemistry -Autoanalyser ,Semiautoanalyser Isoenzyme separation of LDH by electrophoresis. |
| Reading List(Print and Online) | <ol style="list-style-type: none"> https://www.researchgate.net/publication/260182512_Practical_Manual_in_Biochemistry_and_Clinical_Biochemistry https://main.icmr.nic.in/sites/default/files/upload_documents/GCLP_Guidelines_2020_Final.pdfhttps://www.westgard.com/clia.html https://www.researchgate.net/publication/263929434_Biochemistry https://ucms.ac.in/Lectures-C-2020/Renal%20function%20Tests%20-%20PPT.pdf https://youtu.be/i2PjEks4GQ https://www.euro.who.int/data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf |
| Self-Study | <ol style="list-style-type: none"> Laboratory handling of human biological specimen Automation in Clinical Biochemistry |

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| Recommended Texts | <ol style="list-style-type: none"> 1. Practical Clinical Biochemistry-Varley's by Alan H Gowenlock, published by CBS Publishers and distributors, India Sixth Edition , 1988. 2. Manipal Manual of Clinical Biochemistry (ForMed. Lab. And Msc Stud.) 2013(4 Edition) 3. Case Oriented Approach in Biochemistry-Dr. Rajesh Kawaduji Jambhulkar, Dr. Abhijit D. Ninghot: 2019First Edition 4. Medical Lab Technology Vol I&II, Kanai L Mukerjee New Delhi: Tata Mcgraw Hill Publishing Company, 1996. 5. Practical Biochemistry–Plummer, NewDelhi: Tata Mcgraw Hill Publishing Company, 2000. 6. Introductory practical Biochemistry–S.K.Sawhney, RandhirSingh, 2nded, 2005. |
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Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons

Create (K6)–Check knowledge in specific or off beat situations. Discussion.

Mapping with Programme Outcomes:

| | 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 | M | S | M | S | S | S |
| CO5 | S | S | S | S | S | S | S | S | S | S |

S-Strong M-Medium L-Low

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|--------------------------------|---|
| Course | CORE PAPER–X |
| Title of the Course: | MOLECULAR BIOLOGY |
| Credits: | 4 |
| Pre-requisites, if any: | Knowledge of the basics of genetics, cell biology and molecular biology. |
| Course Objectives | <ol style="list-style-type: none"> 1. To introduce the students to the process of inheritance, concepts of genes, genome, chromatin and chromosomes. 2. Acquaint oneself with the knowledge on DNA replication in prokaryotes and eukaryotes 3. To provide a detailed understanding of transcriptional and post transcriptional modifications and processing of eukaryotic RNA 4. To give a detailed explanation of translational and understand the steps involved in translation of prokaryotes and eukaryotes 5. To impart adequate information of the types of mutation and the basis of spontaneous and induced mutation, repair mechanism and gene regulation. |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1: Comprehend the organization of genomes, the molecular basis of genes, genome, chromatin and chromosomes.(K1,K2,K3,K5)</p> <p>CO2: Gain knowledge about how genes are replicated, refers to the process of creating identical copies of something, most commonly referring to DNA replication. . (K1,K2,K3,K4,K5)</p> <p>CO3: Acquire knowledge of the molecular basis of transcription and RNA processing and RNA splicing and the various human pathologies that can result from defects of RNA modification. (K1,K2,K4,K5)</p> <p>CO4: Comprehend the knowledge of translation, to the process by which the genetic code in messenger RNA (mRNA) is decoded to produce a specific sequence of amino acids, ultimately forming a protein.(K1,K2,K3,K4,K5,K6)</p> <p>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)</p> |

| Units | |
|--------------|--|
| I | Introduction to genetic material - DNA/ RNA as genetic material in bacteria, bacteriophage, virus, viroids and prions; The structure and topology of DNA and RNA molecules; Central dogma of molecular biology; Genes – structure of genes, gene families, gene expression, gene promoters, introns, exons, pseudogenes, gene cluster; DNA supercoiling; Complexity of genome – DNA denaturation, microbial genomes, eukaryotic genome, higher order chromatin structure, animal chromosomes, organelle genomes. |
| II | Types of replication, evidence for semiconservative replication - Meselson and Stahl experiment, replications in circular chromosomes - Cairns model, rolling circle model. Replication in prokaryotes , replication bubble, bidirectional replication, replicon, action of SSB, primase, DNA gyrase, topoisomerases, DNA polymerase I, II, and III, lagging and leading strand synthesis, Okazaki fragments, inhibitors of replication, replication in RNA virus, plasmid replication, reverse transcriptase, retroviruses. Eukaryotic replication. |
| III | Transcription of the genetic code – Promoter structure, RNA polymerases-transcription factors, consensus sequences. Detailed overview of the different stages of initiation, elongation and termination in eukaryotes; Detailed mechanism of synthesis and processing of mRNA, rRNA and tRNA; RNA processing in eukaryotic cells; RNA Splicing- spliceosome machinery, Post transcriptional modifications. |
| IV | Genetic code - definition, deciphering of the genetic code, codon dictionary, salient features of genetic code - wobble mechanism and its significance. structure of tRNA, activating enzymes, binding of amino acids to tRNA, composition of prokaryotic and eukaryotic ribosomes, leader region, Shine-Dalgarno sequence, prokaryotic and eukaryotic protein biosynthesis - initiation, elongation, and termination, polysomes, post-translational modifications in eukaryotes, inhibitors of protein synthesis. |
| V | Genome Mutations – change in structure of Chromosome, Changes in the number of Chromosomes, Gene Mutations – Spontaneous Mutation, induced Mutation, Point Mutation, Missense Mutation, Temperature Sensitive Mutation, Hot Spot.DNA Repair Mechanism – Introduction, Direct repair, Excision repair, Mismatch repair, Recombinational repair, Regulation of gene expression – Regulation of gene expression in prokaryotes and eukaryotes |

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| Reading List(Print and Online) | <ol style="list-style-type: none"> 1. Molecular Biology Free Online Course by MIT Part3:RNA Uploaded by edX 2. https://mooc.es/course/molecular-biology/ 3. https://onlinecourses.swayam2.ac.in/cec20_ma13/preview 4. https://learn.genetics.utah.edu/ 5. https://www.cellbio.com/education.html 6. https://lifescienceinteractive.com/category/molecular-biology/ |
| Self-Study | <ol style="list-style-type: none"> 1. Multiple roles of noncoding RNAs (long ncRNA , siRNA, miRNA) in development and differentiation; implication of ncRNAs in pathologies. 2. mRNA degradation-nonsense-mediated decay. |
| Recommended Texts | <ol style="list-style-type: none"> 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 6. An Introduction to Genetic Analysis 12th edition,,GriffithA.F, Doebley J, Peichel C, David A, Wassarman DA; Albion Press.W. H. Freeman & Co, NewYork |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)-Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons.

Create (K6)-Check knowledge in specific or off beat situations, Discussion.

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| CO1 | S | S | S | L | M | L | S | S | S | S |
| CO2 | S | S | S | M | M | L | M | S | S | S |
| CO3 | S | S | S | L | M | L | M | S | S | S |
| CO4 | S | S | S | M | M | L | S | S | S | S |
| CO5 | S | S | S | S | S | M | M | S | S | S |

S-Strong**M-Medium****L-Low**

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|--------------------------------|--|
| Course I | ELECTIVE–V |
| Title of the Course: | BIOCHEMICAL TOXICOLOGY |
| Credits: | 3 |
| Pre-requisites, if any: | The student should have a basic knowledge of pharmacology of drug action and understanding on their biochemical pathways. |
| Course Objectives | <ol style="list-style-type: none"> 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. |
| Course Outcomes | <p>On completion of this course, the student will be able</p> <p>CO1: To appreciate and understand the role of toxicological biomarkers to assess drug toxicities.</p> <p>CO2: To conceive the role of disposition of drug in human system and their metabolism and methodologies pertaining to toxicological studies.</p> <p>CO3: To understand and evaluate the functions of different organs on drug disposition and associated drug toxicities.</p> <p>CO4: To understand the toxicological response to foreign compounds and their pharmacological, physiological and biochemical effects.</p> <p>CO5: To link the mechanism of toxicity and clinical symptoms with underlying physiological disturbances.</p> |

| Units | |
|--------------|--|
| I | Fundamentals of Toxicology and dose-Response Relationships: Introduction Biomarkers Criteria of Toxicity New Technologies Evaluation of Toxicity Interactions; Dose Response; Measurement of Dose-Response; Hazard and Risk Assessment; Duration and Frequency of Exposure and Effect. |
| II | 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, Detoxification mechanism. |
| III | Toxicity testing; Test protocol, Genetic toxicity testing & Mutagenesis assay: In vitro test systems: bacterial mutation tests-Reversion test, Ames test, Fluctuation test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Tissue specific toxicity. |

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| IV | Toxic Responses to Foreign Compounds: Direct Toxic Action: Tissue Lesions; Mechanism and response in cellular toxicity, pharmacological, Physiological and Biochemical effects. |
| V | 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. |

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| Self-Study | ● Case studies to review |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 1. Preclinical Safety Evaluation of Biopharmaceuticals: A Science- Based Approach to Facilitating Clinical Trials by JoyA. Cavagnaro 2. A Comprehensive Guide to Toxicology in Nonclinical Drug Development 2nd Edition by Ali S. Faqi |
| Recommended Texts | <ol style="list-style-type: none"> 1. Principles Of Toxicology by: Karen EStine, Thomas M Brown2006 Publisher. Crc Press 2. Principles of Biochemical Toxicology by John A. Timbrell Publisher: Informa Healthcare 3. Environmental Toxicology by Sigmund F. Zakrzewski,(2002) Publisher: Oxford University Press, USA |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)-Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons

Create (K6)-Check knowledge in specific or off beat situations. Discussion

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | S | S | S | L | S | L | M | M | M | M |
| CO2 | M | M | S | M | M | L | M | S | S | S |
| CO3 | S | S | S | M | M | L | S | S | M | M |
| CO4 | S | M | S | M | M | M | S | S | M | M |
| CO5 | M | S | S | S | S | M | M | M | S | S |

S-Strong M-Medium L-Low

| Course | Skill Enhancement Course [SEC]-II |
|--------------------------------|---|
| Title of the Course: | MOLECULAR BASIS OF DISEASES AND THERAPEUTIC STRATEGIES |
| Credits: | 2 |
| Pre-requisites, if any: | Knowledge of Human Physiology, Metabolism and Clinical Biochemistry |
| Course Objectives | <ol style="list-style-type: none"> 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 |
| Course Outcomes | <p>On completion of this course the student will be able to understand</p> <p>CO1.Overall view about the complications of diabetes mellitus and its management.</p> <p>CO2.Comprehensive understanding of the concepts of cancer biology and implicating the theoretical concepts for further research</p> <p>CO3.Understand and appreciate the pathophysiology of conditions affecting the nervous system.</p> <p>CO4.A thorough knowledge of renal and cardiac diseases with emphasis related to mechanistic aspects and therapeutic interventions.</p> <p>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.</p> |

| Units | |
|--------------|--|
| I | 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. |

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| II | 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. Molecular techniques in cancer diagnosis - Non-invasive imaging techniques, New imaging technique, treatment of cancer- surgery, radiotherapy, chemotherapy, hormonal treatment, and biological therapy. Introduction to personalized medicine. |
| III | Brain-neuronal network-memory-Neurogenerative diseases-Parkinson and Alzheimer Disease- molecular understanding of the neurodegenerative diseases- treatment modalities. |
| IV | Acute and chronic renal failure, glomerular diseases– glomerulonephritis, nephritic syndrome, diabetes insipidus, diagnosis of kidney disease. |
| V | 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. |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 1. The Biochemical basis of disease: 2018, Barr AJ; Portland Press 2. Biochemical Basis of Diseases 3. https://www.biologydiscussion.com/diseases-2/biochemical-basis-of-diseases/44276 |
| Recommended Texts | <ol style="list-style-type: none"> 1. Wills' Biochemical Basis of Medicine:2ndedition,Thomas H, Gillham B; Elsevier 2. Molecular Biochemistry of HumanDiseases,2021,FeuerG,dela Iglesia F; CRC Press |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total |
|--------|---------|------------|--------------------------|-------|
| 10 | 10 | 5 | 75 | 100 |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview

Application (K3)-Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain

Analyse (K4)-Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| CO1 | S | S | S | M | M | S | S | S | S | S |
| CO2 | S | M | S | L | M | M | M | M | M | S |
| CO3 | S | S | M | L | S | S | M | M | S | M |
| CO4 | S | M | M | M | M | M | S | S | M | S |
| CO5 | S | S | M | M | S | M | M | M | S | S |

S-Strong**M-Medium****L-Low**

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|--------------------------------|--|
| Course | CORE PAPER–XI |
| Title of the Course: | GENE EDITING, CELL AND GENE THERAPY |
| Credits: | 5 |
| Pre-requisites, if any: | To introduce students molecular basis of cell gene therapy; viral and nonviral gene transfer techniques and gene therapy applications in hereditary and acquired diseases. |
| Course Objectives | <ol style="list-style-type: none"> 1. To train the student in techniques related to the molecular basis of genetic diseases and to incorporate skills essential for various types of sequencing. 2. To inculcate practical knowledge on comparing the animal models used to model genetic diseases 3. To introduce and also elaborate knowledge about wide varieties of vectors and their features in addition to their applications and to identify the viral and nonviral gene transfer techniques 4. To educate about the characteristics of cell culture, therapeutic strategies in gene therapy with relevant safety/ethics involved and patents as well. |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1. Ability to read, and evaluate scientific articles within the subjects of immune therapy, gene therapy and cell therapy. (K1, &K2)</p> <p>CO2. To clone gene of their interest for several downstream purposes with a robust comprehension about wide variety of applicable gene delivery vectors. (K1, K2 & K5)</p> <p>CO3. Be able to provide examples of diseases that can be treated with immune therapy, gene therapy and cell therapy. (K2, K3 & K4)</p> <p>CO4. To identify knowledge gaps and need for further research within their chosen topic of immune therapy, gene therapy or cell therapy. (K2, K4 & K5)</p> <p>CO5. To critically discuss and reflect on ethical and social aspects of using immune, gene or cell therapy. The student will be persuaded to contemplate on upcoming technologies for futuristic benefits.(K2,K5& K6)</p> |

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| | Units |
| I | Gene Editing: Basis of gene editing, DNA repair mechanisms, Double Strand DNA breaks, nonhomologous End-Joining(NHEJ),Homology directed repair, Programmable nucleases for gene editing, Meganucleases, Zinc-Finger nucleases, Transcription Activator-Like Effector Nucleases (TALEN), CRISPR-Cas systems, gene editing using CRISPR-Cas, drawbacks and major challenge stop resent gene editing techniques, gene editing for human disease therapy. |

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| II | Gene and cell therapy: Basics of Gene and cell therapy, types of gene therapy, gene therapy strategies, therapeutic targets for gene therapy, choice of the therapeutic target, administration routes, delivery systems, expression of transgene, persistence of the gene therapy, cell targeting, immunological response to the therapy, ethical and legal issues, concerns about gene and cell therapy. |
| III | Vectors for Gene therapy: Non-viral and viral vectors for gene therapy, Physical methods of gene delivery, Polymer, Lipid and inorganic material based chemical systems for gene delivery, Viral vectors, Lentiviral, Adenoviral, Adeno-associated virus, Herpes Simplex virus, vaccinia, baculoviral vectors for gene delivery, choice of viral vector and oncolytic virus. Gene therapy applications, Gene therapy for cancer, suicide and oncolytic gene therapy. |
| IV | Stem cells and tissue regeneration: Adult and fetal stem cells, embryonic stem cells, cell reprogramming, induced pluripotent stem cells (iPSC), Chemically induced pluripotent stem cells (CiPSC), reprogramming factors, iPSC derived progenitors 'cells, Organoids, three dimensional (3D) bioprinting. |
| V | Regulatory and Ethical Considerations of stem cell and Gene Therapy, pluripotent stem cell-based cell replacement therapies. Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies. Technological challenges towards development of pluripotent stem cell-based cell replacement therapies. |
| Reading List (Print and Online) | <ol style="list-style-type: none"> 1. Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press 2. Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press 3. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine ,Alexander Battler, |
| Self-Study | <ol style="list-style-type: none"> 1. Applications of gene editing strategies 2. CART therapy for Cancer |
| Recommended Texts | <ol style="list-style-type: none"> 1. An Introduction to Human Molecular Genetics (2ndEdition),J.J. Pasternak, 2005 2. An Introduction to Molecular Medicine and Gene Therapy 1st Edition by Thomas F.K resina Upadhyay, S.K. (Ed.).(2021). 3. Human Molecular Genetics(4thEdition),Tom Strachan & Andrew Read, 2010. 4. StemCells Handbook: Stewart Sell, Humana Press; TotowaNJ, USA; Oct.2003. |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Observe, Explain.

Analyse (K4)-Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons.

Create (K6)-Check knowledge in specific or off beat situations, Discussion, Debating, Presentation.

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | S | L | M | S | M | M | M | M | M | M |
| CO2 | S | S | S | S | M | M | M | M | M | S |
| CO3 | S | M | S | S | M | S | S | S | S | S |
| CO4 | S | L | M | M | M | M | S | M | M | S |
| CO5 | S | S | S | S | S | S | S | S | S | S |

S-Strong M-Medium L-Low

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|--------------------------------|--|
| Course I | CORE PAPER–XII |
| Title of the Course: | PHARMACEUTICAL BIOCHEMISTRY |
| Credits: | 5 |
| Pre-requisites, if any: | The student should have a basic knowledge of drug discovery and development. Student should possess basic knowledge bioinformatics to understand and correlate the drug development process. |
| Course Objectives | <ol style="list-style-type: none"> 1. To understand the basic concepts of drug discovery. 2. To get an overview of how different bioinformatics tools aid in the process of target identification, drug screening and quantitative structure activity relationship. 3. Classify biological data base and to correlate the different file formats by nucleic acid, protein database, structural and metabolic database. 4. Develop algorithms for interpreting biological data. 5. To understand the the concepts of sequence similarity search and its types. 6. Understand the tool used to detect the expression of genes. 7. Apply the various tools employed in Protein structural study and Protein visualization. |
| Course Outcomes | <p>After completion of the course, the students should be able to:</p> <p>CO1. To understand and explain the basic concepts of drug discovery and drug development process.</p> <p>CO2. To review the different software and computational tools which aid in the design of drugs and its rationalization.</p> <p>CO3. To analyze the different concepts of the bioinformatics and its biological databases.</p> <p>CO4. Understand the basic concepts of biological sequences, sequence alignment, and the importance of dynamic programming in bioinformatics.</p> <p>CO5. To understand the Protein structural analysis and its properties calculations.</p> |
| Units | |
| I | Source and nature of drugs, classification and nomenclature. Basic principles of drug action, Pharmacokinetics: Absorption, distribution and elimination of drugs, routes of drug administration. Drug–protein interactions. Pharmacogenetics; dose response curve - ED50 and LD50. Origin of Drug from plants and animals. |

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| II | Drug design – Drug discovery process. Target identification and validation, lead optimization and validation. Methods and Tools in Computer-aided molecular Design, Analog Based drug design:- Pharmacophores (3D database searching, conformation searches, deriving and using 3D Pharmacophore, constrained systematic search, Genetic Algorithm, clique detection techniques, maximum likelihood method) and QSAR. Structure based drug design:- Docking, De Novo Drug Design (Fragment Placements, Connection Methods, Sequential Grow), Virtual screening. |
| III | Definition, Aim and objectives of Bioinformatics, Branches of Bioinformatics, Scope and Research area of Bioinformatics. Sequence and Molecular file format. Definition, types and examples –, Nucleotide sequence database (NCBI, EMBL, Gene bank, DDBJ) Protein sequence database, SwissProt, TrEMBL, Structural Database, PDB, Metabolic database-KEGG. |
| IV | Introduction to Sequences, alignments and Dynamic Programming; Pair wise Sequence alignment and multiple sequence alignment (Clustal W), Online tools for Sequence alignment. Similarity Search Introduction, Working with FASTA, Working with BLAST. Patterns and Profile search, Gene prediction methods, commonly available tools. |
| V | Overview of the Protein Structure, Protein Structure Visualization and prediction: Pymol, Rasmol, and Structure based Protein Classification, Protein Structure Visualization tools. Comparative modeling and its tools. Protein and nucleic acid properties: Proteomics tools at the ExpASy server, GCG utilities and EMBOSS, Computation of various parameters. |
| Self-Study | <ol style="list-style-type: none"> 1. Examples of pharmaceutical development of a drug 2. Basic pharmacology of drug action and kinetics 3. Basics of Bioinformatics and Introduction to Bioinformatics |
| Reading List(Print and Online) | <ol style="list-style-type: none"> 1. Textbook of Drug Design. Krogs gaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002. 2. Drug Discovery Handbook S. C. Gad(Editor)Wiley-Inter science Hoboken USA, 2005 |
| Recommended Texts | <ol style="list-style-type: none"> 1. Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc. 2. 3DQSARinDrugDesign:Theory,MethodsandApplications,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. . Basic of Bioinformatics by Rui Jiang Xuegong Zhang and Michael Q. Zhang Editors 5. Bioinformatics for Beginners Genes, Genomes, Molecular Evolution, Databases and Analytical Tools By: Supratim Choudhuri(Author) 6. Bioinformatics by Saras publication 7. Introduction to Bioinformatics by Arthures k |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)-Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons

Create (K6)-Check knowledge in specific or off beat situations. Discussion.

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | S | M | S | M | S | M | M | S | S | S |
| CO2 | S | S | S | M | M | S | S | S | S | S |
| CO3 | S | S | S | L | S | M | M | S | S | M |
| CO4 | S | M | S | L | S | L | M | S | S | M |
| CO5 | S | ;;S | S | L | S | M | M | S | S | S |

S-Strong M-Medium L-Low

| | |
|--------------------------------|--|
| Course | CORE ELECTIVE-VI |
| Title of the Course: | INDUSTRIAL MICROBIOLOGY |
| Credits: | 3 |
| Pre-requisites, if any: | Basic Knowledge of Microbiology and microbial techniques |
| Course Objectives | <ol style="list-style-type: none"> 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. |
| Course Outcomes | <p>CO1.Students will be able to understand the structure and classification of microorganisms (K2 , K4)</p> <p>CO2.Gain knowledge of the uses of microorganisms in various industrial applications (K3 , K4)</p> <p>CO3.Understand the concepts of fermentation process, harvest and recovery. (K1 , K5)</p> <p>CO4.Students will know the types of microbial fermentation processes and their applications in pharmaceutical industry. (K2 , K3)</p> <p>CO5.Students will learn about the use of microorganisms in beverages, diary and food industries. (K3 , K6)</p> |
| Units | |
| I | 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 |
| II | 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. Sterilization methods in fermentation techniques, air, gas, culture medium sterilization. Steam- Filtration and chemicals. |
| III | Recovery 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, vitaminB12. Beverages-wine and beer. |

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| IV | Food Microbiology: Production of dairy products-bread, cheese and yoghurt 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. |
| V | 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, azospirillum, Production of biofuels (biogas- methane). |
| Self-Study | <ul style="list-style-type: none"> ● Micro-organisms in food processing and pharma industries ● Upstream and Downstream processes in Biopharma |
| Reading List (Print and Online) | <p>Industrial biotechnology: https://nptel.ac.in/courses/102/105/102105058/ Bioreactors: https://nptel.ac.in/courses/102/106/102106053/Food Microbiology: https://nptel.ac.in/courses/126/103/126103017/ Agriculture Microbiology: https://www.youtube.com/watch?v=f7UXyVImZ_c</p> |
| Recommended Texts | <ol style="list-style-type: none"> 1. Food Microbiology: An Introduction:4thedition,Matthews KR, Kniel KE, Montville TJ; American Society for Microbiology 2. Food, Fermentation andMicro-Organisms,2ndedition,Charles, BW; Blackwell Science Ltd 3. Microbiology.5thedition, Pelczar MJ, Chan EC Sand Krieg NR; McGraw Hill Book Company. 4. Textbook of Microbiology:11thedition, Ananthanarayanan R and Paniker CKJ; Universities Press (India) Pvt. Ltd. 5. Food Microbiology, 3rd edition, Frazier WC and Westhoff DC; Tata McGraw Hill Publishing Company Ltd, New Delhi 6. New Methods of Food Preservation:1st edition, Gould GW; SpringerManualofIndustrialMicrobiologyandBiotechnology:3rd edition, Baltz |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)-Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons.

Create (K6)-Check knowledge in specific or off beat situations, Discussion.

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | S | S | M | S | S | S | M | M | S | S |
| CO2 | S | M | S | S | M | S | S | M | M | M |
| CO3 | S | M | L | S | M | M | S | S | M | S |
| CO4 | M | S | S | S | L | M | S | M | S | M |
| CO5 | S | S | M | S | S | M | M | S | S | S |

S-Strong M-Medium L-Low

| Course I | Skill Enhancement Course-III |
|--------------------------------|--|
| Title of the Course: | DEVELOPMENTAL BIOLOGY AND ENDOCRINOLOGY |
| Credits: | 2 |
| Pre-requisites, if any: | Comprehensive Knowledge of Cell Biology |
| Course Objectives | <p>The candidates undertaking this course will understand the concepts of developmental biology and endocrinology</p> <ol style="list-style-type: none"> 1. To understand the background of developmental biology. 2. To gain insights into morphogenesis and organogenesis 3. To gain insight into aspects of hormones 4. To acquire in-depth understanding of various endocrine glands 5. To understand the gonadal hormones. |
| Course Outcomes | <p>CO1.Grasp knowledge about the background of developmental biology CO2.Gain abundant knowledge about model organisms and gametogenesis CO3.Gain knowledge about basic of hormones and their applications. CO4.Good knowledge about organogenesis CO5.Learn the basics of endocrine hormones and its functions.</p> |
| Units | |
| I | Principles of developmental biology –Potency, commitment, specification, induction, competence. Gametogenesis– production of gametes, Formation of zygote, fertilization and early development: molecules in sperm-egg recognition in animals. |
| II | Morphogenesis & Organogenesis: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in amphibia; organogenesis – limb development and regeneration in vertebrates amphibia; differentiation of neurons, post embryonic development- larval formation, metamorphosis; sex determination. |
| III | Hormones–Definition, Chemical nature and classification. Mechanism of action of Group I and Group II hormones, Signal transduction and introduction to Hormonal receptors (Tyrosine receptors). Positive and negative feedback regulation of endocrine system. Pituitary hormones- Chemistry, Secretion, Functions and Regulation. Anterior Pituitary hormones–GH, Pituitary tropic hormones (LH, FSH and Prolactin) and Posterior Pituitary hormones (Vasopressin and Oxytocin). |
| IV | Thyroid and Parathyroid Hormones–Chemistry, Synthesis, Secretion, Functions and Regulations. Pancreatic Hormones-Chemistry, Secretion, Functions and Regulations (Insulin and Glucagon). Adrenal gland hormones-Chemistry, Secretion, Functions and Regulations of Adrenal Cortex hormones (glucocorticoids and mineralocorticoids) and Adrenal Medullary hormones (Epinephrine and Nor-Epinephrine). Renin-angiotensin system. |

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| V | Chemistry, Secretion, Functions and Regulations of Gonadal hormones– Testosterone, Estrogen and Progesterone. Ovarian cycle and its regulation. |
| Reading List (Print and Online) | 1. Developmental Biology–GilbertScott 2. http://bgc.org.in/pdf/study-material/developmental-biology-7th-ed-sf-gilbert.pdf |
| Recommended Texts | 1. Developmental biology: VIII edition, Gilbert, SF; Sinauer Associates, Inc 2. Harper's Illustrated Biochemistry(Murray Robert) 3. Textbook of Endocrinology, 1 st edition, I. Niyas Ahamed,(Association of Indian Biologists publications.) |

Method of Evaluation:

| Test I | Test II | Assignment | End Semester Examination | Total | Grade |
|--------|---------|------------|--------------------------|-------|-------|
| 10 | 10 | 5 | 75 | 100 | |

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)–Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/Evaluation essay, Critique or justify with pros and cons

Create (K6)–Check knowledge in specific or off beat situations, Discussion.

Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | S | M | M | S | S | M | L | S | S | M |
| CO2 | M | M | M | M | M | S | M | S | M | M |
| CO3 | M | M | L | M | M | S | L | S | L | L |
| CO4 | S | M | L | S | S | M | S | S | M | M |
| CO5 | S | S | M | S | L | M | M | S | M | M |

S-Strong M-Medium L-Low