VIDYASAGAR UNIVERSITY

MIDNAPORE – 721 102

WEST BENGAL

Syllabus for M.Sc. Program (NEP 2020)

In

BIOCHEMISTRY

New Education Policy 2020
(Effective from 2025- 2026 session)

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The Preamble:

Biochemistry is a rapidly growing field of science where biological systems are used in diverse applications in the areas of diagnosis, treatment, chemical, food industry etc. for human welfare. It is the most recent branches of biological sciences thriving on the latest technological advancements in medical, engineering technology, recombinant DNA technology, computer sciences and many more. Biochemistry is an interdisciplinary field that brings together knowledge from diverse fields such as physics, statistics, mathematics, chemistry, microbiology, biological sciences, information technology.

Biochemistry encompasses the study of all living beings including bacteria, archaebacteria, fungi, algae, protozoa, helminths, plants, animals and viruses. It includes the basic understanding of each type of cell - prokaryotic, eukaryotic, viral particles along with their intracellular architecture, their anatomical features, their physiological and biochemical process and their molecular mechanisms of inheritance right from chromosomes, genes to the nucleic acids. Biochemistry as a field of science is the most application-oriented field where the knowledge gained in this course has direct and immediate application in the real world, pharmaceutical industry, food industry, diagnostics, personalized medicine, clinical research. The programme also aims to impart competence in applying statistics to biological research and make the learner familiarized with the fast-emerging field of Bioinformatics and applications of computers in Biochemistry.

Why Biochemistry in OIST: Oriental Institute was established in the year 2006 under the affiliation of Vidyasagar University and recognized by Department of Higher Education Govt. of India. OIST has started PhD programs in the year 2010 in Biotechnology and Biochemistry under the affiliation of Vidyasagar University, more than 30 students have awarded their PhD in the Department of Biotechnology and Biochemistry.

The educational approach at OIST focuses on nurturing students' intellectual and personal strengths in a holistic manner. The OIST experience goes beyond the confines of the classroom, fostering creativity and innovation through engaging project work and interactive learning. Recognizing the uniqueness of each individual and their diverse approaches to life, we empower students to select their own pathways according to their interests. OIST has established partnerships with leading companies to offer students valuable industry exposure and immersion. The pedagogical approach at OIST is distinctive, emphasizing experiential learning and guidance from industry practitioners. This approach ensures that our students have hands-

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on experiences throughout their education. At OIST, we provide dedicated success specialists who mentor and support students in achieving their educational goals, offering a wealth of information and resources. Join the Institute with a research-oriented and industry-driven program. Our state-of-the-art facilities, including laboratories and libraries, are designed to facilitate effective learning and help students achieve their planned learning objectives. Creating a seamless, enjoyable, and productive teaching and learning environment requires the right aids, facilities, and infrastructure. At OIST, we prioritize providing our students, scholars, and faculty members with the best resources and infrastructure available. We take pride in our commendable infrastructure facilities, including a computer laboratory with over 60 computers, a Biotech lab equipped with sophisticated instruments, these facilities are accessible to students across disciplines. OIST offers a uniquely productive learning atmosphere for our students and scholars. With access to diverse and interdisciplinary learning and research facilities and infrastructure, they can enjoy an integrated educational experience.

OIST is one of the best options for students who want to establish and build their carrier in the field of Biotechnology and Biochemistry. OIST is a leading choice for students aspiring to establish and advance their careers in the field of modern Biological Sciences. We provide exceptional teaching, professional training, and research/development opportunities that are rapidly expanding to meet the demands of our diverse student community. With expertise and experience in LIFE SCIENCES, we encourage students from all backgrounds to apply. Whether you're interested in pursuing a UG-Honors degree in Microbiology or Biotechnology or seeking opportunities in Biochemistry and Biotechnology for a two-year PG course, we invite you to submit your application and join us on this exciting journey.

• Provide quality education in flexible mode to fulfil the aim of establishing an equitable knowledge society.

• Strive for upgradation of Science and Technology

• Highly qualified, bright and meritorious teaching faculties.

• Well-equipped student laboratory for Biochemistry, Biotechnology, Microbiology, Botany, Tissue culture, Bioinformatics, Chemistry, Physics, and other related biological subjects.

• Very enriched library with multidisciplinary subjects.

• Internal assessment, weekly seminar, group discussion, symposia/ conference.

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Placements:

Regular Job fair and campus interview are organised by OIST. Many of our students have qualified national Level tests like NET, GATE(IIT), ICMR and JNU and Ph.D. entrance tests conducted by different Universities and are placed in various lucrative assignments. Many of our students are conducted PhD and post-Doctoral research in reputed Institutes/ organisation in Country and abroad. Our students are engaging as faculty position ion allied Health Science colleges, **some of the important Company and organisation where our students are well placed:** Cipla, Alkem, Lupin,Torrent, Mankind, Dabur, Morries, Ajanta Pharma, Biocon, TCS, Wipro. Cord Life India, Biological Evans, Sun Pharma, PCG Life Sciences Private Limited,Tata Medical Center. Pallishree Limited. Health Tek Private Limited. Vocis – LLc, etc. and many more. West Bengal Health department.

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
Two-year P.G. Program as per NEP-2020 (Effective from 2025-26)

Distribution of Marks: -
M.Sc. PG 1st year

SEMESTER – I
- Theoretical -200 marks
- Practical -75 marks

Paper Code	Paper name	Type of Paper	IA	EA	Maximum marks	Credits
BICC401X1	Chemistry of Biomolecules	Theory (Core)	5	20	25	2
BICC401X8	Biochemistry	Practical (Core)		25	25	2
BICC402X1	Biophysical Chemistry and Enzymology	Theory (Core)	5	20	25	2
BICC402X8	Biophysical Chemistry	Practical (Core)		25	25	2
BICC403X0	Research Methodology and Ethics	Theory (Core)	10	40	50	4
BICE404A0 BICE404B0	One Elective must be Chosen: Elective I: Human and Plant Physiology Elective II Biochemical and Environmental Toxicology	Theory (Elective)	10	40	50	4
BICC405X1	Cell and Molecular Biology	Theory (Core)	5	20	25	2
BICC405X8	Cell and Molecular Biology	Practical (Core)		25	25	2
BICO406VC	Indian Knowledge System (IKS)	Theory Paper	5	20	25	2
BICO407NC	Vidyasagar: Life and Philosophy	Compulsory Non-Credit Course	-	-	25	-
Total marks and Credits					**275 +25**	**22**

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
Two-year P.G. Program as per NEP-2020 (Effective from 2025-26)

Distribution of Marks: -
M.Sc. PG 1st year

SEMESTER – II

- Theoretical -175 marks
- Practical -100 marks

Paper Code	Paper name	Type of Paper	IA	EA	Maximum marks	Credits
BICC451X1	Microbiology and Virology	Theory (Core)	5	20	25	2
BICC451X8	Microbiology	Practical (Core)		25	25	2
BICE452A1	Immunology	Theory (Elective)	5	20	25	2
BICE452A8	Immunotechnology	Practical (Elective)		25	25	2
BICE453A1	Biostatistics and Bioinformatics	Theory (Elective)	5	20	25	2
BICE453A8	Bioinformatics	Practical (Elective)		25	25	2
BICE454A1	Metabolism and Nutrition	Theory (Elective)	5	20	25	2
BICE454A8	Review Work and Seminar	Practical (Elective)		25	25	2
BICE455A0	Quality Control in Food and Pharma Industry	Theory Paper	10	40	50	4
BICO456X9	Field /Industry Visit	Compulsory	-	-	25	2
Total marks and Credits					**275**	**22**

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
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Distribution of Marks: -
M.Sc. PG 2nd year

SEMESTER – III

- Theoretical -200 marks
- Practical -75 marks

Paper Code	Paper name	Type of Paper	IA	EA	Maximum marks	Credits
BICC501X1	Clinical Biochemistry	Theory (Core)	5	20	25	2
BICC501X8	Clinical Biochemistry	Practical (Core)		25	25	2
BICC502X1	Gene & Gene Regulation	Theory (Core)	5	20	25	2
BICC502X8	Genetic Engineering	Practical (Core)		25	25	2
BICC503X1	Advanced Biochemistry	Theory (Core)	5	20	25	2
BICC503X8	Advanced Biochemistry	Practical (Core)		25	25	2
BICC504X0	Analytical Instrumentation	Theory (Core)	10	40	50	4
BICO505X0	MOOCs	Theory Paper	10	40	50	4
BICO506X9	Social Service/Community Engagement	Compulsory Practical	-	-	25	2
Total marks and Credits					**275**	**22**

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
Two-year P.G. Program as per NEP-2020 (Effective from 2025-26)

Distribution of Marks: -
M.Sc. PG 2nd t year

SEMESTER – IV

- Theoretical -200 marks
- Practical -75 marks

Paper Code	Paper name	Type of Paper	IA	EA	Maximum marks	Credits
BICC551X1	Pharmaceutical Biochemistry & Nanotechnology	Theory (Core)	5	20	25	2
BICC551X8	Nanotechnology and Drug Designing	Practical (Core)		25	25	2
BICC552X0	Genomics and Proteomics	Theory (Core)	5	20	25	2
BICC553X9	Grand Viva	Practical (Core)			25	2
BICC554X9	Research Project and Dissertation	Practical (Core)	20	80	100	8
BICC555X9	Internship/Applied field or Industry Project/ Entrepreneurship	Practical (Core)	10	40	50	4
BICC556X0	Intellectual Property Right and Bio-entrepreneurship	Theory (Core)	5	20	25	2
Total marks and Credits					**275**	**22**

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Vidyasagar University
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SEMESTER – I

*Paper-I (*BICC401X1*)*

*(*2 Credits, EA:20 +IA :5)
(20 Hours)

Chemistry of Biomolecules (*Theory*)

Course Objectives (COBs):

- To understand the structure, significance, and characteristics of the vital biomolecules—carbohydrates, proteins, lipids and nucleic acids.
- To understand protein structures, function, properties of amino acids, peptides.
- To understand the structure and function of lipids, conjugated lipids, role as cofactors.
- To understand the structure and function of Nucleic acids, DNA content variation in different organisms.

Course Outcomes (COs): On completing the course, the student will be able to:

- Comprehend understanding of the structure, function, and properties of carbohydrates, proteins, fats and nucleic acids, which are essential biomolecules in living organisms.
- Acquire a basic understanding of structure and function of carbohydrates, proteins, lipids and nucleic acids.
- Understand the structure and function of Nucleic acids, DNA content variation in different organisms.

Course Contents:

Unit I: Carbohydrate Chemistry: - General structure and classification of monosacchasides, cyclic structure of monosacchasides – Pyran, furan, Mutarotation. Isomerism. Chemical properties of monosacchasides, Homopolysaccharides and Heteropolysacchasides , Glycoprotein, Proteoglycan, Carbohydrates of commercial importance: Modified starch, cellulose, dextrins, pectin, chitosan, microbial polysaccharides. (6 H)

Unit II: Amino acid and protein Chemistry: - Structure, classification, Physio-chemical properties. Peptide and Protein Chemistry: - General idea about Peptides. Protein configuration – Primary, secondary, tertiary and quarternary structure. Ramachandran plot. Structure and function of Myoglobin, haemoglobin and collagen. (6 H)

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Unit III: Lipid chemistry: - Simple lipids (Fats and oils, waxes); Compound lipids (Phospholipids, Glycolipids, sulfolipids, sphingolipid), derived lipids (Steroids, terpenes, Carotenoids), Chemistry and functions of Lipids as signals: phosphatidylinositol, eicosanoids, steroid hormones. Lipids as cofactors: vitamin E, K and ubiquinone. Composition and biological role of lipoproteins. (4 H)

Unit IV: Nucleic acid chemistry: - DNA and RNA chemistry, Double helix model, DNAs with unusual structutes, Single stranded DNA. Informosome. Denaturation and renaturation. C-value paradox, Cot curve. RNA: Structure, function and types of RNAs. (4H)

Reference Books:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 8th edition Pub WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
3. Mathews, Van Holde and Ahern, Biochemistry by 3 rd edition, Pub Pearson education
4. Stryer, L. Biochemistry 4th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2nd Edn.
7. Garrett R.H., Grisham C.M. Biochemistry. 2024. 7th ed. Cengage.
8. Devlin, T.M. (1997). Biochemistry with clinical correlations, Wiley-Liss Inc. NY
9. Zubey, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC.Brown publishers. Oxford.

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Vidyasagar University
Syllabus of M.Sc. Course in Bichemistry
Two-year P.G. Program as per NEP-2020 (Effective from 2025-26)
SEMESTER – I

*Paper-II (*BICC401X8*)*

*(*2 Credits, 25 marks)

Biochemistry (*Practical*)

Course Objectives (COBs):

- To understand the protein by biuret method, Bradford's method and Lowry's method.
- To understand glycogen content in a given liver extract.
- To understand the different enzyme activity test.
- To understand the isolation of nucleic acids, DNA content variation in different organisms.

Course Outcomes (COs): On completing the course, the student will be able to:

- Comprehend understanding the protein by biuret method, Bradford's method and Lowry's method.
- Acquire a basic understanding glycogen content in a given liver extract.
- Understand the isolation of nucleic acids, DNA content variation in different organisms.

Course Contents:

1. Determination of protein content by biuret method, Bradford's method and Lowry's method.
2. Determination of glycogen content in a given liver extract.
3. Determination of amino acids by formal titration and by ninhydrin method.
4. Determination of specific activity of alkaline phosphatase.
5. Determination of km and Vmax value of alkaline phosphatase.
6. Isolation, determination and quantification of DNA and RNA.
7. Spectrophotometric estimation of α-amylase, protease and dehydrogenase.
8. Estimation of cholesterol by colorimetric method.
9. Determination of saponification value and iodine number of lipids.
10. Estimation of total and reduced ascorbic acid by DCIP and DNPH method

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
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SEMESTER – I

*Paper-III (*BICC402X1*)*

(2 Credits, EA:20 +IA :5)
(20 Hours)

Biophysical chemistry and Enzymology (*Theory*)

Course Objectives (COBs):

- To know the different types, structure, mechanism of formation of different bonds involved in atom and molecules.
- To acquire knowledge regarding properties and function of free energy in biological system, laws of thermodynamics, oxidation and reduction in biological system.
- To understand the types, structure and function of different class of enzymes including ribozymes, their kinetics.
- To learn the basic and advanced types of spectroscopic techniques employed in the structure function determination of biomolecules.

Course Outcomes (COs): On completing the course, the student will be able to:

- Able to acquire knowledge regarding types, structure, mechanism of formation of different bonds involved in atom and molecules.
- Understand the properties and function of free energy in biological system, laws of thermodynamics, oxidation and reduction system in cellular processes.
- Gain ideas regarding classification of enzymes, their structure and function of different class of enzymes, their kinetics, inhibition of their activities by different agents.
- Acquire concepts of basic and advanced types of spectroscopic techniques employed in the structure function determination of biomolecules used biochemical research.

Course Contents:

Unit I: Chemical and Physical force involved in Chemical bond formation between atoms and molecules, mechanism of bond formation based on electronic orbitals, sigma, Pi bonds, covalent, ionic, electrostatic, co-ordinate bonds, hydrophobic and Vander-Waal's interaction and their properties (4 H)

Unit II: Bioenergetics – Coupling, the concept of free energy, Thermodynamic principles (First law, second law, combination of two laws), Standard free energy change and equilibrium constant, AG and AGO'. AG as universal currency of free energy in biological system free energy of hydrolysis of ATP and other organophosphates. Phosphoryl group transfer Potential of ATP. Biological oxidation – reductionreaction. (4 H)

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Unit III: Classification of enzymes. General properties. Coenzymes – structure and function. Factors affecting enzyme properties. Enzyme kinetics. Michaelis – Menten equation. Lineweaver – Bark equation. Enzyme inhibition (Competitive, non-competitive, uncompetitive and irreversible inhibition). Feedback inhibition, Enzyme specificity, Mechanism of Catalysis. Regulations of enzyme activity. Allosteric and covalent modification of enzymes, Isozyme, Multienzyme complex. (6 H)

Unit IV: Spectroscopy: Ultraviolet and visible adsorption spectroscopy, Infrared spectroscopy, Raman spectroscopy, Resonance Raman spectroscopy, Circular Dichroism (CD) spectroscopy. Nuclear Magnetic Resonance method. MALDI-TOF, Mass spectroscopy.

(6H)

Reference Books:

1. Mathews, Van Holde and Ahern, Biochemistry by 3 rd edition, Pub Pearson education
2. Stryer, L. Biochemistry 4^{th} Edn. W.H. Freeman and Co. NY.
3. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
4. Voet, D., Voet J.G. (2004). Biochemistry 2^{nd} Edn.
5. Matthews, C.A. (2003). Cellular physiology of nerve and muscle. 4^{th} Edn. Blackwell publishers.
6. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K., Watson, J.D. (1994). Molecular Biology of the Cell.
7. Cooper, G.M. (1997). The Cell: A molecular approach, ASM Press, USA.

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
Two-year P.G. Program as per NEP-2020 (Effective from 2025-26)
SEMESTER – I

*Paper-IV (*BICC402X8*)*

(2 Credits, 25 marks)

Biophysical Chemistry (*Practical*)

Course Objectives (COBs):

- To know the different types of chromatographic and gel electrophoresis technique.
- To acquire knowledge regarding the preparation of buffer.
- To understand the colorimetric determination of Pk value to understand the enzyme function.
- To learn validity of lambert-beers' law and determination of extinction co-efficient of a protein.

Course Outcomes (COs): On completing the course, the student will be able to:

- Able to different types of chromatographic and gel electrophoresis technique.
- Acquire knowledge regarding the preparation of buffer.
- Gain ideas of colorimetric determination of Pk value to understand the enzyme function.
- Acquire validity of lambert-beers' law and determination of extinction co-efficient of a protein.

Course Contents:

1. Chromatographic techniques-two-dimensional paper chromatography. Thin layer chromatography, ion exchange chromatography.
2. Electrophoresis techniques: - SDS polyacrylamide gel electrophoresis.
3. Conductometric titration: - acid-base, precipitation by conductometer.
4. Preparation of buffers (acetate, phosphate, tris-HCl).
5. Colorimetric determination of pk.
6. Measurement of specific rotation by polarimeter.
7. Experiment on distribution law.
8. Establishment of validity of lambert-beers' law and determination of extinction co-efficient of a protein.
9. Determination of reaction kinetics (0 order and 1st Order) `

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SEMESTER – I

*Paper-V (*BICC403X1*)*

(4 Credits, EA:40 +IA :10)
(40 Hours)

Research Methodology and Ethics (*Theory*)

Course Objectives (COBs):

- To understand the fundamental concepts of research, including types of research, research problems, hypothesis formulation, and the research process.
- To apply research design principles, data collection methods, and sampling techniques to conduct effective and systematic research.
- To develop skills to review literature, write research proposals, and integrate research findings into coherent reports or projects.
- To demonstrate knowledge of research ethics, publication ethics, privacy and confidentiality, and evaluate research impact using appropriate metrics.

Course Outcomes (COs): On completing the course, the student will be able to:

- Comprehend understanding the concept of basics of research, research problem, literature review.
- Acquire the knowledge of research hypothesis, process design and plan of research., sampling methods.
- Understanding the writing of research title, abstract, problem statement, literature review, methodology, outcomes, references.
- Understanding the research ethics, ethical judgment, privacy and confidentiality.

Course contents:

Unit-I: Basics of research, definition, importance, and characteristics of research; distinction between method and methodology; types of research – basic, applied, qualitative, quantitative, descriptive, analytical, experimental. (5H)

Unit-II: Research Problem and Literature Review Identification and formulation of research problem; research questions and objectives; survey of literature – importance, sources, and research gaps. (4H)

Unit III: Hypothesis and Research Process Hypothesis – meaning, role, and types (null, alternative, simple, complex, directional, causal); research process – steps of problem identification to report writing. (4H)

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Unit-IV: Research Design and Plan, Research design – meaning, significance, and types (exploratory, descriptive, analytical, experimental); developing a research plan – statement of problem, objectives, methodology, data plan, timeline, budget. (6H)

Unit-V: Sampling Methods, Concept of sampling; probability sampling – simple random, stratified, cluster, systematic; non-probability sampling – purposive, convenience, quota, snowball. (4H)

Unit-VI: Reviewing and Proposal Writing Reviewing articles – analysis of objectives, methodology, findings; writing a research proposal – title, abstract, problem statement, literature review, methodology, outcomes, references. (4H)

Unit-VII: Introduction to Research Ethics, Definition, nature, and scope of ethics; different branches of ethics; importance of ethics in research and academic life. Meaning and significance; responsibilities of researchers towards fellow researchers, public, and academic community; concept of academic integrity. (5H)

Unit-VIII: Ethical Judgments and Scientific Misconduct, Ethical judgments in research: scientific misconduct – falsification, fabrication, plagiarism; redundant, duplicate, and overlapping publications; salami slicing; selective reporting; misrepresentation of data. (4H)

Unit-IX: Privacy and Confidentiality Concepts of privacy, autonomy, confidentiality, and anonymity in research; ethical handling of sensitive data. (4H)

Reference Books:

1. Kothari, C. R., & Garg, G. (2019). *Research Methodology: Methods and Techniques* (4th ed.). New Age International Publishers.
2. Kumar, R. (2019). *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.). Sage Publications.
3. Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). Sage Publications.
4. Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research Methods for Business Students*
5. (8th ed.). Pearson Education.
6. Sekaran, U., & Bougie, R. (2019). *Research Methods for Business: A Skill-Building Approach* (8th ed.). Wiley.
7. Resnik, D. B. (2020). *The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust*. Springer.
8. Shamoo, A. E., & Resnik, D. B. (2015). *Responsible Conduct of Research* (3rd ed.). Oxford University Press.
9. Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics* (8th ed.). Oxford University Press.

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10. COPE (Committee on Publication Ethics). (2017). *Code of Conduct and Best Practice Guidelines for Journal Editors*. Retrieved from https://publicationethics.org
11. American Psychological Association. (2020). *Publication Manual of the American Psychological Association* (7th ed.). APA.

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SEMESTER – I

Paper-VI (BICE404A0)

(4 Credits, EA:40 +IA :10)
(40 Hours)

Human and Plant Physiology (*Theory*)

Course Objectives (COBs):

- To acquire knowledge regarding different system in human like conductive, respiratory, neural, excretory, digestive and reproductive.
- To have thorough idea about the Physiological processes of the said system in human body to regulate the functioning of the various organs.
- To understanding the different physiological processes involved in plant for synthesis of food and to generate oxygen as respiratory product.
- To learn the metabolic pathways for the production of various types of secondary metabolites including phytohormones and their role.
- To acquire knowledge about the accumulation of free nitrogen in to plant system.
- To give an insight about the pathways involved in the absorption and transport of molecules in plant body.
- To understand the basic defense system of plant body to resist biotic and abiotic stress occurred during their entire life.

Course Outcomes (COs): On completing the course, the student will be able to:

- Acquire concept regarding different system in human like conductive, respiratory, neural, excretory, digestive and reproductive. Obtain thorough idea about the Physiological processes of the said system in human body to regulate the functioning of the various organs.
- Understand the different physiological processes involved in plant for synthesis of food and to generate oxygen as respiratory product. Know the metabolic pathways for the production of various types of secondary metabolites including phytohormones and their role.
- Acquire knowledge about the accumulation of free nitrogen in to plant system.
- Have an insight about the pathways involved in the absorption and transport of molecules in plant body.
- understand the basic defense system of plant body to resist biotic and abiotic stress occurred during their entire life for their survival.

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Course contents:

Unit-I

Human Physiology

1. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, Blood composition, blood pressure, neural and chemical regulation. (4 H)
2. Respiratory system - Transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. (3 H)
3. Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system (3H)
4. Excretory system – structure of kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance, acid-base balance. (3H)
5. Digestive system - Digestion, absorption, energy balance, BMR. (3 H)
6. Reproductive system - Reproductive processes, gametogenesis, ovulation. (3 H)

Unit -II

Plant Physiology

1. Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways. (4H)
2. Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. (4H)
3. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. (2 H)
4. Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. (3 H)
5. Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis. (2 H) .Solute transport and photo assimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration. (3 H)
6. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. (2 H)

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Reference Books:

1. Guyton and Hall Textbook of Medical Physiology.
2. Ganong's Review of Medical Physiology, 24th Edition (Lange Basic Science) Paperback – Import, 1May 2012, by Kim E. Barrett (Author)
3. For human physiology Human Physiology: From Cells to Systems (Lauralee Sherwood)
4. For cellular physiology the best one (Cell Physiology Source Book, 4th Edition) bu Sperilakis
5. Cell and Molecular Biology 8 Sub Edition by E. D. P. De Robertis
6. Plant Physiology, Salisbury and Ross 2nd Edition
7. Plant Physiology, Hopkins and Huner 4 th Edition
8. Fundamentals of Plant Physiology, VK Jain

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
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SEMESTER – I

*Paper-VI (*BICE404B0*)*

(4 Credits, EA:40 +IA :10)
(40 Hours)

Biochemical and Environmental Toxicology (*Theory*)

Course Objectives (COBs):

- To understand how chemicals are Absorbed, Distributed, Metabolized, and Excreted (ADME) in organisms and move through the environment (air, water, soil).
- To explain how toxicants cause harm at cellular/molecular levels (e.g., DNA damage, enzyme inhibition, cell death pathways).
- To learn to quantify toxicity, assess exposure, evaluate risks to human/ecosystems, and develop control/remediation strategies.
- To gain skills in toxicological lab work, including molecular techniques (DNA/RNA/protein analysis), cytotoxicity assays, and using models (in vitro/vivo).
- To understand the role of toxicology in public health, relevant regulations (e.g., EPA), and communicating risks to the public.

Course Outcomes (COs): On completing the course, the student will be able to:

- Designing and interpreting toxicology studies.
- Analysing dose-response data and relative potency.
- Identifying cellular targets and mechanisms of toxic action.
- Applying knowledge to real-world environmental problems.
- Using analytical methods to examine toxicological issues

Course contents:

Unit-I: Eco-toxicology and its environmental significance. Toxic effects: Basis for general classification nature. Dose – Response relationship: Synergism and Antagonism, Determination of ED50 andLD50. Acute and Chronic exposures. Factors influencing Toxicity. (5H)

Unit-II: Absorption and distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reactions/Conjugation: Methylation, Glutathione and amino acid conjugations. Detoxification. Mechanisms of Toxicity: Disturbance of Excitable membrane function. Genotoxicity. Tissue specificity of Toxicity. (6H)

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Unit-III: Principles and Procedures of testing for acute toxic effects: Regulatory guidelines, Mammalian systems affected and the clinical signs of Systemic Toxicity. Factors affecting acute Toxicity studies. Toxicity testing: Test Protocol, Genetic toxicity testing & Mutagenesis assays: In vitro Test systems – Bacterial Mutation Tests: Reversion Test, Fluctuation Tests and Eukaryotic Mutation Tests. In vivo Mammalian Mutation tests – Host mediated assay & Dominant Lethal Test. Use of Drosophila in Toxicity testing. DNA repair assays. Chromosome damage test. Toxicological evaluation of Recombinant DNA – derived proteins. (8H)

Unit-IV: Pesticide toxicity: Insecticides: Organochlorines, Organophosphates and Carbamates. Fungicides. Herbicides. Environmental consequences of pesticide toxicity. Biopesticides. Diagnosis of toxic changes in liver and kidneys: Metabolism of Haloalkanes, Haloalkenes and Paracetamol with their toxic effects on tissues. (6H)

Unit-V: Food toxicology: Role of diet in cardio-vascular diseases and cancer. Toxicology of food additives. Metal toxicity: Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity – effect of light, temperature and PH. (7H)

Unit-VI: Air pollution: Common air Pollutants & their sources. Air pollution and ozone. Air pollution due to chlorofluorocarbons (CFCS) and asbestos. Occupational toxicology and assessment of occupational hazards: Industrial effluent toxicology & Environmental health. An overview of regulatory agencies: Responsibilities of regulatory agencies. Management of Toxicological risk. Regulatory systems and organizations. (8H)

Reference Books:

1. General and Applied Toxicology by Marrs and Turner, Macmillan Press Ltd.
2. Basic Environmental Toxicology by Lorris G. Corkerthm and Barbara S S Shane CRP Press Inc.
3. Introduction to Food Technology by Takayurki Shibamato & Leonard F. Bzeldanes.
4. Molecular Biotechnology by Barnard R Glick & J J Pastmak.
5. An Introduction to Environmental Management: Dr. Anand S. Bal, Himalaya Publishing House (2005).
6. Energy Resources and Environment: V.K. Prabhakar, Anmol Publisher
7. Biomass Energy and Environment: H.R. Ravindranath, Oxford University Press, New York.
8. Non-Conventional Energy Sources: G.D. Rai, Khanna Publication, New Delhi

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SEMESTER – I

*Paper-VII (*BICC405X1*)*

(2 Credits, EA:20 +IA :5)
(20 Hours)

Cell and Molecular Biology (*Theory*)

Course Objectives (COBs):

- To provide fundamental knowledge of cell structure, cell membranes, cell motility, organelles, in prokaryotes and eukaryotes, transport across membranes.
- To give an overall insight about de novo synthesis of DNA, their damage by different exogenous and endogenous agent, different mutagen resulting mutation, DNA repair mechanism.
- To familiarize students with the central dogma processes, and mechanisms of gene expression.
- To understanding the process of bio signaling, factors effecting the regulation of cellular mechanism.
- To understand the molecular basis of cancer, role of different tumor suppressor protein.

Course Outcomes (COs): On completing the course, the student will be able to:

- Acquire the knowledge about the structure-function relationship of cells, organelles, cell motility and transport of molecules across membranes.
- Understand DNA replication, transcription, translation, and gene regulation in prokaryotes and eukaryotes.
- Acquire knowledge about signaling pathways, their controlling factors, cellular regulation mechanism.
- Acquainted with cause of formation of cancer, their molecular basis, different tumor suppressive protein factors.

Course contents:

Unit -I: Overview of prokaryotic and eukaryotic cells, ultra structure of animal and plant cell. (2H)

Unit -II: Biological membranes: structure and properties, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins. Transport of nutrients- ions and macromolecules across membrane – passive; diffusion, osmosis, ionophores, reverse osmosis

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and active transport, permease, Na Pump, Ca Pump, Co-transport, symport, antiport, endocytosis and exocytosis. (4H)

Unit -III: Cell motility: Cilia and flagella of eukaryotes and prokaryotes, cyto- skeleton – Microtubules, microfilaments and intermediate filaments. (2H)

Unit -IV: Biosynthesis of DNA – DNA replication, helicases, nucleases, DNA binding and unwinding proteins, topoisomerases, Mechanism of DNA replications in Prokaryotes & Eukaryotes. (3H)

Unit- V: Mutation and DNA damage and repair: - Types of mutation, molecular basis of mutation, normal and induced mutation. Photo reactivation, excision, mismatch, recombination, SOS, double strand break repair. (3H)

Unit -VI: Transcription – RNA polymerases in prokaryotes and Eukaryotes – its molecular composition, different sigma factors – related to stress, viral infection etc. Mechanism of transcription, RNA Processing enzymes, RNA editing, splicing. (3H)

Unit – VII: Translation: Prokaryotic and eukaryotic translation – Mechanism of initiation, elongation and termination. Amino acid activation, inhibitors. (2H)

Unit -VIII: Bio signaling - Over view of extra cellular signaling, G- Protein linked receptor and activity of G-Proteins, role of c-AMP in the regulation of cellular metabolism, Receptor tyrosine kinase, Ca^{++}, IP3, DAG as second messengers. (3H)

Reference Books:

1. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition Pub WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.
3. Mathews, Van Holde, Ahern, Biochemistry by 3rd edition, Pub Pearson education.
4. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
5. Cooper, G.M. (1997). The Cell: A molecular approach, ASM Press, USA.
6. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
7. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
8. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
9. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.

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SEMESTER – I

*Paper-VIII (*BICC405X8*)*

*(*2 Credits,25 Marks)

Cell and Molecular Biology (*Practical*)

Course Objectives (COBs):

- To know the basic techniques of cytology to visualize the chromosome and number, determination of both somatic and germ cell.
- To develop fundamental knowledge in molecular biology techniques such as DNA isolation and visualization DNA from bacteria, plant and animal cells.
- To develop skills in quantification, and characterization of nucleic acids.
- To give hands on knowledge regarding Tm of DNA, UV visible spectroscopic methods to estimate DNA contents in different sample.

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand the basic techniques of cytology to visualize the chromosome and number, determination of both somatic and germ cell.
- Acquire knowledge of some fundamental molecular biology techniques such as DNA isolation and visualization DNA from bacteria, plant and animal cells.
- Develop skills in quantification, and characterization of nucleic acids.
- Achieve hands on training regarding Tm of DNA, UV visible spectroscopic methods to estimate DNA contents in different sample.

Course Contents:

1. Cell fractionation (nucleus and mitochondria).
2. Mitosis – onion root tips
3. Meiosis – Grasshopper testis, flower buds
4. Study of chromosome aberration on mitosis in *Allium cepa / Allium sativum*.
5. Isolation of plasmid DNA from *E. coli* by adopting two methods – (A) Alkaline SDS method (B) Boiling lysis, Agarose Gel electrophoresis
6. Isolation of genomic DNA from bacteria
7. Isolation of genomic DNA from plant cell/animal cell
8. Determination of the melting temperature of DNA.
9. Preparation of the absorption spectra of DNA.

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SEMESTER – I

*Paper-IX (*BICO406VC*)*

(2 Credits, EA:20 +IA :5)
(20 Hours)

Indian Knowledge System (IKS) (Theory)

Course Objectives (COBs):

- To provide a comprehensive and interdisciplinary overview of ancient Indian knowledge systems.
- To explore the genesis of Indian civilization, from the Indus Valley to the Vedic period, and examine the development of its intellectual and philosophical frameworks.
- To delve into the structure of ancient Indian society, astronomy, science and technology.
- To highlight significant contributions of Plants, Anatomy, Physiology, Agriculture, Ecology and Environment, Ayurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Medicine, Surgery, and Yoga

Course Outcomes (COs): On completing the course, the student will be able to:

- Learn about a comprehensive and interdisciplinary overview of ancient Indian knowledge systems.
- Explore the genesis of Indian civilization, from the Indus Valley to the Vedic period.
- Gain ideas about the structure of ancient Indian society, astronomy, science and technology.
- Gather knowledge regarding the role of Plants, Anatomy, Physiology, Agriculture, Ecology and Environment, Ayurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Medicine, Surgery, and Yoga in society.

Course Contents:

Unit -I: Bharatiya Civilization and Development of Knowledge System (6 H)

Genesis of the land, Antiquity of civilization, On the Trail of the Lost River, Discovery of the Saraswati River, the Saraswati-Sindhu Civilization, Traditional Knowledge System, The Vedas, Main Schools of Philosophy, Ancient Education System - the Takṣasila University, the Nalanda University.

Unit-II: Science, Astronomy, and Mathematics (5 H)

Concept of Matter, Life and Universe. Development of Science and Technology in ancient India, Astronomy - History and Culture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth is Spherical and Rotation of Earth. Key Contributions: Aryabhatta and Varahmihir. Mathematics-Shulvasutra and Baksali manuscript, Formulation of Arithmetic, Algebra and trigonometry.

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Unit-III: Life Science, Environment, Medicine and Health (9 H)

Ethnic Studies, Life Science in Plants, Anatomy, Physiology, Agriculture, Ecology and Environment, Ayurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Medicine, Surgery, and Yoga, etc.

Reference Books:

1. Textbook on The Knowledge System of Bharata by Bhag Chand Chauhan,
2. Histrory of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al.
3. National Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata (2014).
4. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).
5. Vedic Physics by Keshav Dev Verma, Motilal Banarsidass Publishers (2012).
6. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).

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SEMESTER – I

Paper-X (BICO407NC)
Compulsory Non-credit Course

(25 marks)
(25 Hours)

Vidyasagar: Life and Philosophy (*Theory*)

Course Objectives (COBs):

- Aims to provide a comprehensive understanding of the life and philosophy of Ishwar Chandra Vidyasagar, a key figure of the Bengal Renaissance.
- To trace his journey from birth and lineage to his transformation into "Vidyasagar" (ocean of learning).
- To delve into his pivotal role in Indian education, examining his reforms as a teacher, writer, and planner, as well as his efforts to modernize the system.
- To explore his relentless work in women's emancipation, focusing on his campaigns for widow remarriage and his opposition to child marriage.
- To highlight his immense philanthropy and analyze his unique position as a figure who bridged tradition and modernity.
- To discuss the enduring relevance of his thoughts and values for contemporary society.

Course Outcomes (COs): On completing the course, the student will be able to:

- Acquire the knowledge regarding the life and philosophy of Ishwar Chandra Vidyasagar, a key figure of the Bengal Renaissance.
- Understanding his journey from birth and lineage to his transformation into "Vidyasagar" (ocean of learning).
- Gather knowledge regarding contribution of his thoughts and values for contemporary society.

Course Contents:

Unit-I:
Early Life and Education: (4 H)

1.Birth and Lineage
2. Journey from Iswar Chandra Bandyopadhyay to Iswar Chandra Vidyasagar.

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Unit-II:
Vidyasagar and Indian Education: (5 H)

1. The then Indian education system
2. Vidyasagarian plan for reformation of Indian education- Vidyasagar as teacher,Vidyasagar as writer, planner and reformer of Indian education.

Unit-III
Vidyasagar and Women Emancipation: (5 H)

1. Introduction of widow remarriage
2. Struggle to stop child marriage

Unit-IV
Philanthropist Vidyasagar (3 H)

Vidyasagar's philanthropy as narrated by others

Unit-V
Vidyasagar: Traditions and modernity (5 H)

1. Tradition
2. Modernity
3. Vidyasagara as Traditional modernizer

Unit-VI
Relevance of Vidyasagarian thoughts and values (3 H)

1. Vidyasagar and the then Society of Bengal
2. Lesson for future generations.

Further Readings:

Online course. Available on the University website.

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SEMESTER – II

*Paper-I (*BICC451X1*)*

(2 Credits, EA:20 +IA :5)
(20 Hours)

Microbiology and Virology (*Theory*)

Course Objectives (COBs):

- To give an insight about the classification, structure of Eubacteria, Rickettsiae, Mycoplasma, Spirochetes and Cyanobacteria, fungi and viruses.
- To understand the bacterial cell wall composition, biosynthesis of bacterial wall components.
- To understand the growth kinetics of bacteria, nutritional classification and requirements, effects of different factors on their growth.
- To understand the structure and nature of genetic material, their structure, replication.
- To know the different reproduction methods of Viruses.

Course Outcomes (COs): On completing the course, the student will be able to:

- Comprehend understanding of the classification, structure of Eubacteria, Rickettsiae, Mycoplasma, Spirochetes and Cyanobacteria, fungi and viruses
- Acquire a basic understanding bacterial cell wall composition, biosynthesis of bacterial wall components.
- Understand the growth kinetics of bacteria, nutritional classification and requirements, effects of different factors on their growth.
- Acquire the structure and nature of genetic material, their structure, replication.
- Acquainted with the different reproduction methods of Viruses.

Course Contents:

Unit I: Microorganisms: General structure, characteristic features and classification of Eubacteria, Rickettsiae, Mycoplasma, Spirochetes and Cyanobacteria, fungi and viruses. Laboratory culture and methods to study microbes: Concept of pure culture, aseptic conditions, sterilization and staining methods. microbial culture media and its types. (5 H)

Unit II: Morphology and fine structure of bacteria. Bacterial cell wall. Peptidoglycan structures of Staphylococcus aureus, E. coli, Micrococcus luteus etc. Outline of bacterial cell wall biosynthesis and effect of various cell wall biosynthetic inhibitors. Cell wall hydrolytic enzymes. (4 H)

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Unit III: Growth Kinetics of bacteria, Nutritional classification and requirements. Effects of Physical and Chemical factors on microbial growth. Biogeochemical cycle: Nitrogen, Sulphur and Phosphorus emphasizing role of microorganisms. (3 H)

Unit IV: Microbial genetics: Recent advances in molecular genetics of viruses and bacteria. Transformation, conjugation and transduction, complementation. (3 H)

Unit V: Elements of Virology. General introduction and classification of virus. General idea of Bacterial (T4, T7, M13 and Lambda phases), Plant (TMV) and Animal Viruses (Influenza virus). Lambda phases, Fine structure gene expression in phase lambda: Early transcription events, Molecular basis of Lytic and Lysogenic pathways. Site specific recombination in bacteriophage lambda. (5 H)

Reference Books:

1. Microbiology by MJ Pelczar Jr, ECS Chan, NR Krieg 7th Edition (2024), Pub: Tata Mcgra-Hill Publishing Co Ltd.
2. General Microbiology 5e (Intern Ed*) · by Roger Y Stanier | 27 September 2021*
3. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2nd Edition, Milan Publishing Co.
4. Brock T.D. and Madigan M.T (1992) Biology of Microorganisms 6th Edn. Prentice Hall, Eagle wood cliffs N.j.
5. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T (1994) Bergey‟s Manual of Systemic Bacteriology 9th Edn. William and Wilkins, Baltimore.
6. Prescott L.M, Harley T.P and Klein D.A. 12 th Ed. (2023) Microbiology WMC. Brown publishers
7. Microbiology An Introduction (13th Ed.) By Gerard Tortora, Berdell Funke, and Christine Case
8. Field's Virology: Emerging Viruses, Vol 1, 7ed (2020). by Peter M. Howley , David M. Knipe , Sean Whelan
9. Fields Virology: RNA Viruses Publication (2022) Edition:7th: Howley, Peter M.; Knipe, David M. Publisher: Lippincott Williams & Wilkins (LWW).
10. Introduction to Modern Virology, N. J. Dimmock A. J. Easton K. N. Leppard sixth edition (2007)

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SEMESTER – II

*Paper-II (*BICC451X8*)*

(2 Credits, 25 marks)

Microbiology (*Practical*)

Course Objectives (COBs):

- To know the preparation and sterilization of different types of bacterial culture media. And determination of bacterial growth curve.
- To acquire the knowledge of isolation of bacteria and staining of bacteria o visualize the bacterial structure.
- To understand the different biochemical tests to characterize the bacteria.
- To learn the techniques of bacteriological analysis of water to check the bacterial quality in respect of microbial contamination.

Course Outcomes (COs): On completing the course, the student will be able to:

- Able to acquire knowledge regarding the preparation and sterilization of different types of bacterial culture media. And determination of bacterial growth curve.
- Understand the knowledge of isolation of bacteria and staining of bacteria o visualize the bacterial structure.
- Gain the ideas regarding the different biochemical tests to characterize the bacteria.
- Acquire concepts of bacteriological analysis of water to check the bacterial quality in respect of microbial contamination

Course Contents:

1. Preparation and sterilization of culture media
2. Isolation of microorganisms from air and soil
3. Simple staining, gram staining, endospore staining and capsule staining.
4. Preparation of bacterial growth curve.
5. Estimation of viable cells in a bacterial suspension.
6. Biochemical tests of bacteria: - indole production. Tests for catalase, protease, amylase and oxidase. Starch hydrolysis test. Methyl red test.
7. Determination on minimum inhibitory concentration (MIC) of antibiotic.
8. Bacteriological analysis of water – (1) presumptive test, (2) confirmed test, (3) completed test.
9. Preparation of agar slant and glycerol stock for microbial culture preservation.

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SEMESTER – II

*Paper-III (*BICE452A1)

(2 Credits, EA:20 +IA :5)
(20 Hours)

Immunology (*Theory*)

Course Objectives (COBs):

- To give an overall insight about the initiation and development of immune system, their types structure and functions.
- To familiarize students with the organization and expression of genes responsible for immunity development.
- To understanding the process of antibody and cell mediated effector, complement system.
- To understand the hypersensitivity reactions and their types, different types of autoimmunity and immunodeficiency.
- To acquire knowledge regarding antibody production and application, types of vaccines and process of develop immunity by vaccination.

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand the initiation and development of immune system, their type's structure and functions, the organization and expression of genes responsible for immunity development.
- Understand the process of antibody and cell mediated effector, complement system.
- Acquire knowledge hypersensitivity reactions and their types, different types of autoimmunity and immunodeficiency.
- Acquainted with antibody production and application, types of vaccines and process of develop immunity by vaccination.

Course Contents:

Unit-I: Historical development in Immunology. Overview of the immune system: Innate and adaptive immunity, Cells and organs of the immune, system, Antigens, antigenicity and immunogenicity, haptens and epitopes, Immunoglobulins: Structure and function. [5H]

Unit-II: Organization and expression of immunoglobulin genes, Major histocompatibility complex (MHC) – Structure and functions of MHC and the HLA system. Generation, maturation, activation and differentiation of T and B Lymphocytes. [5H]

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Unit-III: Antibody and Cell mediated effector mechanism, Complement components, activations, pathways and regulations, Cytokines. [4H]

Unit-IV: General features of hypersensitivity reactions, overview of Type – I, Type – II, Type – III and Type – IV hypersensitivity, Autoimmunity and their types, Immunodeficiency. [3H]

Unit-V: Monoclonal antibody Production and Application. Chimeric antibody, Humanized antibody, Reshaped antibody. Vaccines – Different types of vaccines. Active and Passive immunization. Production of toxoids, production of Recombinant vaccines. [3H]

Reference Books:

1. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. Sanders College Pub.
2. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4 th edition- Wiley- Liss. Publ.NY.
3. *Textbook of Basic and Clinical Immunology* · Sudha Gangal;Shubhangi Sontakke · ISBN: 9788173718298 | Year: 2013 |
4. Hyde, R.M. (1992). Immunology, 2nd edition, Williams and Wilkins, Baltimore.
5. Kuby, J. (2018). Immunology 8th Edition. WH. Freeman and Company, NY.
6. Klaus D. Elgert (1996). Immunology. ELBS, Blackwell Scientific Publishers, London.
7. Roitt, I.M. (2016). Essential Immunology, ELBS, Blackwell Scientific Publishers,London.
8. Tizard I.R. (1995). Immunology, 4th edition, Saunder College Pub.

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SEMESTER – II

*Paper-IV (BICE*452A8)

(2 Credits, 25 marks)

Immunotechnology (*Practical*)

Course Objectives (COBs):

- To give an overall insight about the immunization of model mice.
- To familiarize students with the basic techniques of serum separation from blood sample.
- To understanding the process of some common immune techniques to disease diagnosis.
- To understand the techniques of protein hybridization.

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand the overall insight about the immunization of model mice.
- Acquire students with the basic techniques of serum separation from blood sample and several similar techniques clinical laboratory.
- Acquainted with the process of some common immune techniques to disease diagnosis and protein hybridization

Course Contents:

1. Immunization of mice
2. Serum separation from whole blood and Precipitation of immunoglobulins (IGs) from serum by ammonium sulphate precipitation followed by dialysis of ammonium sulphate precipitated Immunoglobulins.
3. Electrophoresis of the immunoglobulin preparation
4. Separation of Lymphocytes from blood
5. Single radial immuno diffusion and determination of Ig concentration, Ochterlony double diffusion method
6. Blood group testing
7. ELISA
8. Western Blotting.

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SEMESTER – II

*Paper-V (*BICE453A1*)*

(2 Credits, EA:20 +IA :5)
(20 Hours)

Biostatistics and Bioinformatics (*Theory*)

Course Objectives (COBs):

- To give an overall idea about basic statistical tools and techniques used in biological sciences.
- To familiarize students with the basic concepts of hypothesis testing and use of some recently used statistical software for statistical analysis study.
- To understanding basic computer and biological databases.
- To understand the concept of computational sequence analysis.
- To give an overall idea about primer designing, comparative genomics proteomics and their application.
- To acquainted with molecular structure analysis and tools and techniques used for analysis.

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand the overall idea about basic statistical tools and techniques used in biological sciences.
- Acquired knowledge about the basic concepts of hypothesis testing and use of some recently used statistical software for statistical analysis study, basic computer and biological databases, concept of computational sequence analysis.
- Acquainted with the overall idea about primer designing, comparative genomics proteomics and their application.
- Familiarize students with molecular structure analysis and tools and techniques used for analysis.

Course Contents:

Unit-I: Statistical methods – Collection tabulation and graphical representation of data, Measures of central tendency – Arithmetic mean, median, mode, range, standard deviation, Standard error and co-efficient of variation, Concept of correlation and regression method of least squares. [3H]

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Unit-II: Hypothesis testing – Basic idea about sample distribution, tests based on normal, student t test, Chi square test for goodness of fit, Analysis of Variance. Concept of ORIGIN, SPSS and AI based statistical software. [4H]

Unit-III: Basic computer and biological databases: Concept on basic computers, Accession codes and identifiers, major tools and contents of the biological database. [3H]

Unit-IV: Computational sequence analysis: Sequence analysis – sequence reading, sequence alignment – Global local sequence alignment, Pair-wise sequence alignment, Multiple sequence alignment, phylogenetic analysis, coding region identification. Protein analysis, secondary structure prediction. [4H]

Unit-V: Primer designing, comparative genomics - Gene Prediction, Gene Counting and SNPs, potentiality of Proteomics, Application of Proteomics technology. [3H]

Unit-VI: Molecular structure analysis: Toxicity analysis tools, Molecular dynamics, molecular modeling and simulation, Homology modeling, Computer aided drug designing, Molecular docking. [3H]

Reference Books:

1. Daniel (1999). Biostatistics (3rd edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York.
6. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series 2. Jan (2001). Nucleic acid research, Genome Database issue
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2014). Bioinformatics: A practical guide
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

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SEMESTER – II

*Paper-VI (*BICE453A8)

(2 Credits, 25 marks)
(20 Hours)

Biostatistics and Bioinformatics (*Practical*)

Course Objectives (COBs):

- To give an overview of computational analysis of biological sequences, use of statistical software
- To familiarize students with the sequence analysis, analysis tools for sequence data bank, pairwise and multiple sequence alignment.
- To give an insight about the process of phylogenetic tree analysis, BLAST database, BLAST and genome annotation
- To acquainted with the prediction of bimolecular structure and analysis, molecular docking analysis.

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand the overview of computational analysis of biological sequences and use of statistical software
- Acquire knowledge about the sequence analysis, analysis tools for sequence data bank, pairwise and multiple sequence alignment.
- Acquainted with the process of phylogenetic tree analysis, BLAST database, BLAST and genome annotation
- Understand the prediction of bimolecular structure and analysis, molecular docking analysis.

Course Contents:

1. Application of statistical software (EXCEL/ORIGIN/SPSS/AI based software)
2. An overview of computational analysis of biological sequences
3. Sequence analysis, Analysis Tools for Sequence Data Bank
4. Pairwise and Multiple sequence alignment
5. Phylogenetic tree analysis
6. BLAST database, BLAST and genome annotation
7. Prediction of bimolecular structure and analysis
8. Molecular Docking Analysis

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SEMESTER – I

*Paper-VII (BICE*454A1)

(2 Credits, EA:20 +IA :5)
(20 Hours)

Metabolism and Nutrition (*Theory*)

Course Objectives (COBs):

- To give an overview of carbohydrate, protein, lipid and nucleic acid metabolism.
- To understand the students about the amino acid synthesis and protein degradation.
- To give an insight about the oxidation process of fatty acid, regulation of lipid metabolism.
- To acquainted the students with regulation, formation of nucleosides and nucleotide. abnormal metabolism of purine, pyrimidines and associated diseases.
- To understand the students with basic concepts of nutritional biochemistry.

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand the overview of carbohydrate, protein, lipid and nucleic acid metabolism.
- Acquire students about the amino acid synthesis and protein degradation.
- Acquainted with the process of oxidation process of fatty acid, regulation of lipid metabolism.
- Understand the students with regulation, formation of nucleosides and nucleotide.
- Understand the students with basic concepts of nutritional biochemistry.

Course Contents:

Unit I: Carbohydrate metabolism: Glycolysis, citric acid cycle, pentose phosphate pathway, gluconeogenesis, Glycogenolysis, Metabolism of sugar other than glucose. Glyoxylate cycle, electron transport system, oxidative phosphorylation. Metabolic regulation. (4H)

Unit II: Amino acid and protein metabolism: Metabolism of a few individual amino acids. Amino acids as biosynthetic precursors. Protein Catabolism – proteolytic enzymes. Protein turnover. Nitrogen excretion and urea cycle, metabolic diseases. (4H)

Unit III: Lipid metabolism: Biosynthesis of saturated and unsaturated fatty acids, formation of triglycerides. Lipid breakdown- β- oxidation of fatty acids and its energetic, α -oxidation, ω - oxidation. Lipid storage and transport, lipoproteins, regulation of lipid metabolism. (4H)

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Unit IV: Nucleic acid metabolism: Biosynthesis of purines and pyrimidines. Regulation, formation of nucleosides and nucleotide. Abnormal metabolism of purine, pyrimidines and associated diseases. (3H)

Unit V: Nutritional Biochemistry: Basic nutrition, Role of major nutrient, vitamin and minerals, Therapeutic Nutrition, clinical assessment, Anthropometric measurements, BMR, SDA, RQ. Protein- Calorie malnutrition states. Nutritional status and toxicological interaction. Pre and probiotics, nutraceuticals, nutritionally important phytochemicals. Specificity of amino acids in several physiological processes – e.g. Suppression of pain, stimulation of appetite, Effect of metal and non-metal in food and nutrition. (5H)

Reference Books:

1. Nelson, D.L., Cox, M.M. Lehninger. (2017). Principles of Biochemistry, 7th Edition Pub WH Freeman Co.
2. Biochemistry and molecular biology Mathews, Van Holde and Ahern, Biochemistry by 3 rd edition, Pub Pearson education (2020).
3. Stryer, L. Biochemistry 4th Edn. (1995) W.H. Freeman and Co. NY.
4. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition (2004) Pub: McGraw-Hill.
5. Biochemistry. by: Voet, Donald; Voet, Judith G. Publication date: 2004; Topics: Biochemistry, Biochemistry; Publisher: New York : J. Wiley .
6. Textbook of Biochemistry With Clinical Correlations. Fourth Edition Edited by Thomas M. Devlin. Wiley-Liss, Inc., New York. 1997Wiley-Liss Inc. NY
7. Nutrition Science by B. Srilakshmi, revised 2nd Ed. (2006) , New Age International publishers.
8. Nutrition: Science and Everyday Application -2nd Ed (2020) Callahan, Leonard, and Powell Publisher: Open Oregon Educational Resources

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SEMESTER – II

*Paper-VIII (*BICE454A8)

(2 Credits, 25 marks)

Review work and Seminar (*Practical*)

Course Objectives (COBs):

- To familiarize with the students to know the methodology to write the review work by following research article related to the course studied and to write the review work.
- To know the prepare and present the review work by power point presentation

Course Outcomes (COs): On completing the course, the student will be able to:

- Acquire knowledge about the methodology to write the review work by following research article related to the course studied and to write the review work.
- Acquainted with the preparation and present the review work by power point presentation

Course Contents:

1. Student have to review a particular recent research topics by downloading the research article/ news and read carefully the nature of work, aims and objectives, result and discussion and future scope of the research topics.
2. Have to prepare a comprehensive write up on that basis.
3. Have to prepare a power point presentation on that topic and to deliver a seminar before the competent Examiner/ faculty members.

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SEMESTER – II

*Paper-IX (*BICE455A0)

*(*4 Credits, EA:40 +IA :10)
(40Hrs)

Quality Control in Food and Pharma Industry (*Theory*)

Course Objectives (COBs):

- To give an overall insight about the ethical issues and biosafety to be employed in Biotech research laboratory and Industry.
- To familiarize students with the process to assess the quality of the products/goods of food, Pharma and Chemical Industry.
- To understanding the concept and importance of pharmaceutical quality control and quality assurance as per different standards amended by Government.
- To understand different rules and regulations of international organization of standardization (ISO).

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand the ethical issues and biosafety to be employed in Biotech research laboratory and industry
- Acquire knowledge about with the process to assess the quality of the products/goods of food, pharma and chemical industry.
- Acquainted with the concept and importance of pharmaceutical quality control and quality assurance as per different standards amended by Government.
- understand different rules and regulations of international organization of standardization (ISO).

Course Contents:

Unit- I: Bioethics Legality, morality and ethics, the principles of bioethics, autonomy, human rights, beneficence, privacy justice equality etc. Biosafety Concept and issues, rational Vs subjective perceptions of risks and benefits – relationship between risk hazard, exposure, and safe guards – biosafety concerns at the level of individuals, institutions, society, region country and the world – Lab associated infections. (10 H)

Unit-II: Quality control laboratory: Design of QC laboratory for chemical, instrumental and microbiological analysis. Good Practices in QC laboratory, Schedule L1, standardization of

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reagents, labeling of reagents, control samples, controls on animal house, data generation and storage, QC documentation, LIMS. (10 H)

Unit-III: Concept and importance of pharmaceutical quality control and quality assurance. Process validation, purity and shelf life of pharmaceuticals.: Good Manufacturing Practices (GMP), CGMP, Good Hygienic Practices (GHP), Good Agricultural Practice (GAP), GSP, Storage and distribution of food, sanitation and safety in food services. (10 H)

Unit-IV: International Organization of Standardization (ISO): Overview, structure, interpretation and case studies of food safety and Quality management including ISO-22000, ISO-9001:2000, ISO22000:2005, ISO 17025/CODES/GLP, Retailers standards: BRC food and BRC IOP standards, IFS, SQF: 1000, SQF: 2000. Hazard Analysis Critical Control Point (HACCP), FASSAI (10 H)

Reference Books:

1. Quality Control in the Food Industry V2,: 1st Edition - December 2, 2012, Latest edition, Editor: S Herschdoerfer
2. Pharmaceutical Quality Control Handbook: December 1989. Rhys Bryant
3. A Text Book of Pharmaceutical quality assurance: Mr. Mahendra Singh, Mr. Priyesh Pankaj, Mr. Tulsi Das Patel, ISBN : 978-93-7462-913-0
4. GMP/ISO Quality Audit Manual for Healthcare Manufacturers and Their Suppliers (Leonard Steinborn, 6th Ed, CRC Press). Vol I & Vol II.
5. Documentation Practices: A Complete Guide to Document Development and Management of GMP and ISO 9000 Compliant Industries (Carol DeSain)
6. Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents (Mindy J. Allport-Settle, 2nd Ed)

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SEMESTER –I I

*Paper-X (*BICO456X9*)*

(2 Credits, 25 marks)

Field/ Industry Visit (*Practical*)

Course Objectives (COBs):

- To provide exposure to industrial/research laboratory practices in microbiology and biotechnology.
- To bridge the gap between theoretical classroom learning and real-world applications.
- To develop professional skills in documentation, teamwork, and technical communication.

Course Outcomes (COs): On completing the course, the student will be able to:

- Students will gain first-hand understanding of industrial processes, laboratory protocols, and organizational workflow.
- Ability to maintain records, prepare detailed reports, and present observations effectively.
- Students will acquire practical experience and professional confidence for future research or industry careers.

Course Contents:

1. **Visit to Industry:** Students will compulsorily participate in educational tour to Microbiology/Biotechnology /Pharmaceutical/ Food based Industries conducted by the department and will submit a tour report separately.
2. **Internship:** Students will experience the real-world working experience in industries/research laboratories/ hospitals/ food and dairy units/ environmental monitoring facilities for 10 days. Students have to maintain a logbook, recording their daily activities and observations. At the end of the training, they must submit a comprehensive report and present their findings through a seminar/viva-voce. Evaluation will be based on performance at the host institution, quality of documentation, report writing, and oral presentation.

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SEMESTER – III

*Paper-I (*BICC501X1)

(2 credits,25 marks)
(20 Hours)

Clinical Biochemistry (*Theory*)

Course objectives (COBs):

- To develop basic knowledge on the organization of a clinical laboratory and the associated instrumentation and automation systems in clinical biochemistry laboratories.
- To develop knowledge about different specimen collection and their clinical importance
- To develop knowledge about blood parameters used for clinical diagnosis.
- To develop comprehensive ideas on important clinical diagnostics process.

Course outcomes(COs): On completing the course, the student will be able to:

- Know the principles and practice of quality control, handling of biological fluids and their significance in maintaining good health; understand clinical significance of plasma proteins and blood disorders.
- Explain the role of enzymes and other biochemical markers in clinical diagnostics and organ function tests; use the knowledge of metabolism of xenobiotics in various interdisciplinary courses.
- Understand and explain disorders associated with various hormones and endocrine glands.

Course contents:

Unit-I: Introduction of Clinical Laboratory, instrumentation and automation in clinical biochemistry Lab Management - Method Evaluation: Analytical goals, precision and accuracy, Specimen collection – blood, (primary /Secondary specimen)., urine and CSF. Preservation of biological specimens -blood, urine, CSF and amniotic fluid. (4H)

Unit- II:

Diagnosis and Classification of Diabetes mellitus, Diabetic nephropathy, retinopathy and Diabetic foot ulcers. (2 H)

Unit- III: Lipid profile: Estimation of Cholesterol, Triglyceride, HDL, LDL Cardiac function tests. (2H)

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Unit-IV: Principles of diagnostic enzymology, Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, lactate dehydrogenase, alkaline phosphatase, acid phosphatase. Enzymes as therapeutic agent. (4 H)

Unit-V: Hepatobiliary function tests: Laboratory findings and diagnosis of jaundice, Fibrosis. Renal function tests - Biochemical laboratory findings in acute and chronic renal failure. (4 H)

Unit- VI: 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. (4H)

Reference Books:

1. Textbook of Biochemistry for Medical student by Vasudevan DM (2019), 9th edition, Jaypee Brothers Medical Publishers
2. Teitz text book of clinical Chemistry (2016), 6thedition, Carl A. Burtis and Edward R. Ashwood, W. B. Saunders Company.
3. Harper's Biochemistry, 31st edition, by R.K. Murray, P.A. Hayes, D.K. Granner, P.A. Mayes and V.W. Rodwell (2018) Prentice Hall International.
4. Textbook of Biochemistry with Clinical Correlations, 6th edition by T.M. Devlin (2005). Wiley-liss.
5. Biochemistry by U. Satyanarayana (2019). Books and allied (P) Ltd.
6. Text Book of Biochemistry & Human Biology by G.P. Talwar (1989) Prentice Hall, New Delhi

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SEMESTER – III

*Paper-II (*BICC501X8)

(2 Credits, 25 marks)

Clinical Biochemistry (*Practical*)

Course objectives (COBs):

- To develop basic knowledge on the organization of a clinical laboratory and the associated instrumentation and automation systems in clinical biochemistry laboratories.
- To develop practical knowledge about different specimen collection and their clinical importance.
- To develop knowledge about procedure of specimen collection.
- To develop comprehensive ideas on important clinical diagnostics process.

Course outcomes (COs): On completing the course, the student will be able to:

- Collect different types of Biological sample and preserve it.
- Develop skill in assay of different blood parameters
- Explain the role of enzymes and other biochemical markers in clinical diagnostics and organ function tests
- Explain different hormonal assay procedure and their clinical significance.

Course Contents:

1. Estimation of glucose by GOD-POD method.
2. Estimation of cholesterol by enzymatic method.
3. Estimation of triglyceride by enzymatic method.
4. Estimation of SGPT and SGOT by enzymatic method.
5. Estimation of alkaline phosphatase .
6. Estimation of Bilirubin.
7. Estimation of total protein, albumin and globulin.
8. Estimation of urea DAM method.
9. Estimation of uric acid by enzymatic method.
10. Estimation of creatinine by alkaline picret method.
11. Biochemical detection of urine abnormalities.
12. DC of human WBC and TC of human WBC and RBC.
13. Estimation of ESR.
14. Estimation of PCV.
15. Estimation of hemoglobin.

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SEMESTER – III

*Paper-III (*BICC50X1)

(2 Credits, EA:20+ IA:5)
(20 Hours)

Gene and Gene Regulation *(Theory)*

Course objectives (COBs):

- To develop an understanding of the Mendelian Genetics, Human genetics and Population genetics, molecular basis of Chromosome and chromosomal abnormalities.
- To gain knowledge about gene mapping, counselling
- To develop the concept of regulation of gene expression.
- To give an overall insight about gene cloning and to familiarize students with the different carrier of DNA to be carried the recombinant product to host cell.
- To develop knowledge about gene editing technology.

Course outcomes(COs): On completing the course, the student will be able to:

- Understand the concept of Mendelian, Human and population genetics, law, inheritance, gene mapping.
- Explain regulation of gene expression by explain operon concept.
- Acquire knowledge about the different process of foreign delivery to another host organism.
- Understand the Gene editing technology to produce different gene/ protein product by using single set of gene.

Course contents:

Unit-I: Overview of Mendelian Genetics, molecular organization of chromosomes Linkage and Crossing over, Maternal inheritance, Polygenic inheritance, ISH, FISH and its applications. Hardy-Weinberg law. Pedigree analysis, inheritance of sex linked and autosomal traits, chromosome aberrations, Biochemical genetics, genetic counselling. (5H)

Unit-II: Regulation of gene expression: Operon concept, lac operon, trp operon Chromosome folding, HATs, Gene silencing, Exon shuffling, Frame shifting, Protein splicing, RNA editing and all other mode of regulation. (5H)

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Unit-III: Gene cloning: General concept, restriction endonucleases, enzymatic tools for gene cloning, linkers and adaptors. Vectors: Plasmids (pBR 322, PUC Vectors,). DNA cloning, therapeutic cloning, somatic cell nuclear transfer (5H)

Unit-IV: Gene Editing Technology**:** *Site* directed mutagenesis, Antisense and ribozyme technology, Gene Knock Out, Gene Knock in, CRISPR-Cas9 Technology. (5H)

Reference Books:

1. Nicholl D.S.T. Introduction to Genetic Engineering Cambridge (3rd Ed.) University press.UK. 2008
2. Old R.W., Primrose S.B. Principles of gene manipulation and Genomics- An introduction to genetic engineering (7th Ed.), Blackwell Scientific Publications, UK.
3. Benjamin Lewis, Genes XII (12 th Ed.) Oxford University & Cell Press, NY.2017
4. Robert Williamson. Genetic Engineering (1st Ed.) Academic Press.1981.USA
5. Rodriguez. R.L (Author), Denhardt D.T. Vectors: A Survey of Molecular Cloning
6. Vectors and Their Uses (1st Ed.) Butterworth-Heinemann publisher.UK. 1987
7. Ansubel F.M., Brent R., Kingston R.E., Moore D.D. et al. short protocols in molecular biology (4th Ed), Wiley publishers. India. 1999.
8. S. B. Primrose, Richard M. Twyman. Principles of gene manipulation and genomics (7th Ed.) John Wiley & Sons publishers.2006

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SEMESTER – III

Paper – IV(BICC502X8)

(2 Credits, 25 marks)

Genetic Engineering (*Practical*)

Course Objectives (COBs):

- To give an overall insight about isolation and *in vitro* synthesis of DNA, their polymorphic pattern by digestion with different enzymes.
- To familiarize with the isolation of digested DNA from Agarose gel.
- To understanding the process of foreign DNA cloning into carrier DNA.
- To understand the how the cloned DNA transferred to host cell chromosome.
- To understand the basic concept of plant tissue culture techniques.

Course Outcomes (COs): On completing the course, the student will be able to:

- Understand DNA isolation replication, digestion and analysis of polymorphic pattern.
- Acquire knowledge about the isolation of digested DNA from Agarose gel.
- Acquainted with process of foreign DNA cloning into carrier DNA.
- Understand how the cloned DNA transferred and integrated into host cell chromosome.

Course Contents:

1. Isolation of Bacterial genomic DNA
2. Restriction enzyme digestion of DNA
3. Elution of digested DNA from Agarose gel
4. Ligation of DNA fragment with cloning vector
5. Preparation of Competent cells
6. Transformation in *E. coli* with recombinant vector
7. Polymerase Chain Reaction.
8. Plant tissue culture – Media preparation, induction of callus, cell suspension culture, somatic embryo, microshort development.
9. Demonstration of In vitro fertilization (IVF).

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SEMESTER – III

Paper – V (BICC503X1)

(2 Credits,EA:20+ IA:5)
(20 Hours)

Advanced Biochemistry (Theory)

Course Objectives (COBs):

- To acquire knowledge about Biochemistry and molecular mechanism of metabolic disorders and neurodegenerative disorders
- To understand the basic concepts of molecular mechanism and different reasons of cancer.
- To understand the basic concept of stress and biochemistry and activity of different antioxidants
- To acquire knowledge about phytochemicals and their important functions.

Course Outcomes (COs): On completing the course, the student will be able to:

- Acquire concepts regarding the types of metabolic disorders
- Develop ideas about neurodegenerative disorders
- Explain the molecular mechanism of different types of cancer, their diagnosis and prevention.
- Develop ideas about stress and importance of antioxidant.
- Explain about secondary metabolites of plants and their classification.

Course Contents:

Unit- I: Metabolomics and Molecular basis of metabolic disorders**:** Biochemistry and molecular basis of different disorders related to carbohydrate, protein, fat and nucleic acids, Inborn errors of metabolism. Cardiovascular disease (4H)

Unit- II: Neurodegenerative disorders: Molecular basis, Biochemistry and clinical manifestations of Alzheimer's disease, Parkinson's disease and Human Multiple sclerosis (4H)

Unit- III: Molecular mechanism of cancer: Cellular proto-oncogenes and their activation mechanism, Tumor suppressor genes, Invasion and metastasis, VEGF signaling and angiogenesis, Growth factors (EGF, TNF, TGF) and growth factor receptors, signal transduction in cancer, and the mechanism of transcription factors. Viral cancer. Retroviruses: Structure, replication, life cycle and transformation. Retrotransposons.

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Diagnostic and therapeutic implication of cancer of Liver, Breast and cervical and Colon Cancer. (6H)

Unit- IV: Stress and diseases**:** Concept of stress, Stress induced genes and their role, free radicals and antioxidant defense systems. (2H)

Unit- IV: Phytochemistry: Classification, Structure, function and synthesis pathway of some common secondary metabolites (Alkaloids, Phenols, Flavonoids, Glycosides, Resins etc.) and Role of secondary metabolites in medicine and other uses. (4H)

Reference Books:

1. Soccol, C.R., Brar, S.K., Permaul, K., Pakshirajan, K., de Carvalho, J.C. Biohydrogen - Advances and Processes. 2024. 1st ed. Springer Cham.
2. Rena, Kumar S. Biofuels – Technologies, Policies and Opportunities. 2023. 1st ed. CRC Press.
3. Koller, M. The Handbook of Polyhydroxyalkanoates. 2023. 1st ed. CRC Press. Sahay, S. Handbook of Biofuels. 2021.1st ed. Academic Press.
4. Editor(s): Christopher D. Byrne, Sarah H. Wild Published Online: 10 JUN 2011 02:59AM EST Print ISBN: 9781444336580 Online ISBN: 9781444347319 DOI: 10.1002/9781444347319
5. Inborn Metabolic Diseases: Diagnosis and Treatment 5th ed. 2012 Edition by Jean-*Marie* Saudubray (Editor), Georges van den Berghe (Editor), John H. Walter (Editor)
6. Nutrition Management of Inherited Metabolic Diseases: Lessons from Metabolic University 2015th Edition by Laurie E. Bernstein (Editor), Fran Rohr (Editor), Joanna R Helm (Editor)
7. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics Paperback – 26 Apr 2012 by Lauren Pecorino (Author)
8. The Biology of Cancer Paperback – Import, 12 Jun 2013 by Robert A. Weinberg (Author), Robert A Weinberg (Author)
9. The Molecular Biology of Cancer: A Bridge from Bench to Bedside, 2nd Edition Stella Pelengaris (Editor), Michael Khan (Editor) May 2013, ©2013, Wiley-Blackwell
10. Neurodegenerative Diseases: Neurobiology, Pathogenesis and Therapeutics by M. Flint Beal (Author), Dr Anthony E. Lang (Author), Albert C. Ludolph (Author)
11. Neurodegenerative Diseases Editors: Ahmad, Shamim (Ed.)
12. Neurodegenerative Diseases Editor(s): Nitsch R.M. (Zürich)
13. Pharmacognosy by Trease G.E and Evans. W.C ,16th edition
14. Textbook of Pharmacognosy and Phytochemistry , by Shah and Seth , 2nd Edition.

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Vidyasagar University
Syllabus of M.Sc. Course in Biochemistry
Two-year P.G. Program as per NEP-2020 (Effective from 2025-26)
SEMESTER – III

Paper – VI (BICC503X8)

(2 credits, 25 marks)

Advanced Biochemistry (*Practical)*

Course Objectives (COBs):

- To acquire knowledge about qualitative and quantitative estimation of Phytochemicals.
- To gain knowledge on separation techniques of phytochemicals by chromatography.
- To understand the basic concepts of cancer cell and *in silico* analysis of cancer gene.
- To acquire knowledge about activity of different antioxidants

Course Outcomes (COs): On completing the course, the student will be able to:

- Acquire concepts regarding analysis of phytochemicals.
- Develop ideas about chromatographic techniques for phytochemical separation.
- Explain the properties of different types of cancer cells.
- Develop *in silico* ideas about progression of cancer cell.

Course Contents:

1. Qualitative assay of phytochemicals (Chemical and TLC)
2. Quantitative estimation of Alkaloids
3. Quantitative estimation of Phenolics.
4. Separation of phytochemicals by column chromatography.
5. Determination of antioxidant activity.
6. Cytological studies of animal cells.
7. Histopathological analysis of cancer tissues.
8. Protein sequence analysis of cancer related genes and proteins.
9. Homology search for cancer related genes.
10. In silico determination of physicochemical properties and 3-D structure analysis of a cancer related protein.

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SEMESTER – III

*Paper-VII (*BICC504X0*)*

*(*4 Credits, EA:40 +IA :10)
(40 Hours)

Analytical Instrumentation (*Theory*)

Course Objectives (COBs):

- To impart core knowledge regarding radioactivity, spectroscopy, thermal analysis, and separation techniques used in biological and pharmaceutical research.
- To explain the principles of advanced structural determination techniques, including X-ray crystallography, NMR, and electron microscopy.
- To familiarize students with the operations and applications of modern chromatographic and electrophoretic instrumentation.
- To illustrate how physical and chemical methodologies are applied to solve complex problems in biological systems and pharmaceutical analysis.

Course Outcomes (COs): Upon successful completion of this course, students will be able to:

- Apply radiochemical concepts to design safety-compliant experiments involving radioisotopes in biological systems and Evaluate Thermal and Electrochemical Data from TGA, DTA, and DSC curves to quantify chemical and pharmaceutical compounds.
- Analyse spectroscopic profiles to characterize molecular structures and electronic properties and elucidate protein structures using X-ray crystallography and NMR spectroscopy to determine the three-dimensional structures of proteins and macromolecules.
- Optimize chromatographic systems to effectively isolate, identify, and quantify complex biomolecules and drugs and Execute Macromolecular Separations to separate nucleic acids and proteins based on size, charge, or isoelectric point.
- Utilize Advanced Imaging and Cytometry to analyse cellular populations.

Course Contents:

Unit I: Isotopes and radioactivity: Radioactivity, autoradiography, G.M. Counter, scintillation counter, use of radioisotopes in biological system. (5 H)

Unit II: Thermal and Electroanalytical Methods: Thermogravimetry (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), potentiometry, and voltammetry. Basic Understanding of Chemical and Pharmaceutical analysis (6 H)

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Unit III: Spectroscopy: Ultraviolet and visible adsorption spectroscopy, Infrared spectroscopy, Raman spectroscopy, Resonance Raman spectroscopy, Circular Dichroism (CD) spectroscopy. (6 H)

Unit IV: Determination of structure of proteins: X-ray Crystallography, Nuclear Magnetic Resonance method. (5 H)

Unit V: Electrophoresis: PAGE and Agarose Gel Electrophoresis, Pulsed Field Electrophoresis, Isoelectric focusing, capillary Gel electrophoresis. (6 H)

Unit VI: Chromatography: Paper chromatography, Thin-layer chromatograph, Ion exchange chromatography, Affinity chromatography. HPLC, GC-MS and LC-MS (6 H)

Unit VII: Electron microscopy: Freezing, sample preparation, Imaging, Low dose of electrons methods used in cryo-microscopy, confocal microscopy, Flow cytometry (6 H)

Reference Books:

1. Inorganic quantitative analysis by Vogel.
2. Practical HPLC analysis by Veronica Meyer
3. Instrumental methods of Analysis by Skoog, Holler and Nieman.
4. Devlin, T.M. (1997). Biochemistry with clinical correlations, Wiley-Liss Inc. NY
5. Chromatography: Concepts and Contrasts by James M. Miller.
6. Basic Principles of Chromatography and HPLC by Arunadevi S. Birajdar.
7. Electron Microscopy by Bozzella and Russell.

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SEMESTER – III

*Paper-VIII (*BICO505X0*)*

(4 Credits, EA:40 +IA :10)
(40 Hours)

MOOCS (*Theory)*

Course Objectives (COBs):

- To provide global, barrier-free access to high-quality higher education without strict entry prerequisites.
- To cover foundational theories, advanced concepts, or specialized industry skills within a compact timeline (typically 4 credits and 12 weeks).
- To design a self-paced, asynchronous learning environment supported by multi-modal resources like e-tutorials and e-content.
- To offer collaborative learning windows via centralized peer discussion forums and crowdsourced problem-solving.
- To implement automated testing matrices (such as quizzes and peer-reviewed metrics) capable of grading thousands of students simultaneously.

Course Outcomes (COs): Upon successful completion of this course, students will be able to:

- Engage in Continuous Self-Learning, demonstrate advanced self-regulation, time management and independent digital research capabilities.
- Earn Professional/Academic Credentials and secure valid certificates, professional badges, or transferable academic credits to boost career profiles or university transcripts.

Course Contents:

Students have to register and select a Massive Open Online Courses (MOOCs) from SWAYAM platform of their choice. They have to complete the course and submit the assignment/quizzes given to them in order to sit in the end semester examination.

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SEMESTER – III

*Paper-IX (*BICO506X9*)*

(2 Credits, (EA:25)
(20 Hours)

*(*Social Service/Community Engagement*) (Practical)*

Course Objectives (COBs):

- To cultivate deep civic awareness, exploring the socio-economic, environmental, and structural factors that impact marginalized or underserved populations.
- To develop community-based intervention strategies, learning how to conduct grass-roots needs assessments and build sustainable project models alongside local stakeholders.
- To apply academic learning to real-world challenges, utilizing multidisciplinary problem-solving skills to address community-identified priorities.]
- To foster personal and professional leadership traits, building cross-cultural communication, emotional intelligence, teamwork, and ethical reflective practices.

Course Outcomes (COs): By the end of this course, students will be able to:

- Analyse complex social issues (such as literacy, public health, or environmental distress) by evaluating localized socioeconomic and systemic data.
- Collaborate effectively with non-governmental organizations (NGOs), local government bodies, and diverse community members to execute service initiatives.
- Evaluate the legal, ethical, and environmental sustainability impacts of public welfare and community development programs.
- Refine personal civic values and career goals through systematic, structured reflections on fieldwork experiences and community interactions.

Course Contents:

Students will serve the society in any form (by spreading social awareness on microbial diseases / water quality testing and hygiene/fermented food/ Soil Health and organic Farming Awareness/School Science outreach programme/ Nutrition and Anemia Screening) and will prepare a detailed report and submit during semester examination. Evaluation will be based on both the assigned report and presentation.

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SEMESTER – IV

Paper-I (BICC551X1)

(2 Credits, EA:20 +IA :05)
(20 Hours)

Pharmaceutical Biochemistry & Nanotechnology (Theory)

Course Objectives (COBs):

- To understand drug metabolism with their activity of enzymes
- To know about the effect of different transcription factors on drug metabolism
- To gain knowledge about molecular drug designing and about different database.
- To evaluate synthesis and characterization methodologies, contrasting top-down and bottom-up engineering approaches with a heavy emphasis on sustainable green synthesis and structural spectroscopy.
- To analyse advanced nanomedicine systems, focusing on targeted intracellular drug delivery vehicles, diagnostic nanoshells, and the integration of DNA structures into nanomechanics.

Course Outcomes (COs): By the end of this course, students will be able to:

- Understand and explain drug metabolism with pharmacokinetics and pharmacodynamics.
- Interpret raw analytical data from material characterization tools including XRD, SEM, TEM, and FTIR spectroscopy to evaluate nanoparticle morphology.
- Formulate a conceptual framework for utilizing liposomes, dendrimers, and gold nanoshells as functional vehicles for site-specific drug and gene delivery.

Course Contents:

Unit -I: Drug metabolizing enzymes, CYP450, SULTS, GULT. pharmakokinetics, pharmakodynamics, LD50, ED50. Role of Nuclear receptors and transcription factors on drug metabolizing gene expression. (5H)

Unit -II: Small molecule databases. Basic idea of molecule design, Chemical databases and its implications, Pharmacophore model, Virtual screening, Ligand based and structure-based molecular design. File format, conversion of file format, sketching compounds. Calculation of Drug like properties and applying of Lipinski rule. (5H)

Unit III: Introduction to nanotechnology, Synthesis of nanoparticles, 'Top-Down' and 'Bottom-Up' approaches, physical, chemical, and biological approach of nanoparticle synthesis,

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limitations and advantages of physical, chemical and green synthesis approach. Characterization of nanoparticles, UV spectrophotometer, XRD, SEM, TEM, HR-TEM, FTIR and dynamic light scattering, etc. (5H)

Unit IV: Applications of nanoparticles, antimicrobial activity, cytotoxicity of nanomaterials, phytotoxicity of nanoparticles. antioxidant activity, anticancer activity, anti-inflammatory activity, dye degrading potential, nano fertilizers, application of nanoparticles in the treatment of Industrial wastewater, and pollution control, Nanomedicine, Drug delivery, gene delivery, protein delivery, and uptake, diagnostic applications of nanotechnology. (5H)

Reference Books:

1. Jeremy Ramsden, Essentials of Nanotechnology, Ventus Publishing ApS, 2014
2. Nanotechnology: A Gentle Introduction to the Next Big Idea, by Mark A. Ratner and Daniel Ratner.
3. Introduction to Nanoscience by Gabor L Hornyak, Joydeep Dutta and H. F. Tebbals.
4. Nanomaterials: An Introduction to Synthesis, Properties and Applications by Thomas Varghese and K. M. Balakrishna.
5. Nano Comes to Life: how nanotechnology is transforming Medicine and the future of Biology by Sonia Contera.

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SEMESTER – IV

*Paper-II (*BICC551X8*)*

(2 Credits, 25 Marks)

Nanobiotechnology and Drug Designing *(Practical)*

Course Objectives (COBs):

- Understand the fundamentals of eco-friendly, green, and microbial synthesis pathways for nanomaterials using biological extracts.
- Master the laboratory protocols for extracting phytochemicals and utilizing them as reducing and capping agents.
- Acquire skills in utilizing analytical instruments to characterize the structural and morphological properties of nanoparticles.
- Evaluate the therapeutic potential of synthesized nanomaterials through antioxidant and antimicrobial bioassays.
- Assess the ecological safety and cellular biocompatibility of nanomaterials using in vitro screening models.

Course Outcomes (COs): Upon successful completion of this course, students will be able to:

- Isolate bioactive phytochemicals from plant matrices using optimized extraction methods and execute the green synthesis of metallic or metal-oxide nanoparticles by optimizing reaction parameters like pH and temperature.
- Demonstrate how to use microorganisms and their extracts as biological factories for scaling up nanoparticle production.
- Analyse the optical properties of nanoparticles using UV-Visible Spectroscopy and interpret functional groups, surface coating and chemical bonding interactions using FTIR,
- Quantify the free-radical scavenging capacity of nanoparticles using standard antioxidant assays (e.g., DPPH or ABTS).
- Determine the minimum inhibitory concentration (MIC) and zones of inhibition against pathogenic strains.
- Appraise the phytotoxic impact of nanomaterials on seed germination and seedling growth metrics and measure cellular safety by executing an Erythrocyte Haemolysis Assay to calculate percentage haemolysis and verify biocompatibility.

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Course Contents:

1. Virtual small molecule databases
2. Visualization and generation of 2D and 3Dmolecular structures,
3. ADMET models and screening, Virtual screening of active compounds and Molecular Docking.
4. Preparation of plant extract for nanoparticle synthesis
5. Green synthesis of nanoparticles using plant extract.
6. Microbial Biosynthesis of nanoparticles.
7. Characterization of nanoparticles using UV- Spectrophotometer and FTIR.
8. Evaluation of the antioxidant activity of nanoparticles.
9. Evaluation of the antimicrobial activity of nanoparticles.
10. In Vitro Phytotoxicity Studies of synthesized nanomaterials
11. In Vitro Biocompatibility Assessment (Erythrocyte Hemolysis Assay) of synthesized nanomaterials

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SEMESTER – IV

*Paper-III (*BICC552X0*)*

(2 Credits, EA:20 +IA : 05)
(20 Hours)

Genomics and Proteomics (Theory)

Course Objectives (COBs):

- To master eukaryotic gene organization and mapping techniques, exploring gene families, genomic paradoxes, and diverse polymorphic DNA fingerprinting markers.
- To evaluate modern sequencing and genomics workflows, contrasting Sanger sequencing with Next-Generation Sequencing (NGS) alongside gene isolation, identification, and functional annotation.
- To analyse the strategies and technologies of proteomics, studying advanced protein separation, high-resolution mass spectrometry, and real-time kinetic tracking methods.
- To deconstruct macromolecular interaction networks, evaluating experimental techniques to detect DNA-protein and protein-protein interactions for clinical and biomedical diagnostics.

Course Outcomes (COs): By the end of this course, students will be able to:

- Explain the genetic implications of the C-value paradox, gene clusters, and multigene families across different living systems.
- Select appropriate molecular markers (such as SNPs, STRs, RAPD, or AFLP) for specific applications in DNA fingerprinting, barcoding, and genetic mapping.
- Outline the complete pipeline for structural and functional genomic analysis, from genomic DNA isolation to functional gene annotation and microarray analysis.
- Compare the throughput, chemical mechanisms, and data outputs of Sanger sequencing with Next-Generation Sequencing (NGS) technologies.
- Interpret protein profiles and structural configurations using 2D gel electrophoresis, MALDI-TOF mass spectrometry, and Surface Plasmon Resonance (SPR).
- Design experimental assays (such as yeast two-hybrid, ChIP, or protein chips) to map intracellular protein-protein and DNA-protein interaction networks.

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Course Contents:

Unit I: Organization of genes across living systems, gene content and C value paradox – gene cluster and gene families. restriction mapping, chromosome walking and chromosomal localization of genes, DNA Fingerprinting - RAPD, ISSR, DArT, SNP, STR, AFLP, c-DNA AFLP, RFLP, SNP expressed sequenced Tags (ESTs), DNA barcoding, Microarray, Concept of structural and functional genomics -isolation, identification and function annotation of a gene. (5H)

Unit II: Concept of structural and functional genomics -isolation, identification and function annotation of a gene. Methods of preparing genomic DNA, DNA sequence analysis methods, Sanger Di deoxy method, next generation sequencing, Gene disease association, fungal genome and genomics. PCR based Analysis, (5H)

Unit III: Proteomics: Aims, strategies and challenges in proteomics, structural and functional proteomics. Proteomics technologies: Protein sequencing techniques, 2D gel electrophoresis, MALDI-TOF, Surface Plasmon resonance (SPR), and mass spectrometry. (5H)

Unit IV: DNA-protein interactions: DNA binding motif, and methods for detecting DNA-protein interactions, protein motifs and domains, methods for protein-protein interactions detection, protein chips, clinical and biomedical applications of proteomics. (5H)

Reference Books:

1. Rastogi, S.C., Rastogi, P., Mendiratta, N. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. 2022. 5th ed. PHI.
2. Rudolph, M. Genomics and Proteomics: Functional and Computational Aspects. 2019. 1st ed. Syrawood Publishing House.
3. Keerthikumar, S., Mathivanan, S. Proteome Bioinformatics. 2017. 1st ed. Springer, Humana, New Yark.
4. Kussmann, M., Stover, P.J. Nutrigenomics and Proteomics in Health and Disease. 2017. 2nd ed. John Wiley & Sons Ltd.
5. Campbell, A.M., Heyer, L.J. Discovering Genomics, Proteomics, and Bioinformatics. 2007. 2nd ed. San Francisco, CSHL Pearso/Benjamin Cummings.

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SEMESTER – IV

Paper-IV (BICC553X9)

(2 Credits, EA: 25 Marks)
(20 Hours)

Grand Viva (Practical)

Course Objectives (COBs):

- To evaluate the comprehensive understanding of concepts, techniques, and applications covered across the two-year programme.
- To assess the students' ability to integrate theoretical knowledge with experimental/practical skills in microbiology and biotechnology.
- To develop confidence in scientific communication, critical reasoning, and problem-solving through expert interaction.

Course Outcomes (COs): By the end of this course, students will be able to:

- Students will demonstrate holistic knowledge of core and advanced topics in microbiology, biotechnology, and related interdisciplinary fields.
- Students will gain the ability to critically analyse, interpret, and apply concepts to real-world biological and industrial challenges.
- Students will enhance their oral presentation, defence, and discussion skills before an expert panel, preparing them for research, industry, or higher studies.

Course Contents:

Students will be evaluated on all the topics discussed in the two years programme by a panel of experts.

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SEMESTER – IV

Paper-V (BICC554X9)

(8 Credits, EA: 80, IA: 20)
(80 Hours)

Research Project and Dissertation (Practical)

Course Objectives (COBs):

- To provide students with hands-on training in independent research methodology, experimental design, and data analysis.
- To encourage critical thinking, creativity, and problem-solving in addressing research questions in microbiology/biotechnology.
- To develop scientific writing and presentation skills through dissertation preparation and defence before experts.

Course Outcomes (COs): By the end of this course, students will be able to:

- Conduct independent laboratory research, analyse results, and draw meaningful scientific conclusions.
- Produce a dissertation report demonstrating clarity, scientific rigor, and adherence to academic standards.
- Communicate their research findings through oral presentations and defend them before an expert panel.

Course Contents:

Three months duration research work to be done at any laboratory. The outcome of the work is to be presented during end-term examination with submitting a project dissertation write up duly certified by the host institute and supervisor. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.

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SEMESTER – IV

*Paper-VI (*BICC555X9*)*

(4 Credits, EA: 40, IA: 10)
(40 Hours)

Internship/Applied field or Industry Project/ Entrepreneurship (Practical)

Course Objectives (COBs):

- To familiarize students with the structure, requirements, and standards of national grant proposal formats.
- To develop skills in formulating innovative, feasible, and impactful research/start-up ideas in biological sciences.
- To train students in professional scientific communication, budgeting, and proposal defence before experts.

Course Outcomes (COs): By the end of this course, students will be able to:

- Design a structured and well-justified research/start-up proposal with clear objectives and methodology.
- Demonstrate the ability to prepare project timelines, budget plans, and address feasibility issues.
- Effectively defend their proposal through critical discussion, demonstrating confidence, clarity, and depth of subject knowledge.

Course Contents:

A grant proposal on any relevant topic in biology will have to be prepared by students following the format of DST/DBT/ICMR, India. The students will also be required to defend the proposal before a panel of experts. Both the written proposal and its defence will be taken into consideration for evaluation.

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SEMESTER – IV

*Paper-VII (*BICC556X0*)*

(2 Credits, EA: 20, IA: 05)
(20 Hours)

Intellectual Property Rights (IPR) and Bio-Entrepreneurship (Theory)

Course Objectives (COBs):

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development
- To become familiar with India's IPR Policy
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products

Course Outcomes (COs): By the end of this course, students will be able to:

- Understand the rationale for and against IPR and especially patents.
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations.
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents.

Course Contents:

Unit-I: Intellectual property (IP): Introduction, history and evolution of patent laws. Types of IP: Patents, trademarks, copyright & related rights, Idea-expression dichotomy, industrial design, traditional knowledge, geographical indications, significance of IPR. (5H)

Unit- II: International conventions and treaties: History of GATT & TRIPS agreement, World trade organization, post TRIPS scenario, Madrid agreement, Hague agreement, Budapest treaty, patent cooperation treaty, Indian patent act 1970 & recent amendments, India's IPR policy, and World intellectual property organization (WIPO). (5H)

Unit- III: Discovery vs invention: A concept of 'prior art', invention in context of 'prior art', introduction & classifications of patents, and patentability criteria. Diamond vs Chakraborty case study, IP as a factor in R&D, legal and IPR issues in biotechnology, licensing and compulsory licensing, patent infringement and legal action (5H)

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Unit-IV: Concept of entrepreneurship: Introduction and scope in bio-entrepreneurship, risk and benefits, general idea about bio-sector firms and commercialization of a biotechnological pharmaceutical product, introduction to the entrepreneurship development programs (MSME, DBT, BIRAC, and Make in India), incubation center, and start-up India. (5H)

Recommended Books:

1. Gurnani, S.R. Intellectual Property Rights. 2024. 1st ed. C. Jamnadas & Co.
2. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy. 2017. 1st ed. McGraw Hill Education.
3. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Government of India (http://www.ipindia.nic.in).
4. World Trade Organisation (http://www.wto.org).
5. World Intellectual Property Organisation (http://www.wipo.int).

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