VIVEKANANDHA

COLLEGE OF ARTS AND SCIENCES FOR WOMEN

ELAYAMPALAYAM, TIRUCHENGODE (Tk.), NAMAKKAL (Dt.).

An ISO 9001: 2015 Certified Institution
(Affiliated to Periyar University, Approved by AICTE, recognized u/s 2 (f) & 12 (B) & Re-accredited with 'A+' by NAAC)

AUTONOMOUS

DEPARTMENT OF BIOCHEMISTRY

M.Sc., BIOCHEMISTRY

SYLLABUS AND REGULATIONS

FOR CANDIDATES ADMITTED FROM 2023-2024 ONWARDS UNDER AUTONOMOUS OBE AND CBCS PATTERN

VIVEKANANDHA EDUCATIONAL INSTITUTIONS
Angammal Educational Trust
Elayampalayam, Tiruchengode (Tk.), Namakkal (Dt.)

COLLEGE VISION AND MISSION

Vision

- To evolve into a center of excellence in higher education through creative and innovative practices to social equity for women.

Mission

- To provide sufficient learning infrastructure to the students to pursue their studies.
- To provide good opportunity for higher education and conducive environment to the students to acquire education.
- To provide quality academic programs training activities and research facilities.
- To facilitate industry-institute interaction.

DEPARTMENT

Vision

To be recognized as a centre for excellence in Biochemistry that provides an atmosphere to acquire skills in identifying the link between biological and human resources and transform it to enhance the quality of life.

Mission

- To help the students to gain more knowledge through visit to research Institutions, Industries, and hospitals through Job training and project work.
- To give an opportunity to students to meet eminent scientists working in various fields of Biochemistry by way of invited lectures, seminars & workshops
- Designing strategies and catalysts for making chemical bonds in new ways
- To provide opportunities to get hands on experience in –
    - Research oriented education in Biochemistry
    - Programming and application skills in Bioinformatics and Drug Designing
    - Molecular Biology and Biotechnology
    - Apprenticeship in industries and service agencies
    - Entrepreneurship in Biochemistry-related areas.
- Promote research based projects/activities in the emerging areas of technology convergence.

PROGRAMME EDUCATIONAL OBJECTIVES

1. To make the graduates to afford fundamentals and applications of current biochemical concepts at an advanced level.
2. To promote research in the thrust areas of Biochemistry ranging in wide areas like structural biology, gene regulation and to connect various field through Biochemistry
3. To equip with the up-to-date skills of evolving technologies as per industrial forecast

PROGRAMME SPECIFIC OBJECTIVES (PSO)

1. To provide students with learning experiences that help instill deep interests in learning Biochemistry; develop broad and balanced knowledge and understanding of biomolecules, like biochemical concepts, principles and theories related to Biochemistry and quip students with appropriate tools of analysis and with theoretical technical and analytical skills to tackle issues and problems in the field of Biochemistry.

2. To equip the graduates with the ability to prepare to a fast changing situations by gaining strength to learn and apply the new skills with competency and to provide students with the knowledge and skill base that make them undertake further studies in Biochemistry and related areas or I multidisciplinary areas that help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

3. To expose the students to a wide range of careers that combine biology, plants and medicine and render graduates with some work experience, as summer internship and a research project in a research laboratory to further boost the career prospects.

PO and Knowledge level

PO No	PROGRAMME OUTCOME	Knowledge Level
PO1	***Disciplinary knowledge:***Capable of demonstratingcomprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme ofstudy.	K2
PO2	***Communication Skills:***Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one"s views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to differentgroups.	K1
PO3	***Critical thinking:***Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefson the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theoriesby following scientific approach to knowledgedevelopment.	K4
PO4	***Problem solving:***Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real lifesituations.	K3
PO5	***Analytical reasoning****:*Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; drawvalid conclusions and support them with evidence and examples, and addressing opposingviewpoints.	K5
PO6	***Research-related skills:*** A sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment orinvestigation.	K6
PO7	***Cooperation/Team work****:* Ability to work effectively and respectfully with diverse teams, facilitate cooperative or coordinated effort on the part of a groupand act together as a group or a team in the interests of a common cause and work efficiently as a member of ateam.	K6
PO8	***Scientific reasoning:***Ability to analyse, interpret and draw conclusions from quantitative/qualitativedata;andcriticallyevaluateideas,evidenceandexperiences from an open-minded and reasoned perspective.	K4
PO9	***Reflective thinking:*** Critical sensibility to lived experiences, with self awareness and reflexivity of both self andsociety.	K2
PO10	***Information/digital literacy:***Capability touse ICT in a variety of learning situations, demonstrate abilityto access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.	K3
PO11	***Self-directed learning:***Ability to work independently, identify appropriate resources required for a project, and manage a project through tocompletion.	K6
PO12	***Multicultural competence:***Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to	K5

	effectively engage in a multicultural society and interact respectfully with diversegroups.	
PO13	***Moral and ethical awareness/reasoning:*** Ability toembrace moral/ethical values in conducting one‟s life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adoptingobjective, unbiased and truthful actions in all aspects ofwork.	K3
PO14	***Leadership readiness/qualities:*** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth andefficientway.	K6
PO15	***Lifelong learning:***Ability to acquire knowledge and skills, including ‘’learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed atpersonal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skilldevelopment/reskilling.	K6

ELIGIBILITY FOR ADMISSION

- Candidates seeking admission to the first year M.Sc., Degree Course could have a Bachelors Degree in Science with Biochemistry, Chemistry, Botany, Zoology, Nutrition and dietetics or Food and Nutrition or Food Sciences as the main subject or a Bachelors Degree in Agriculture and Life sciences as main subject of this University or any other qualification accepted as equivalent there to are eligible for admission to M.Sc., Degree course.

DURATION OF THE COURSE

The duration of the course is for two academic years consisting of four semesters.

EXAMINATIONS

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and the end of the second academic year, respectively.

SCHEME OF EXAMINATIONS

The scheme of examinations for different semesters shall be as follows:

Theory External marks		=	**75**
	Part A	=	**10 Marks (01 x 10)**
	Part B	=	**35 Marks (05 x 07)**
	Part C	=	**30 Marks (03 x 10)**
Internal marks		=	**25**
	Total Marks	=	**100**
	Time	=	**3 Hrs.**

The following procedure will be followed for Internal Marks

Theory - Internal Marks

Theory best average of two tests	10 Marks
Attendance	5 Marks
Seminar	5 Marks
Assignment	5 Marks
Total	**25 Marks**

Practical - Internal Marks

Practical best average of two tests	25 Marks
Attendance	10 Marks
Observation Note	5 Marks
Total	**40 Marks**

Project- Internal Marks

Presentations [Two reviews 25+25]	50 Marks
Project Report	100 Marks
Viva - Voce	50 Marks
Total	**200 Marks**

Break-up Details for Attendance

Below 75%	No Marks
76 to 80%	01 Marks
81 to 85%	02 Marks
86 to 90%	03 Marks
91 to 95%	04 Marks
96 to 100%	05 Marks

REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS

(i) Candidates shall register their names for the first semester examination after the admission in the PG courses.

(ii) Candidates shall be permitted to proceed from the first semester up to the final semester irrespective of their failure in any of the semester examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subject) semester subjects.

(iii) Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Syndicate from time to time. Provided in case of candidate earning less than 50% of attendance in any one of the semester due to any

extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Principal of the College, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the college from time to time.

PASSING MINIMUM

a) There shall be no Passing Minimum for Internal.

b) For External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.

c) In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.

d) Grading shall be based on overall marks obtained (Internal + External)

CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who secured not less than 60% of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the first class. All other successful candidates shall be declared to have passed in second class. Candidates who obtain 75% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in first class with distinction, provided they pass all the examinations (theory papers, practical, project and viva-voce) prescribed for the course in the first appearance.

GRADING SYSTEM

The term grading system indicates a 7 point scale of evaluation of the performances of students in terms of marks obtained in the Internal and External examination, grade points and letter grade.

SEVEN POINT SCALE (As per UGC notification, 1998)

GRADE	GRADE POINT	PERCENTAGE EQUIVALENT
'O'= Outstanding	**5.50 – 6.00**	**75 – 100**
'A'= Very Good	**4.50 – 5.49**	**65 – 74**
'B' = Good	**3.50 – 4.49**	**55 – 64**
'C'= Average	**3.00 – 3.49**	**50 – 54**
'D'= Below Average	**1.50 – 2.99**	**35 – 49**
'E'= Poor	**0.50 – 1.49**	**25 – 34**
'F'= Fail	**0.00 – 0.49**	**00 – 24**

RANKING

Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction. Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the first appearance will not be eligible for ranking.

PATTERN OF QUESTION PAPER

PART A (Objective):	Answer All the Questions	**01 x 10 = 10 Marks**
PART B (200 words):	Answer All the Questions (Internal choice)	**05 x 07 = 35 Marks**
PART C (500 words):	Answer All the Questions (Internal choice)	**03 x 10 = 30 Marks**

PROCEDURE IN THE EVENT OF FAILURE

If a candidate fails in particular subjects, she may reappear for the examination in the concerned subject in subsequent semester and shall pass the examination**.**

COMMENCEMENT OF THESE REGULATIONS

These regulations shall take effect from the academic year 2023-224 (i.e.,) for the students who are to be admitted to the first year of the course during the academic year 2023-24 and thereafter.

TRANSITORY PROVISION

Candidates who were admitted to the PG course of Biochemistry before 2023 – 2024 shall be permitted to appear for the examinations under those regulations for a period of two years i.e., upto and inclusive of the examination of Apr/May 2023. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)
DEPARTMENT OF BIOCHEMISTRY
CBCS AND OBE PATTERN SYLLABUS - PG
(For candidates admitted from 2023-2024 onwards)

Sem	Subject code	Course	Subjects	Hrs/ week	Credit	Int. marks	Ext. mark	Tot. mark
I	23P1BCC01	Core – I	Basics of Biochemistry	4	4	25	75	100
	23P1BCC02	Core – II	Biochemical and Molecular Biology Techniques	5	4	25	75	100
	23P1BCC03	Core – III	Physiology and Cell Biology	5	4	25	75	100
	23P1BCCP01	Practical I	Core Practical I (6 Hrs)	5	4	40	60	100
	23P1BCCP02	Practical II	Core Practical II (6 Hrs)	5	4	40	60	100
	23P1BCDE01	Elective I	Plant Biochemistry	3	3	25	75	100
	23P1BCDE02		Immunology and Immunotechnology					
	23P1BCDE03	Elective II	Biosafety, lab safety and IPR	3	3	25	75	100
	23P1BCDE04		Cancer Biology					
			Total	**30**	**26**	**205**	**495**	**700**
Sem	**Subject code**	**Course**	**Subjects**	**Hrs/ week**	**Credit**	**Int. marks**	**Ext. mark**	**Tot. mark**
II	23P2BCC04	Core – IV	Enzymology	4	4	25	75	100
	23P2BCC05	Core – V	Cellular Metabolism	4	4	25	75	100
	23P2BCC06	Core – VI	Clinical Biochemistry	4	4	25	75	100
	23P2BCCP03	Practical III	Core Practical III (6 Hrs)	5	3	40	60	100
	23P2BCCP04	Practical IV	Core Practical IV (6 Hrs)	5	3	40	60	100
	23P2BCDE05	Elective III	Energy and drug metabolism	4	3	25	75	100
	23P2BCDE06		Biomedical Instrumentation					
	23P2BCDE07	Elective IV	Nutritional Biochemistry	4	3	25	75	100
	23P2BCDE08		Biochemistry in Human Health					
			Total	**30**	**24**	**205**	**495**	**700**

Sem	Subject code	Course	Subjects	Hrs/ week	Credit	Int. marks	Ext. mark	Tot. mark
III	23P3BCC07	Core – VII	Industrial Microbiology	4	4	25	75	100
	23P3BCC08	Core – VIII	Molecular Biology	4	3	25	75	100
	23P3BCC09	Core – IX	Gene Editing, Cell and Gene therapy	4	4	25	75	100
	23P3BCCP05	Practical V	Core Practical V (6 Hrs)	5	4	40	60	100
	23P3BCCP06	Practical VI	Core Practical VI (6 Hrs)	5	4	40	60	100
	23P3BCDE09	Elective V	Biostatistics and Research Methodology	3	3	25	75	100
	23P3BCDE10		Biochemical Toxicology					
	23P3BCDE11	Elective VI	Developemental Biology	3	3	25	75	100
	23P3BCDE12		Medical Coding					
	23P3HR01		Human Rights	2	1	25	75	100
	23P3INT01		Internship Training		1			
			Total	**30**	**27**	**205**	**495**	**700**
Sem	**Subject code**	**Course**	**Subjects**	**Hrs/ week**	**Credit**	**Int. marks**	**Ext. mark**	**Tot. mark**
IV	23P4BCC10	Core – X	Pharmaceutical Biochemistry	5	5	25	75	100
	23P4BCED01	EDC	Diagnostic Biochemistry	3	3			
	23P4BCPR01	Project	Project viva	22	6	40	60	100
			Total	**30**	**14**	**90**	**210**	**300**
OVER ALL TOTAL				**120**	**91**	**705**	**1695**	**2400**

I YEAR I SEMESTER
BASICS OF BIOCHEMISTRY

Paper	: Core I	Total Hours	: 75
Hours/Week	: 4	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P1BCC01**	External	: 75

SUBJECT DESCRIPTION:

Basic Knowledge of Biochemistry and Biomolecules

OBJECTIVES:

The main objectives of this course are to:

1. Students will be introduced to the structure of biomolecules.
2. The significance of carbohydrate sin biological processes will be understood.
3. The structure, properties and biological significance of lipids in the biological system will be studied
4. Students will learn about the concepts of protein structure and their significance in biological processes and creatively comprehend the role of membrane components with their biological significance.

COURSE OUTCOME:

Course No	Course Outcome	Knowledge Level
CO1	Explain the chemical structure and functions of carbohydrates	K1,K2
CO2	Using the knowledge of lipid structure and function, explain how it plays a role in Signaling pathways	K3,K4
CO3	Describe the various levels of structural organization of proteins and the role of proteins in biological system	K4,K5
CO4	Apply the knowledge of proteins in cell-cell interactions	K3,K4
CO5	Applying the knowledge of nucleic acid sequencing in research and diagnosis	K2,K3,K4

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	S	S	S	S	M	M	M	S	S	S	M	S	S	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	M	S	S	M	M	S	M	M	M	S
CO4	S	S	S	M	S	S	S	S	S	M	S	S	S	S	S
CO5	S	M	M	S	M	M	S	M	S	M	S	S	M	M	S

S- Strong; M-Medium; L-Low

CONTENT:

Unit I – (15 Hrs.):

Carbohydrates- Classification, structure (configurations and conformations, anomeric forms), function and properties of monosaccharides, mutarotation, Disaccharides and oligosaccharides with suitable examples. Polysaccharides – Homopolysaccharides (starch, glycogen, cellulose, inulin, dextrin, agar, pectin, dextran). Heteropolysaccharides – Glycosaminoglycans– source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, Glycoproteins – proteoglycans. O- Linked and N-linked glycoproteins. Biological significance of glycan. Bacterial cell wall (peptidoglycans, teichoic acid) and plant cell wall carbohydrates.

Unit II – (15 Hrs.):

Lipids – Classification of lipids, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, sphingolipids and steroids – Biological importance. Eicosanoids- classification, structure and functions of prostaglandins, thromboxanes, leukotrienes. Lipoproteins – Classification,structure, transport (endogenous and exogenous Pathway) and their biological significance.

Unit III – (15 Hrs.):

Overview of Amino acids – classification, structure and properties of amino acids, biological role.Non Protein aminoacids and their biological significance .Proteins – classification based on composition, structure and functions. Primary, secondary, super secondary (motifs) (Helix-turn –helix, helix-loop-helix, Beta-alpha-beta motif, RosemannRossmann fold, Greek key),tertiary and quaternary structure of proteins. Structural characteristics of collagen and hemoglobin. Determination of amino acid sequence, Forces involved in stabilization of protein structure. Ramachandran plot.

Unit IV – (15 Hrs.):

Membrane Proteins – Types and their significance. Cytoskeleton proteins – actin, tubulin , intermediate filaments . Biological role of cytoskeletal proteins. Membrane structure-fluid mosaic model

Unit V – (15 Hrs.):

Nucleic acids – types and forms (A, B, C and Z) of DNA. Watson-Crick model- Primary, secondary and tertiary structures of DNA. Triple helix and quadruplex DNA. Mitochondrial and chloroplast DNA. DNA supercoiling (calculation of Writhe, linking and twist number). Determination of nucleic acid sequences by Maxam Gilbert and Sanger's methods. Forces stabilizing nucleic acid structure. Properties of DNA and RNA. C-value, C-value paradox, Cot curve. Structure and role of nucleotides in cellular communications. Major and minor classes of RNA, their structure and biological functions**.**

TEXT BOOKS:

1. Deb, A.C (2004) **Fundamentals of Biochemistry.** 8th Edition, New Central Book Agency,
2. Jain, J.L & Jain, (2005) **Fundamentals of Biochemistry.** Sixth Edition,S.Chand & Company, New Delhi.
3. U.Sathayanarayana,(2009). **Biochemistry.** 5th Edition by Books and Allied (P) Ltd., India.

REFERENCE BOOKS

1. Murray, K.R. Granner, K.D.Mayes, P.A. and Rodwell W.V. (2016).**Harper's Biochemistry.** 31rd Edition, Prentice Hall International Inc.,New Jersey.
2. Nelson, D.L. and Cox, M.M (2017). **Lehninger Principles of Biochemistry**. 8th Edition, W.H.Freeman and Company, New York.
3. Bery J.M., Tymoezko J.L. and Stryer L. (2008) **Biochemistry**, 5th Edition, W.H. Freeman and Company, New York.

WEB OF RESOURCES

1. http://ull.chemistry.uakron.edu/genobc/.
2. http://www.biology.arizona.edu/biochemistry/biochemistry.html.
3. https://www.sciencedirect.com/topics/neuroscience/dna-binding-protein
4. https://biologydictionary.net/nucleic-acid/
5. https://www.helpguide.org/harvard/vitamins-and-minerals.htm

PEDOGOGY: CHALK and Talk , PPT

YEAR I – SEMESTER I
BIOCHEMICAL AND MOLECULAR BIOLOGY TECHNIQUES

Paper	: Core II	Total Hours	: 75
Hours/Week	: 5	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P1BCC02**	External	: 75

SUBJECT DESCRIPTION:

Comprehensive Knowledge of Tools of Biochemistry/Molecular Biology.

OBJECTIVES:

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

1. To understand the various techniques used in biochemical investigation and microscopy.
2. To explain chromatographic techniques and their applications
3. To explain electrophoretic techniques.
4. To comprehend the spectroscopic techniques and demonstrate their applications in biochemical investigations.

OUTCOME:

Course No	Course Outcome	Knowledge Level
CO1	Attain good knowledge in modern used in biochemical investigation and microscopy and apply the experimental protocols to plan and carry out simple investigations in biological research.	K1, K5
CO2	Demonstrate knowledge to implement the theoretical basis of chromatography in upcoming practical course work	K3, K5
CO3	Demonstrate knowledge to implement the theoretical basis of electrophoretic techniques in research work.	K3, K5
CO4	Tackle more advanced and specialized spectroscopic techniques that are pertinent to research.	K1, K2 & K5
CO5	Tackle more advanced and specialized radioisotope and centrifugation techniques that are pertinent to research work.	K1, K2 & K5

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	S	S	L	M	L	L	M	L	S	S	M	L	L	M
CO2	M	M	M	M	S	M	M	S	L	M	M	M	L	L	M
CO3	S	S	L	M	L	M	L	S	L	M	L	M	S	S	S
CO4	S	S	L	M	M	M	S	L	M	L	M	S	M	L	L
CO5	L	M	L	S	M	M	M	M	M	L	M	M	M	S	S

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 hour**

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

Unit II **15 hour**

Chromatographic Techniques Basic principles of chromatography- adsorption and partition techniques. Adsorption Chromatography – Hydroxy apatite chromatography and hydrophobic interaction Chromatography. Affinity chromatography, Gas liquid chromatography- principle, instrumentation, column development, detectors and applications. Low pressure column chromatography – principle, instrumentation, column packing, detection, quantitation and column efficiency, High pressure liquid chromatography- principle, instrumentation, delivery pump, sample injection unit, column packing, development, detection and application. Reverse HPLC, capillary electro chromatography and perfusion chromatography. (Bharathidasan University PG BC).

Unit III **15 hour**

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

Unit IV **15 hour**

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

Unit V- 15 hour

Radiolabeling Techniques and Centrifugation: Nature of radioactivity-detection and measurement of radioactivity, methods based upon ionization (GM counter) and excitation (scintillation counter), autoradiography and applications of radioactive isotopes, biological hazards of radiation and safety measures in handling radioactive isotopes. Basic principles of Centrifugation. Preparative ultracentrifugation - Differential centrifugation, Density gradient centrifugation. Analytical ultracentrifugation - Molecular weight determination.

TEXT BOOKS:

1. Keith Wilson , John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th ed) Cambridge University Press
2. David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell
3. David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology,W.H.Freeman

REFERENCE BOOKS

1. Rodney F.Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques,(2nd ed),Prentice Hall
2. Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer
3. Segel I.H (1976) Biochemical Calculations (2nd ed),John Wiley and Sons

Robyt JF (2015) Biochemical techniques: Theory and Practice (1st ed), CBS Publishers & Distributors

WEB SOURCES:

1. https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookCELL2.html
2. https://www.physics.uoguelph.ca/~dutcher/download/.../1.pdf
3. https://www.khanacademy.org/.../cells/cell-cell-interactions/.../cell-cell-interactions-ho...
4. https://en.wikipedia.org/wiki/Programmed_cell_death
5. https://www.cellsignal.com/contents/science/key-signaling-networks-in-cancer/cancer-research

PEDOGOGY: CHALK and Talk , PPT

YEAR I – SEMESTER I
PHYSIOLOGY AND CELL BIOLOGY

Paper	: Core III	Total Hours	: 75
Hours/Week	: 5	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P1BCC03**	External	: 75

SUBJECT DESCRIPTION:

To understand the functions and activities of organs, tissues or cells and of physical and chemical phenomena involved in the human body

OBJECTIVES

The Students should update their knowledge about the functions and activities of organs, tissues or cells and of physical and chemical phenomena involved in the human body

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Specifically understand the biological and chemical processes within a human cell	K1, K2, K5, K6
CO2	Identify and prevent diseases	K2, K3,K4, k5, K6
CO3	Understand defects in digestion, nutritional deficiencies and intolerances, and gastrointestinal pathologies	K1, K2, K3,K4, K5
CO4	Identify general characteristics in individuals with imbalances of acid-base, fluid and electrolytes.	K2 , K3,K4
CO5	Process the mechanism: the transmission of biochemical information between cell membrane and nucleus.	K1, K2, K5

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

Major classes of cell junctions- anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs)- cadherins, integrins. Types of tissues. Epithelium- organization and types. The basement membrane. Cell cycle- mitosis and meiosis, Cell cycle-phases and regulation. Cell death mechanisms- an overview-apoptosis, necrosis.

Unit II **15 Hrs**

Reproductive system- sexual differentiation and development; sperm transport, sperm capacitation, semen analyses and Acrosome reaction. Clinical relevance of female reproductive physiology- menstrual cycle, pregnancy and menopause. Fertilization and infertility issues.

Unit III **15 Hrs**

Digestive system- structure and functions of different components of digestive system, digestion and absorption of carbohydrates, lipids and proteins, role of bile salts in digestion and absorption, mechanism of HCl formation in stomach, role of various enzymes and hormones involved in digestive system. Respiratory system- Gaseous transport and acid-base homeostasis. Mechanism of the movement of O2 and CO2 through lungs, arterial and venous circulation. Bohr effect, oxygen and carbon dioxide binding hemoglobin.

Unit IV **15 Hrs**

Sensory transduction, Nerve impulse transmission- nerve cells, synapses, reflex arc structure, resting membrane potential, Nernst equation, action potential, voltage gated ion-channels, impulse transmission, neurotransmission, neurotransmitter receptors, synaptosomes, rod and cone cells in the retina, changes in the visual cycle, photochemical reaction and regulation of rhodopsin, odour receptors, learning and memory. Chemistry of muscle contraction – actin and myosin filaments, theories involved in muscle contraction, mechanism of muscle contraction, energy sources for muscle contraction.

Unit V **15 Hrs**

Hormones – Classification, Biosynthesis, circulation in blood, modification and degradation. Mechanism of hormone action, Target cell concept. Hormones of Hypothalamus, pituitary, Pancreatic, thyroid & parathyroid, adrenal and gonadal hormones. Synthesis, secretion, physiological actions and feedback regulation of synthesis.

TEXT BOOKS

1.Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6th ed). John Wiley & Sons Inc.

2.Bruce Alberts and Dennis Bray (2013),Essential Cell Biology,(4th ed),Garland Science.

3.De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology.(8th ed). Lippincott Williams and Wilkins, Philadelphia.

REFERENCE BOOKS

1.Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. (5th ed). Sunderland, Mass. Sinauer Associates, Inc.

2.Wayne M. Baker (2008) the World of the Cell. (7th ed). Pearson Benjamin Cummings Publishing, San Francisco. Cell Biology

3.John E. Hall (2010). Guyton and Hall Textbook of Medical Physiology (12th ed), Saunders

Harrison's Endocrinology by J. Larry Jameson Series: Harrison's Specialty, 19th Edition Publisher: McGraw-Hill, Year: 2016.

WEB SOURCES

www.ebi.ac.uk/enzymeportal
http://expasy.org/enzyme/.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi.
www1.lsbu.ac.uk/water/enztech/inhibition.html
https://www.khanacademy.org/...enzymes/enzyme.../basics-of-enzyme-kinetics-graphs

PEDOGOGY: CHALK and Talk , PPT

PLANT BIOCHEMISTRY

Paper	: Elective I	Total Hours	: 60
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: **23P1BCDE01**	External	: 75

SUBJECT DESCRIPTION:

Comprehensive Knowledge of Plant cell structure and functions

OBJECTIVES

This paper aims to provide a basic understanding of plant physiology, photosynthesis, nitrogen fixation, and pytohormones. This paper also provides the knowledge about secondary metabolites and plant tissue culture

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Understand the basic knowledge of mechanism of water transport and Photosynthesis	K1,K2,K3
CO2	Describe the nitrogen fixation mechanisms in plants and interrelationship between photosynthesis and nitrogen metabolism.	K1,K2,K3
CO3	Get the Knowledge about the Biosynthesis, transport, distribution, mechanism of action and physiological effects of plant hormones	K1,K2,K3,K4
CO4	Understand the role of secondary metabolites in drug development	K1,K2,K3,K4
CO5	Know about the isolation, fusion and culture of protoplast and also understand genetic manipulation of plants.	K2,K3,K4

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **12 Hrs**

Water absorption – Mechanism of water absorption, symplast and apoplastconcepts. Transpiration – types, mechanism and factors affecting transpiration. Photosynthesis – Photosynthetic apparatus, role of photosynthetic pigments, Biochemistry of light reactions of Photosynthesis –photo systems, factors affecting photosynthesis, cyclic and non- cyclic photophosphorylation. Biochemistry of dark reactions of Photosynthesis – Carbon reactions in C3, C4 and CAM plants – Calvin cycle, Hatch – Slack pathway.

Unit II **12 Hrs**

Nutrients – Role of macro and micronutrients in plants and hydroponics,Nitrogen fixation and its types. Biochemistry of symbiotic and nonsymbioticnitrogen fixation. Physiology of nodule formation. Gene manipulation of nitrogen fixation genes. Nitrogen assimilation, Interrelationship between photosynthesis and nitrogen metabolism.

Unit III **12 Hrs**

Biosynthesis, transport, distribution, mechanism of action and physiologicaleffects of Phytohormones – Auxin, Gibberellins, Cytokines, Abscisic acid and Ethylene. Phytochrome, biological clock, physiology and biochemistry of seed germination. Dormancy – types and methods to overcome dormancy.Senescence.

Unit IV **12 Hrs**

Secondary metabolites – Basic biosynthetic pathways. Functions of secondary metabolites – Flavonoids, alkaloids, terpenoids, anthocyanins, Tannins, steroids and lignin. Applications of secondary metabolites – Drug development, Biopesticides and Biofertilizers.

Unit V **12 Hrs**

Plant tissue culture- Micropropagation, Callus induction, cell and protoplast culture, organogenesis and somatic embryogenesis. Applications of tissue culture for crop improvement in agriculture, horticulture and forestry.

TEXT BOOKS

1.Plant Biochemistry, Dey J.B. Harborne, 2000. Academic Press.
2.Plant Biochemistry and Molecular Biology Peter J. Lea Richard. C. Leegood,1999 2nd edition. John Wiley & Sons, NY.
3.Introduction to Plant Biochemistry Goodwin T.W. and Mercer E.I 1998. 2ndedition. CBS publication.

RECOMMENDED BOOKS

1.Plant pathology by Pandey B.P, S. 2009 Chand & Co.
2.An introduction to Plant Tissue culture. Razdan M.K. 2003. Oxford & IBH Publishing Co, New Delhi.
3.Plant Tissue culture, A Practical approach Dixon R.A and Gonzales R.A., 2nd edition.
4.Natural Products: A Laboratory Guide. Raphael Ikan. 1991. Academic Press

YEAR I – SEMESTER I
IMMUNOLOGY AND IMMUNOTECHNOLOGY

Paper	: ELECTIVE II	Total Hours	: 75
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: **23P1BCDE02**	External	: 75

SUBJECT DESCRIPTION:

The student should possess basic knowledge about microorganisms, types and their ral characteristics. The students are also expected to possess basic understanding about rocess of infection, immunological defence and pathological outcomes, if any.

OBJECTIVES:

To study the immune responses of human body against antigen, immunological techniques and vaccine synthesis.

COURSE OUTCOMES:

Course No	Course Outcome	Knowledge Level
CO1	Understand basics of immune system and about the cells and organs of immunesystem	K2
CO2	Describe the Antigen and Antibody structure and properties and obtain theknowledge about the hybridoma technology	K3
CO3	Familiarize with complement system, autoimmunity and immunodeficiencydisorders	K3
CO4	Get a clear idea about the immunization and hypersensitivity reactions.	K4
CO5	To Comprehend the antigen and antibody reactions and immunological techniques.	K5

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	M	M	L	L	L	M	S	M	L	L	M	L	L
CO2	M	M	M	S	M	M	L	M	M	S	L	L	S	L	L
CO3	M	M	M	S	M	M	L	M	M	S	L	L	S	L	L
CO4	M	L	S	M	M	L	L	S	M	M	L	M	M	L	L
CO5	L	L	M	M	S	S	S	M	L	L	S	S	L	M	M

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

The Immune System: History of immunology- Cells and Organs of the immune system-primary and secondary lymphoid organs. Differentiation and Generation of T-cells and B-cells from bone marrow. Stem cells – sources, types, properties & applications. Antigens– types, properties that influence antigenicity & immunogenicity, epitopes, crossreactions. Haptens and mitogens. Adjuvants-types and properties. Antibodies–structure, types of immunoglobulins-structure, properties and functions, immunoglobulin superfamily. Complement cascades-components, mechanism of Classical, Alternative and other pathways, biological consequences of complement cascades and their fragments.

Unit II **15 Hrs**

Types of immunities –Innate and Acquired. Immune response-Humoral and Cellular immuneresponses-their characteristics & effector mechanisms. Regulation of immune response. Immune response to infections-bacterial, viral, fungal and others. Immunodeficiency diseases-primary and secondary .Immuno genetics-antibody diversity- theories of antibody formation, organization of immunoglobulin gene and their expression, class switching. Major Histocompatibility Complex- organization, structure and functions of MHC and HLA genes and non-MHC molecules. Gene products. Role in antigen processing and presentation.

Unit III **15 Hrs**

Hypersensitivity and Autoimmunity: Hypersensitivity–classification, causes, mechanism, clinical manifestations, diagnosis and treatment of TypesI–IV hypersensitivities. Autoimmunity-classification, role of MHC, TH cells and TCR in autoimmunity, spectrum of autoimmune diseases, overlap, pathogenesis, diagnosis and treatment of autoimmune diseases. DNA & RNA Vaccines

Unit IV **15 Hrs**

Transplantation Immunology: Immunology of Allogeneic Transplantation,Types of Graft Rejection, Specific Immunosuppressive Agents, Immunology of Xenogeneic Transplantation, Transplantation- types of grafts, principles involved and mechanism of transplantation of various organs ,immunosuppressive therapy, Graft Versus Host Disease. Role of MHC in transplantation, disease susceptibility and resistance and genet control of primary histocompatibility

Unit V **15 Hrs**

Immunotechniques: Antigen-antibody interactions-Precipitation techniques. Agglutination techniques, ABO blood grouping & Rh typing.Tagged assays-RIA, ELISA, immunofluorescence, immunoblotting, immunoelectron microscopy. Isolation of pure antibodies, Assays for complement, FACS, Flow cytometry. Antibody engineering – Hybridoma technology- polyclonal and monoclonal antibody production and their applications. Recombinant antibody production. Vaccine production- types of vaccines, principles of vaccine production, production of conventional and modern vaccines.

TEXT BOOKS

1.Tizard(1984).**An Introduction Immunology**: Tizard K, Saunders college Publishing

2.Immunology Roitt. Brostoff and David(1998). **Immunology**, 4th Edition, Mosby Times Mirror Int Pub Ltd.

3. Janeway Jr.Paul., (2001). **The Immune System in Health and Disease**. Travels and Co.,

REFERENCE BOOKS

1 . Kuby Richard, (2005). **Immunology**, 4th Edition, W.H. Freeman and Company, NewYork.

2. Stites D.P. Stobo, J.D.Fundanberg. H.A and Wells. J.V. (1990) **Basic and Clinical Immunology**. 6th Edition Los AtlasLange.

5. Wilson, K and Goulding, KH (1987). A Biologist Guide to Principles and Tecchniques of Practrical Biochemistry, 3rd edition, Edward Arnold Publishers. Londan, UK.

WEB OF RESOURCE:

https://www.ijam.co.in/index.php/ijam/article/view/1326 (Krumi (Microorganisms) in Ayurveda- a critical review)
Virtual Lectures in Microbiology and Immunology, University of Rochester
https://www.frontiersin.org/articles/10.3389/fphar.2020.578970/full#h9
https://www.frontiersin.org/articles/10.3389/fmicb.2018.02151/full
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7559905/

BIOSAFETY, LAB SAFETY AND IPR

Paper	: Elective – II	Total Hours	: 60
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P1BCDE03	External	: 75

SUBJECT DESCRIPTION:

The student should have a basic knowledge of hazards associated with the handling of biological agents and importance of intellectual property from scientific research.

COURSE OBJECTIVES:

1. To assimilate the hazards associated with the handling of biological and chemical agents.
2. To understand how to protect from the hazards by the implementation of various safety measures in biochemical laboratories.
3. To implicate the importance of protecting the scientific intellect by filing patent and understand the various offices for filing and maintaining patents
4. To understand the scope of patenting in biological research.

Course No	Course Outcome	Knowledge Level
CO1	To understand and implement various aspects of biosafety and carry out risk assessment of products in biological research	K1,K2&K5
CO2	Understand the basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights	K1, K2 &K4
CO3	To appreciate the intellectual property rights and its implementation of on the invention related to biological research.	K1 & K2
CO4	To understand the statutory bodies that regulate the property rights and its validity in various countries.	K2,K5& K6
CO5	Critique the ethical concerns associated with modern biotechnology processes and plan accordingly.	K2, K4 &K5

CONTENT:

Unit I **12 Hrs**

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

Unit II **12 Hrs**

Laboratory safety – Chemical, electrical and fire hazards; handling and manipulating human or animal cells and tissues, toxic, corrosive or mutagenic solvents and reagents; mouth pipetting, and inhalation exposures to infectious aerosols, Safe handling of syringe needles or other contaminated sharps, spills and splashes onto skin and mucous membranes. Health aspects; toxicology, allergenicity, antibiotic resistance.

History of biosafety microbiology and molecular biology, Risk assessment, Personal protective equipment, Laboratory facilities and safety equipment, Disinfection, decontamination, and sterilization, Regulatory compliance, Laboratory security and emergency response and administrative controls.

Unit III **12 Hrs**

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

Unit IV **12 Hrs**

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

Unit V **12 Hrs**

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

TEXT BOOKS

1.V. Shree Krishna, (2007). Bioethics and Biosafety in Biotechnology, New Age International Pvt. Ltd. Publishers.

2. Deepa Goel, Shomini Parashar, (2013). IPR, Biosafety and Bioethics, Pearson.

3. R. Ian Freshney, 2016. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, John Wiley & Blackwell. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.

REFERENCE BOOKS

1.Biosafety in Microbiological and Biomedical Laboratories, (2020) 6th Ed.

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

WEB REFERENCES:

https://www.cdc.gov/labs/pdf/SF 19_308133-A_BMBL6_00-BOOK-WEB- final3.pdf

PEDOGOGY: CHALK and Talk , PPT

CANCER BIOLOGY

Paper	: Elective – IV	Total Hours	: 60
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: **23P1BCDE04**	External	: 75

SUBJECT DESCRIPTION:

The student should have a basic knowledge of cell Biology research.

COURSE OBJECTIVES:

1. To understand the genetic basis of cancer.
2. To understand the disease processes involved in malignancy

Course No	Course Outcome	Knowledge Level
CO1	To understand cell signal transduction pathways	K1,K2&K5
CO2	To comprehend the concepts of apoptosis	K1, K2 &K4
CO3	To know the process of carcinogenesis	K1 & K2
CO4	To aware of carcinogens.	K2,K5& K6
CO5	To understand the functions of tumor suppressor genes	K2, K4 &K5

CONTENT:

Unit I **12 Hrs**

Cell signaling; Extra cellular signal molecules, Cell surface receptor proteins- Ion channel linked receptors, G-Protein coupled receptors, and Enzyme linked receptors. Signal transduction; RTK-Ras dependent pathway, RTK-Ras independent pathway, MAP kinase pathways.

Unit II **12 Hrs**

Overview of cell cycle, check points in cell cycle, Regulation of cell cycle. Programmed cell death or Apoptosis: mechanism, regulation, pro-apoptotic regulators. CART-T therapy, Personalized medicine in cancer treatment.

Unit III **12 Hrs**

Introduction to cancer, Differences between normal cell and cancer cell, Cytological changes, Molecular changes and genetic changes in cancer cell.

Onset of cancer: Carcinogenesis- initiation, promotion and progression, Tumor micro environment influence cancer development, Angiogenesis

Unit IV **12 Hrs**

Causes of cancer- physical and chemical carcinogens. Oncogenes, viral oncogenes, activation of proto oncogenes.

Unit V **12 Hrs**

Tumor suppressor genes- Rb, p53, BCL2 and BRCA2. Loss of heterozygosity, Tumor markers.

TEXT BOOKS

1.V. Shree Krishna, (2007). Bioethics and Biosafety in Biotechnology, New Age International Pvt. Ltd. Publishers.

2. Deepa Goel, Shomini Parashar, (2013). IPR, Biosafety and Bioethics, Pearson.

3. R. Ian Freshney, 2016. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, John Wiley & Blackwell. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.

REFERENCE BOOKS

1.The Cell – A Molecular Approach, Geoffrey M. Cooper and Robert ausman, sixth edition,2013

2.Cell Biology, Veer Bala Rastogi, MedTech Science Press.

WEB REFERENCES:

https://www.cdc.gov/labs/pdf/SF 19_308133-A_BMBL6_00-BOOK-WEB- final3.pdf

PEDOGOGY: CHALK and Talk , PPT

YEAR I – SEMESTER I
CORE PRACTICAL I

Paper	: Core Practical I	Total Hours	: 45
Hours/Week	: 5	Exam Hours	: 06
Credit	: 4	Internal	: 40
Paper Code	: **23P1BCCP01**	External	: 60

COURSE OUTCOMES:

Course No	Course Outcome	Knowledge Level
CO1	Learn and understand the concepts of separation of aminiacids and carbohydrates	K1 & K2
CO2	Demonstrate the level of glucose, DNA, RNA	K1 & K2
CO3	Learn the isolation of compounds like starch, Glycogen etc	K1,K2 & k3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	M	S	S	S	S	M	M	L	M	M	M	M	M
CO2	S	M	M	S	M	S	M	M	L	L	M	L	L	S	S
CO3	S	S	M	M	S	M	M	M	L	L	M	L	L	S	M

S- Strong; M-Medium; L-Low

I. Biochemical studies and estimation of macromolecules

1. Isolation and estimation of glycogen from liver.
2. Isolation and estimation of DNA from animal tissue.
3. Isolation and estimation of RNA from yeast.
4. Isolation and estimation of fructose from fruits by seliwanoffs method
5. Isolation and confirmation of lecithin from egg yolk.
6. Purification of Polysaccharides –Starch and assessment of its purity
7. Identification of Sugars by Paper Chromatography
8. Identification of Amino acids by Paper Chromatography
9. Separation of identification of lipids by thin layer chromatography.

REFERENCE BOOKS:

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

YEAR I – SEMESTER I
CORE PRACTICAL II

Paper	: Core Practical II	Total Hours	: 45
Hours/Week	: 5	Exam Hours	: 06
Credit	: 4	Internal	: 40
Paper Code	: **23P1BCCP02**	External	: 60

COURSE OUTCOMES:

Course No	Course Outcome	Knowledge Level
CO1	Learn and understand the concepts of Isolation of plasmid DNA	K1 & K2
CO2	Demonstrate the electrophoresis	K1 & K2
CO3	Learn the Preparation of Blood antigens and Immunodiffusion	K1,K2 & k3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	M	S	S	S	S	M	M	L	M	M	M	M	M
CO2	S	M	M	S	M	S	M	M	L	L	M	L	L	S	S
CO3	S	S	M	M	S	M	M	M	L	L	M	L	L	S	M

S- Strong; M-Medium; L-Low

1. Isolation of plasmid DNA
2. Isolation of Genomic DNA
3. Isolation of RNA
4. Agarose Gel Electrophoresis
5. Restriction digestion of DNA
6. Preparation of competent cell and Transformation
7. Identification of blood group & Rh typing
8. Preparation of Blood antigens
9. Testing: Widal slide test and Pregnancy Test (Slide Test)
10. Immunodiffusion –Single radial and double diffusion
11. Immunoelectrophoresis – Counter Current immunoelectrophoresis
12. C reactive protein
13 PCR – Demonstration

REFERENCE BOOKS:

1.David Plummer (2001) An Introduction to Practical Biochemistry (3rded) McGraw Hill Education (India) Private Ltd

2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers

3. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).

4. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley-VCH Publishers (2000).

5. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, Pearson Education Inc

6. Practical Enzymology, Second Revised Edtion: Hans Bisswanger, Wiley –Blackwell; 2 edition (2011)

YEAR I – SEMESTER II
CORE PRACTICAL III

Paper	: Core Practical III	Total Hours	: 45
Hours/Week	: 5	Exam Hours	: 06
Credit	: 3	Internal	: 40
Paper Code	: **23P2BCCP03**	External	: 60

COURSE OUTCOMES:

Course No	Course Outcome	Knowledge Level
CO1	Learn and understand the concepts of Enzymes	K1 & K2
CO2	Demonstrate the level of Immobilisation of peroxidase by matrix	K1 & K2
CO3	Learn the isolation of compounds like Pyruvate, Tryptophan	K1,K2 & k3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	M	S	S	S	S	M	M	L	M	M	M	M	M
CO2	S	M	M	S	M	S	M	M	L	L	M	L	L	S	S
CO3	S	S	M	M	S	M	M	M	L	L	M	L	L	S	M

S- Strong; M-Medium; L-Low

I. Assay of enzymes

Effect of pH,Temperature and Substrate concentration-MM Plot, V max)

1. Peroxidase
2. Amylase
3. Acid Phosphatase

III. Immobilised Enzyme Reactions

1. Immobilisation of peroxidase by matrix entrapment method

IV. Separation of Isoenzymes

1. Seperation of LDH by SDS-PAGE

II. Colorimetric estimations

1. Estimation of Pyruvate
2. Estimation of tryptophan.

III. Estimation of minerals

1. Estimation of calcium
2. Estimation of iron

REFERENCE BOOKS:

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

YEAR I – SEMESTER II
CORE PRACTICAL IV

Paper	: Core Practical IV	Total Hours	: 45
Hours/Week	: 5	Exam Hours	: 06
Credit	: 3	Internal	: 40
Paper Code	: **23P2BCCP04**	External	: 60

COURSE OUTCOMES:

Course No	Course Outcome	Knowledge Level
CO1	Learn and understand the concepts of separation of aminoacids and carbohydrates	K1 & K2
CO2	Demonstrate the level of glucose, Ascorbic acid, Lecithine	K1 & K2
CO3	Learn the isolation of compounds like starch, Glycogen etc	K1,K2 & k3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	M	S	S	S	S	M	M	L	M	M	M	M	M
CO2	S	M	M	S	M	S	M	M	L	L	M	L	L	S	S
CO3	S	S	M	M	S	M	M	M	L	L	M	L	L	S	M

S- Strong; M-Medium; L-Low

Plant Biochemistry

Qualitative analysis

1. Phytochemical screening

Quantitative analysis

2.Estimation of Flavonoids

3.Estimation of Alkaloids

Group Experiments

4.Fractionation of sub-cellular organelles by differential centrifugation Mitochondria and nucleus

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

6. Separation of plant pigments from leaves by columnchromatography

II. PLANT TISSUE CULTURE

1. Streilization and media preparation
2. Callus Induction and micro propagation
3. Isolation of protoplasts
4. Protoplast Culture
5. Anther culture

REFERENCE BOOKS:

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

YEAR II – SEMESTER III
CORE PRACTICAL V

Paper	: Core Practical V	Total Hours	: 45
Hours/Week	: 5	Exam Hours	: 06
Credit	: 4	Internal	: 40
Paper Code	: **23P3BCCP05**	External	: 60

COURSE OUTCOMES:

Course No	Course Outcome	Knowledge Level
CO1	To inculcate the knowledge of collection, preservation of blood sample and learning various hematological parameters and their significance	K1 & K2
CO2	To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the investigation of biological samples, clinical approach, normal values of biochemical constituents and clinical interpretations.	K1 & K2
CO3	To introduce visit to hospital so that students may be aware of Phleobotomy ,Collection and storage of specimen, Good laboratory practices, Automation and current methods adopted in the diagnostic labs	K1,K2 & k3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	M	S	S	S	S	M	M	L	M	M	M	M	M
CO2	S	M	M	S	M	S	M	M	L	L	M	L	L	S	S
CO3	S	S	M	M	S	M	M	M	L	L	M	L	L	S	M

S- Strong; M-Medium; L-Low

Haematology:

1. Enumeration of RBC
2. Enumeration of WBC
3. Differential Smear- Blood Cell Count
4. Evaluation of ESR
5. Evaluation of PCV
6. Evaluation of MCV
7. Bleeding Time
8. Clotting Time
9. Estimation of Hemoglobin by Colorimetric method
10. Isoenzyme separation of LDH by electrophoresis.
11. Determination of Electrolytes :Sodium, Potasium and Calcium
12. Detaermination of Glycosylated Hemoglobin
13. Glucose Tolerence Test (Kit Method)

Group Experiments

a. Antigen – Antibody Reaction – HCG kit method , RA kit method

b. Phlebotomy –Venipuncture , Different techniques of venipuncture

c. Collection of blood ,Serum or Plasma separation and Storage

d. Automation in Clinical Biochemistry –Autoanalyser ,Semiautoanalyser

REFERENCE BOOKS:

1. Practical Clinical Biochemistry- Varley's by Alan H Gowenlock, published by CBS Publishers and distributors, India Sixth Edition ,1988.
2. Manipal Manual of Clinical Biochemistry (For Med.Lab. And MSc Stud.) 2013 (4 Edition)
3. Case Oriented Approach in Biochemistry – Dr. Rajesh Kawaduji Jambhulkar, Dr. Abhijit D. Ninghot: 2019 First Edition
4. Medical Lab Technology Vol I& II, Kanai L Mukerjee New Delhi: Tata Mcgraw Hill Publishing Company, 1996.
5. Practical Biochemistry – Plummer, New Delhi: Tata Mcgraw Hill Publishing Company, 2000.
6. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh, 2nd ed, 2005

YEAR II – SEMESTER III
CORE PRACTICAL VI

Paper	: Core Practical VI	Total Hours	: 45
Hours/Week	: 5	Exam Hours	: 06
Credit	: 4	Internal	: 40
Paper Code	: **23P3BCCP06**	External	: 60

COURSE OUTCOMES:

Course No	Course Outcome	Knowledge Level
CO1	To perform urine analysis, estimate BUN and clearance test to assess renal function .	K1 & K2
CO2	To perform experiments to assess liver functions. And also to study the marker enzymes of liver	K1 & K2
CO3		K1,K2 & k3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	M	S	S	S	S	M	M	L	M	M	M	M	M
CO2	S	M	M	S	M	S	M	M	L	L	M	L	L	S	S
CO3	S	S	M	M	S	M	M	M	L	L	M	L	L	S	M

S- Strong; M-Medium; L-Low

Liver function test:

1. Estimation of bilirubin – direct and indirect.
2. Estimation of Total protein & A/G Ratio by Biuret Method
3. Determination of SGOT, SGPT

Renal function test:

1. Collection and Preservation of Urine sample
2. Qualitative tests for normal components of urine.
3. Qualitative tests for pathological components of urine.

BUN

1. Estimation of blood Urea
2. Estimation of creatinine
3. Estimation of uric acid
4. Estimation of blood glucose by Asatoor & King method.
5. Estimation of cholesterol by Zak's method

REFERENCE BOOKS:

1. Practical Clinical Biochemistry- Varley's by Alan H Gowenlock, published by CBS Publishers and distributors, India Sixth Edition ,1988.
2. Manipal Manual of Clinical Biochemistry (For Med.Lab. And MSc Stud.) 2013 (4 Edition)
3. Case Oriented Approach in Biochemistry – Dr. Rajesh Kawaduji Jambhulkar, Dr. Abhijit D. Ninghot: 2019 First Edition
4. Medical Lab Technology Vol I& II, Kanai L Mukerjee New Delhi: Tata Mcgraw Hill Publishing Company, 1996.
5. Practical Biochemistry – Plummer, New Delhi: Tata Mcgraw Hill Publishing Company, 2000.
6. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh, 2nd ed, 2005

YEAR I – SEMESTER II
ENZYMOLOGY

Paper	: Core IV	Total Hours	: 75
Hours/Week	: 4	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P2BCC04**	External	: 75

SUBJECT DESCRIPTION:

Basic knowledge about catalysis, kinetics and chemical reaction mechanisms.

OBJECTIVES

1. Students will be introduced to the theory and practice of enzymology.
2. Mechanisms of catalysis and factors affecting catalysis will be understood
3. The kinetics of enzyme catalyzed reactions in the absence and presence of inhibitors will be studied and the options for applying enzymes and their inhibitors in medicine will be analyzed.
4. Students will learn about the applications of enzymes in research, medicine, and industry, which will prepare them for careers in industrial and biomedical research.
5. The control of metabolic pathways and cellular responses through enzyme regulation will be emphasized.

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Describe the catalytic mechanisms employed by enzymes	K1, K2, K5
CO2	Choose and use the appropriate methods to isolate and purify enzymes and check the purity of the enzyme.	K1,K2 , K3,K4 & K5
CO3	Analyze enzyme kinetic data graphically, calculate kinetic parameters, determine the mechanism of inhibition by a drug/chemical and analyze options for applying enzymes and their inhibitors in medicine	K1, K2, K3 &K4
CO4	Menten kinetics from sigmoidal kinetics. The role played by enzymes in the regulation of vital cellular processes will be appreciated	(K1, K2 , K5, K6
CO5	Highlight the use of enzymes in industries and biomedicine	K1,K2& K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

Introduction to enzymes and features of catalysis: A short history of the discovery of enzymes and how they became powerful biochemical tools. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, Classification and Nomenclature, Specificity of

enzyme action-group specificity, absolute specificity, substrate specificity, stereochemical specificity. Active site, Identification of amino acids at the active site-trapping of ES complex, identification using chemical modification of amino acid side chains and by site-directed mutagenesis.Mechanisms of enzyme catalysis: acid-base catalysis, covalent catalysis, electrostatic catalysis, metal ion catalysis, proximity and orientation effects, Low barrier H-bonds, Structural flexibility Mechanism of action of chymotrypsin

Unit II **15 Hrs**

Enzyme techniques: Isolation and purification of enzymes – Importance of enzyme purification, methods of purification- choice of source , extraction, fractionation methods-based on size or mass (centrifugation, gel filtration); based on polarity (ionexchange chromatography, electrophoresis, isoelectric focusing, hydrophobic interaction chromatography); based on solubility (change in pH, change in ionic strength); based on specific binding sites (affinity chromatography) ,choice of methods, Criteria of purity of enzymes. Enzyme units – Katal, IU. Measurement of enzyme activity – discontinuous, continuous, coupled assays; stopped flow method and its applications. Isoenzymes and their separation by electrophoresis with special reference to LDH

Unit III **15 Hrs**

Enzyme kinetics I: Thermodynamics of enzyme action, Activation energy, transitionstate theory, steady-state kinetics & pre-steady-state kinetics.Single substrate enzyme catalyzed reactions –assumptions, Michaelis-Menten and Briggs-Haldane kinetics, derivation of Michaelis-Menten equation . Double reciprocal (Lineweaver-Burk) and single reciprocal (Eadie –Hofstee) linear plots, their advantages and limitations. Analysis of kinetic data-determination of Km, Vmax, kcat, and their physiological significance, Importance of kcat/Km. Enzyme inhibition: Irreversible inhibition. Reversible inhibition-Competitive, uncompetitive ,noncompetitive, mixed and substrate inhibition. Michaelis –Menten equation in the presence of competitive, uncompetitive and non-competitive inhibitors. Graphical analysis – Diagnostic plots for the determination of inhibition type. Therapeutic use of enzyme inhibitors Aspirin, statins (irreversible inhibitors), Methotrexate (competitive inhibitor), Etoposide (non-competitive inhibitor), camptothecin (uncompetitive inhibitor). Demonstration :Using Microsoft Excel to Plot and Analyze Kinetic Data

Unit IV **15 Hrs**

Enzyme kinetics II: Allosteric enzymes: Cooperativity, MWC and KNF models of allosteric enzymes, Sigmoidal kinetics taking ATCase as an examp le. Regulation of amount and catalytic activity by – extracellular signal, transcription, stability of mRNA, rate of translation and degradation, compartmentation, pH, temperature, substrate concentration, allosteric effectors, covalent modification. Regulation of glycogen synthase and glycogen phosphorylase. Feedback inhibition-sequential, concerted, cumulative, enzyme-multiplicity with examples. Bi – Substrate reactions: Single Displacement reactions (SDR) (Ordered and Random bi bi mechanisms), Double Displacement reactions (DDR) (Ping pong mechanism), Examples, Cleland's representation of bisubstrate reactions

Unit V **15 Hrs**

Enzyme technology: Immobilization of enzymes – methods – Reversible immobilization (Adsorption, Affinity binding), Irreversible immobilization (Covalent coupling, Entrapment and Microencapsulation, Crosslinking, Advantages and Disadvantages of each method, Properties of immobilized enzymes,. Designer enzymes- ribozymes and deoxyribozymes, abzymes, synzymes. Enzymes as therapeutic agents-therapeutic use of asparaginase and streptokinase. Application of enzymes in industry- Industrial application of rennin, lipases, lactases, invertase, pectinases, papain.

TEXT BOOKS

1.Enzymes: Biochemistry, Biotechnology and Clinical chemistry, 2nd edition, 2007, Palmer T and Bonner P; Affiliated- East West press private Ltd, New Delhi
2.Fundamentals of Enzymology, 3rd edition, 2003, Price NC and Stevens L; Oxford University Press, New York

REFERENCE BOOKS

1.Voet's Biochemistry, Adapted ed, 2011,Voet,D and Voet JG; Wiley, India
2.Lehninger Principles of Biochemistry, 8 th edition, 2021, .Nelson DL and Cox MM; WH Freeman & Co, New York
3. Biochemistry, Berg JM, Stryer L, Gatto,G, 8 th ed, 2015;WH Freeman & Co., New York.
4.Enzyme Kinetics and Mechanism; Cook PF, Cleland W, ;2007; Garland Science, London

WEB REFERENCES:

https://ocw.mit.edu/high-school/biology/exam-prep/chemistry-of-life/enzymes/
https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
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https://dth.ac.in/medical/courses/biochemistry/block-1/1/index.php

PEDOGOGY: CHALK and Talk , PPT

YEAR I – SEMESTER II
CELLULAR METABOLISM

Paper	: Core V	Total Hours	: 75
Hours/Week	: 4	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P2BCC05**	External	: 75

SUBJECT DESCRIPTION:

Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds

OBJECTIVES

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

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Appreciate the modes of synthesis and degradation of glucose and will be able to justify the pros and cons of maintain the blood sugar level	K1, K2, K5
CO2	Gain knowledge on polysaccharide metabolism and glycogen storage disease	K1, K2, K5
CO3	Acquaint with the making and braking of nucleotides	K1,K2,K4
CO4	Differentiate the diverse reaction a particular amino acid can experience	K1,K2,K3
CO5	Correlate the disturbance of metabolic reactions to clinical manifestations with reference to heme and sulphur metabolism	K1, K2, K4, K5

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

Glycolysis – aerobic and anaerobic, inhibitors, and regulation. Feeder pathway- entry of hexoses into glycolysis, Galactosemia, fructosuria, Pyruvate dehydrogenase complex-mechanism and regulation. Glyoxalate cycle and its regulation. Gluconeogenesis – source, key enzymes, reaction sequence and its regulation. Blood glucose homeostasis and the role of hormones. Pentose phosphate pathwaysignificance and its regulation. Metabolism of glycogen and its regulation. Biosynthesis of N-linked and O-linked glycoproteins and mucopolysaccharides.

Unit II **15 Hrs**

Oxidation of fatty acids-oxidation of saturated and unsaturated fatty acids (α, β & ω oxidation) Oxidation of fatty acids with odd and even numbered carbon atoms. Regulation of β oxidation. Ketogenesis and its regulation. Biosynthesis of fatty acid–saturated and unsaturated, chain elongation, regulation. Biosynthesis of prostaglandins, thromboxanes and leukotrienes and hydroxyl eicosanoic acids. Biosynthesis and degradation of triacylglycerol, phosphoglycero lipids-lecithin, cephalin, plasmalogens and phosphatidyl inositol, Sphingolipid-sphingomyelin, cerebrosides, sulfatides, and gangliosides. Cholesterol biosynthesis and its regulation. Lipoprotein metabolism-chylomicrons, VLDL, HDL and LDL.

Unit III **15 Hrs**

Metabolism of nucleotides- De novo synthesis and salvage pathways of purine and pyrimidine nucleotides. Regulation and inhibitors of nucleotide biosynthesis. Role of ribonucleotide reductase and its regulation. Degradation of purine and pyrimidine nucleotides.

Unit IV **15 Hrs**

Biosynthesis of non- essential amino acids.- Role and biological significance of glutamate dehydrogenase, glutamine, lysine, proline and phenylalanine hydroxylase. Interconversion of amino acids – proline to glutamate, methionine to cysteine, serine to glycine. Biosynthesis of spermine and spermidine. Degradation of amino acids –glucogenic and ketogenic amino acids. Formation of acetate from leucine and aromatic amino acid, pyruvate from cysteine, threonine and 37mphibia proline, α-keto glutarate from histidine and proline, succinate from methionine, threonine, valine and isoleucine, Oxaloacetate from aspartat e, glycine and serine.

Unit IV **15 Hrs**

Biosynthesis and degradation of heme. Jaundice-classification, pathology and Differential diagnosis Oxidation and reduction of inorganic sulphur compounds by microbes and plants. Sulpho transferases and their biological role-rhodanases, sulphatases, 3-mercapto pyruvate sulphur transferases. Mucopolysaccharidoses – Hunter syndrome, Sanfilippo syndrome and Maroteaux-Lamy syndrome. Oxidation of cysteine to sulphate and inter conversion of sulphur compounds.

TEXT BOOKS

1.David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6 th ed), W.H.Freeman

2.Voet.D and Voet. J.G (2010) Biochemistry , (4 th ed), John Wiley & Sons, Inc.

3.Metzler D.E (2003). The chemical reactions of living cells (2 nd ed), Academic Press.

REFERENCE BOOKS

1. Zubay G.L (1999) Biochemistry , (4 th ed), Mc Grew-Hill.

2. Textbook of Biochemistry with Clinical Correlations, 7 th Edition,Thomas M. Devlin (Editor), Wiley

3. Human Biochemistry – James M.Orten&Otto.W.Neuhan- 10 th ednThe C.V.Mosby Company

WEB REFERENCES:

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

YEAR I – SEMESTER II
CLINICAL BIOCHEMISTRY

Paper	: Core VI	Total Hours	: 75
Hours/Week	: 4	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P2BCC06**	External	: 75

SUBJECT DESCRIPTION:

The student should have a basic knowledge of body fluids and their composition and metabolism; anatomy and physiology of vital organs.

OBJECTIVES

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

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	To appreciate the biological significance of sample collection and awareness of the diagnostic/screening tests to detect common non-communicable diseases so as to understand role of laboratory investigations for biochemical parameters and understand the disorders associated with blood cells	K1, K2, K5
CO2	To understand the etiology of metabolic diseases like diabetes and atherosclerosis and avoid such lifestyle disorders by healthy eating and correlate the symptoms with underlying pathology based on diagnostic and prognostic markers.	K1, K2, K5
CO3	To understand the diagnostic application of serum/plasma enzymes to correlate their levels with the organ pathologies associated with specific diseases.	K1,K2,K4
CO4	To appreciate the role of pre and post-natal diagnosisleading to healthy progeny.	K1,K2,K3
CO5	To link the serum hormone levels and clinical symptoms with underlying hormonal disturbances. To review the onward transmission of signal via downstream signaling molecules from cell surface to the nucleus by different pathways by comparing and contrasting them and critically evaluate the network between them resulting in the biological outcome.	K1, K2, K4, K5

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

Biochemical investigations in diagnosis, prognosis, monitoring, screening: Specimen collection – blood, (primary /Secondary specimen)., urine and CSF. Preservation of biological specimens –blood, urine, CSF and amniotic fluid. Biological reference ranges; Disorders of blood cells: Hemolytic, iron deficiency and aplasticanemia and diagnosis, sickle cell anaemia, thalassemia HBA1C variants. Porphyrias, Thrombocytopenia, Causes of leucopenia, leukemia and leucocytosis. Disorders of blood clotting mechanism – Von willebrand's disease, Hemophilia A, B and C, diagnostic test for clotting disorders, D-dimer and its clinical significance

Unit II **15 Hrs**

Diabetes mellitus: pathology and complications, Random/Fasting/PP glucose testing, Impaired glucose tolerance (IGT), Impaired fasting glucose (IFT), Diagnosis-by GTT, Pre-diabetes, Gestational DM ,Glycosylated Haemoglobin (HBA1c) Hypoglycaemia and critical alert value for glucose. Markers of complications of Diabetes mellitusLipid profile & lipoproteinemia, Atherosclerosis, Microalbuminuira, Point of care testing for glucose (Glucometers) and continuous glucose monitoring (CGM) : principle and its use. Diet and life style modifications

Unit III **15 Hrs**

Diagnostic Enzymology: Clinically Important Enzymes and Isoezyme as diagnostic markers: Clinical significance of AST, ALT, ALP, ACP, CK, γ-GT, amylase, Liver disease, Bone disease, Muscle disease, Cancer (tumor markers), GI tract pancreatitis); Enzymes as therapeutic agents. Pre- and post-natal testing: Amniocentesis, prenatal detection of inborn errors of metabolism in developing fetus- Autosomal recessive mode of inheritance- cystic fibrosis, X linked recessive inheritance-Duchenne muscular dystrophy. New born screening (NBS) for In born errors of metabolism

Unit IV **15 Hrs**

Liver function tests: Liver function test panel, Fatty liver. Plasma protein changes in liver diseases. Hepatitis A, Band C. Cirrhosis and fibrosis. Portal hypertension and hepatic coma. Acute phase proteins –CRP, Haptoglobins, α-fetoprotein, ferritin and their clinical significance, Interpreting serum protein electrophoresis. Inflammatory markers (cytokines such as TNF-alpha IL6 and others)

Unit V **15 Hrs**

Renal function tests – tests for glomerular and tubular function-Acute and chronic renal failure-Glomerulonephritis, Nephrotic syndrome, uraemia-urinary calculiNephrocalcinosis and Nephrolithiasis-causes, pathology and symptoms. Chronic kidney disease. Dialysis-Hemodialysis and peritoneal dialysis. Electrolyte disorder : calcium: hypercalcemia and hypocalcemia; Calcium homoestasis in Blood;phosphate: hyperphosphatemia or hypophosphatemia; Clinical significance: Potassium: hyperkalaemia and hypokalaemia, Sodium: hypernatremia and hyponatremia; Chloride: hyperchloremia, hyporchloremia Hormonal disorders and diagnostics: T3,T4 and TSH in the diagnosis of thyroid disorders; Diagnostic methods for disorders associated with adrenal, pituitary and sex hormones – Addison's disease, Cushing's syndrome, pituitary tumour, Hypopituitarism, Hypogonadism

TEXT BOOKS

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

REFERENCE BOOKS

1. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2018) (8th ed), Saunders
2. M.N.Chatterjee and RanaShinde (2012).Textbook of Medical Biochemistry (8 th ed), Jaypee Brothers Medical Publishers.
3. Clinical Case Discussion In Biochemistry A Book On Early Clinical Exposure (ECE), Poonam Agrawal , 2021, CBS Publishers & distributors pvt. Ltd

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YEAR I – SEMESTER II
ENERGY AND DRUG METABOLISM

Paper	: Elective V	Total Hours	: 60
Hours/Week	: 4	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P2BCDE05	External	: 75

SUBJECT DESCRIPTION:

Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds

OBJECTIVES

1. Familiarize on concepts of enthalpy, entropy, free energy, redox system, biological oxidation and high energy compounds
2. Provide an insight into the relationship between electron flow and phosphorylation
3. Inculcate knowledge on processes involved in converting light energy to chemical energy and associated food production by autotrophs
4. Provide a platform to understand the versatile role of Krebs cycle, transport of NADH across mitochondrial membrane
5. Educate on the various phases xenobiotic metabolism

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Appreciate the relationship between free energy and redox potential and will be able to justify the role of biological oxidation and energy rich compounds in maintaining the energy level of the system	K1,K2,K3,K4
CO2	Gain knowledge on role of mitochondria in the production of energy currency of the cell	K1, K2, K5, K6
CO3	Acquaint with the process of photosynthesis	K1,K2,K5
CO4	Comprehend on the diverse role of TCA cycle and the energy obtained on complete oxidation of glucose and fatty acid	K1,K2,K4,K5
CO5	Correlate the avenues available to metabolize the xenobiotics	K1, K2, K4,K5

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **12 Hrs**

Thermodynamic- principles in biology- Concept of entropy, enthalpy and free energy change. Redox systems. Redox potential and calculation of free energy. Biological oxidation – Oxidases, dehydrogenases, hydroperoxidases, oxygenases. Energy rich compounds – phosphorylated and non-phosphorylated. High energy linkages.

Unit II **12 Hrs**

Electron transport chain-various complexes of ETC, Q-cycle. Inhibitors of ETC. Oxidative phosphorylation-P/O ratio, chemiosmotic theory. Mechanism of ATP synthesis – role of F0-F1 ATPase, ATP-ADP cycle. Inhibitors of oxidative phosphorylation ionophores, protonophores .Regulation of oxidative phosphorylation

Unit III **12 Hrs**

Light reaction-Hills reaction, absorption of light, photochemical event. Photo ETC-cyclic and non-cyclic electron flow. Photophosphorylation-role of CF0-CF1 ATPase. Dark reaction- Calvin cycle, control of C3 pathway, and HatchSlack pathway (C4 pathway), Photorespiration. Synthesis and degradation of starch

Unit IV **12 Hrs**

Interconversion of major food stuffs. Energy sources of brain, muscle, liver, kidney and adipose tissue. Amphibolic nature of Citric acid cycle. Anaplerotic reaction. Krebs cycle, Inhibitors and regulation of TCA cycle. Transport of extra mitochondrial NADH – Glycerophosphate shuttle, malate aspartate shuttle. Energetics of metabolic pathways – glycolysis, (aerobic and anaerobic) , citric acid cycle, beta oxidation

Unit V **12 Hrs**

Activation of sulphate ions – PAPS, APS, SAM and their biological role. Metabolism of xenobiotics – Phase I reactions – hydroxylation, oxidation and reduction. Phase II reactions – glucuronidation, sulphation, glutathione conjugation, acetylation and methylation. Mode of action and factors affecting the activities of xenobiotic enzymes.

TEXT BOOKS

1. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012), Harper's Illustrated Biochemistry, (29 thed), McGraw-Hill Medical
2. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press.
3. Zubay G.L (1999) Biochemistry , (4 th ed), Mc Grew-Hill.
4. Devlin RM (1983) Plant Physiology (4 th ed), PWS publishers
5.Taiz L , Zeiger E (2010), Plant Physiology (5 th ed), Sinauer Associates, Inc

REFERENCE BOOKS

1.David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6thed), W.H.Freeman
2.Taiz L , Zeiger E (2010), Plant Physiology (5 th ed), Sinauer Associates, Inc

WEB REFERENCES:

https://www.researchgate.net/figure/Oxidative-phosphorylation-inmitochondrial-electron-transport-chain-ETC-and-proton_fig1_230798915

YEAR I – SEMESTER II
BIOMEDICAL INSTRUMENTATION

Paper	: Elective VI	Total Hours	: 60
Hours/Week	: 4	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P2BCDE06	External	: 75

SUBJECT DESCRIPTION:

Basic knowledge on biochemical techniques

OBJECTIVES

The Course focus on the instrumentations used in the medical field. By learning this course, the students can able to understand the basic concepts in Biomedical Instrumentation which will be very useful for operating the instruments in future.

CONTENT:

Unit I **12 Hrs**

Biomedical Instrumentation: Definition, Classification of Biomedical equipments – Diagnostic, therapeutic and clinical Laboratory equipments, sources of biomedical signals, components, design factors and characteristics.

Unit II **12 Hrs**

Biosensors – Principle and mechanism of calorimetric, potentiometric, optical biosensors. Autoanalyser – types and application. Electrodes- theory, types-biopotential, microelectrodes, metal plate and needle electrodes. Transducers – types – magnetic induction, piezoelectric, photovoltaic, thermoelectric, strain guage.

Unit III **12 Hrs**

Biopotential Recorders: Resting and action potential, propagation of action potential, wave forms- ECG, EMG, EEG, EOG, EGG & ERG. Specialized Medical Equipments: X- ray machine, Angiography.

Unit IV **12 Hrs**

Physiological assist devices- pace makers, artificial heart valves, defibrillators, nerve and muscle stimulator (Galvanic and interrupted Galvanic current), heartlung machine- mechanical functions, oxygenators- bubble, film. Kidney machine-hemo and peritoneal dialysis.

Unit V **12 Hrs**

Advances in biomedical instrumentation- Lasers, endoscopes-types. Cryogenic surgery. Gamma ray camera, computerized tomography, infrared thermography, ultrasonic imaging, magnetic resonance imaging.

TEXT BOOKS

1. Anandanatarajan, R. 2013. Biomedical Instrumentation and measurements. PHI Learning Pvt., Ltd. New Delhi.

2. Arumugam, M. 2011. Biomedical Instrumentation. Anuradha publications, Chennai.

REFERENCE BOOKS

1. Khandpur, R. S. 1995. Hand book of Biomedical instrumentation. Tata Mc.Graw-Hill publishing company Ltd., New Delhi.

2.Biomedicalinstrumentation,LeslieCromwell,FredJ.Weibell,ErichA.Pfeiffer,1953 80.2ndEdn.Prentice-Hall,

3. Medical Instrumentation, JohnG.Webster, 2003, JohnWiley&Sons.

4. Principles of applied Biomedical instrumentation by L.A. Goddes andL.E. Baker,1989. 3rdEdn. John Wiley India Pvt. Ltd.

YEAR I – SEMESTER II
NUTRITIONAL BIOCHEMISTRY

Paper	: Elective VII	Total Hours	: 60
Hours/Week	: 4	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P2BCDE07	External	: 75

SUBJECT DESCRIPTION:

Basic knowledge on food, nutrition & dietetics, and metabolism of nutrients.

OBJECTIVES

1. To understand basic concepts involved in growth , health, nutrition, physiology and metabolism
2. To discuss the concepts and applications of nutrition in correlation with biochemistry
3. To define nutritional needs in healthy individuals and modification of diet during illness.

COURSE OUTCOMES

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

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **12 Hrs**

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

Unit II **12 Hrs**

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

Unit III **12 Hrs**

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

Unit IV **12 Hrs**

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

Unit V **12 Hrs**

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

TEXT BOOK:

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

WEB REFERENCES:

- https://www.researchgate.net/figure/Relationship-between-malnutritioninfection-andimmunity-Malnutrition-is-considered-the_fig1_280722727
- https://en.wikipedia.org/wiki/Novel_food
- https://www.chemicalsafetyfacts.org/preservatives/
- https://www.sciencedirect.com/topics/agricultural-and-biologicalsciences/food-enrichment

YEAR I – SEMESTER II
BIOCHEMISTRY IN HUMAN HEALTH

Paper	: Elective VIII	Total Hours	: 60
Hours/Week	: 4	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P2BCDE08	External	: 75

SUBJECT DESCRIPTION:

Basic Knowledge On Nutrition And Pathophysiology Of Diseases

OBJECTIVES

1. To provide students with up-to-date understanding of the biochemical basis of a wide rangeof human diseases and conditions.
2. To become knowledgeable in the mechanisms of disease, etiology, progression and pathogenesis in humans..
2. To understand the thr role of antioxidants in human health

CONTENT:

Unit I **12 Hrs**

International Agencies-Introduction to biochemistry programme, Relationship of health and biochemistry, Role of various agencies to improve the nutritional status of the community (WHO, UNICEF, NIN, ICAR, FAO, CSIR). National Health Programs-Planning, Execution and Evaluation of various health programs.

Unit II **12 Hrs**

Energy – Energy content of food, energy utilization in cells. Basal metabolic rate (BMR) and specific dynamic action (SDA) and factors affecting BMR. Energy balance and Energy requirements of man and woman and factors affecting energy requirements.

Unit III **12 Hrs**

Community Health and Communicable Diseases Concepts of community Health, National Health Policy .Epidemiology of Communicable Diseases Factors responsible for the spread of communicable diseases, mode of transmission — typhoid fever, tuberculosis, leprosy, filariasis and AIDS.

Unit IV **12 Hrs**

Non-communicable diseases Etiology and management of diseases like Obesity, Diabetes mellitus, and Cardiovascular disorders. Immune responses to SARS-CoV-2,Vaccines and Immunotherapy. Preventive health checkups (PHC)- important parameters/biomarkers; relevance of PHC in health and disease prevention/early diagnosis.

Unit V **12 Hrs**

Antioxidants and human health Chemistry of free radicals and reactive oxygen species, Free radicals in health and disease. Antioxidant defence enzymes-Superoxide dismutase, catalases, glutathione peroxidase, Glutatione reductase, glutathione-S-transferases.

TEXT BOOKS

1. The Assessment of Nutritional Status of Community WHO/FAO. Jelliffe, D. B. Latest Ed. Monograph series No.53, WHO Geneva.
2. Nutrition in the Community 2 nd Ed. Maclaren, D. S. 1986. John Willey and Sons, NewYork.
3. Manual on Community Nutrition. Mann, S. K, Sangha, J. K, Mehta, U and Jain, R. 1999. College of Home Science, PAU, Ludhiana.
4. Text Book of Biochemistry for Medical Students. Vasudevan D.M and Sreekumari S. 2007 5 th Edition. Jaypee Publishers.
5. Textbook of Medical Biochemistry. Chatterjea M. N and Rana Shinde 2012 8 th EditionJaypee Brothers Medical Publishers (P) Ltd New Delhi 110 002, India.

INDUSTRIAL MICROBIOLOGY

Paper	: Core VII	Total Hours	: 75
Hours/Week	: 4	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P3BCC07**	External	: 75

SUBJECT DESCRIPTION:

Basic Knowledge of Microbiology and microbial techniques

OBJECTIVES

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

COURSE OUTCOMES

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

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

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

Unit II **15 Hrs**

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

Unit III **15 Hrs**

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

Unit IV **15 Hrs**

Food Microbiology: Production of dairy products-bread, cheese and yoghurt (preparation and their types).Food borne diseases- Bacterial and Non- Bacterial. Food preservation – Principles– Physical methods: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, Chemical methods – salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit V **15 Hrs**

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

TEXT BOOKS

1.Food Microbiology: An Introduction: 4thedition,Matthews KR, Kniel KE, Montville TJ;

2.American Society for Microbiology Food, Fermentation and Micro-Organisms,2nd edition, Charles, BW; Blackwell Science Ltd

3.Microbiology. 5th edition ,Pelczar MJ, Chan ECS and Krieg NR; McGraw Hill BookCompany.

REFERENCE BOOKS

1.Text book of Microbiology:11th edition, Ananthanarayanan R and Paniker CKJ; Universities Press (India) Pvt.Ltd.

2.FoodMicrobiology, 3rd edition, Frazier WC and WesthoffDC;TataMcGrawHill Publishing Company Ltd, NewDelhi

3.New Methods of Food Preservation:1st edition, Gould GW;Springer Manual of Industrial Microbiology and Biotechnology: 3rd edition, Baltz

WEB REFERENCES:

Industrial biotechnology: https://nptel.ac.in/courses/102/105/102105058/
Bioreactors: https://nptel.ac.in/courses/102/106/102106053/

MOLECULAR BIOLOGY

Paper	: Core VIII	Total Hours	: 75
Hours/Week	: 4	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P3BCC08**	External	: 75

SUBJECT DESCRIPTION:

The student should have a basic knowledge of genetics, cell biology and molecular biology.

OBJECTIVES

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

COURSE OUTCOMES

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

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

Mendel's laws of inheritance-dominance-complete, incomplete and codominance, multiple alleles-gene mapping in haploids and diploids, recombination mapping- restriction mapping- modes of gene information transfer in bacterialconjugation, transformation and transduction. The bacterial chromosome, the eukaryotic genome- chromosome structure – Histones, Nucleosome, chromatinheterochromatin, euchromatin, chromatin remodeling, DNAase hypersensitive sites, genome organization – the C-value paradox, reassociation kinetics, repetitive sequences, gene amplification, telomeres, pseudogenes, split genes, organelle genomes – mitochondrial and chloroplast genome.

Unit II **15 Hrs**

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

Unit III **15 Hrs**

Transcription – Prokaryotic transcription-subunits of RNA polymerase, E. coli promoters, sigma factor and promoter recognition, alternative sigma factors, initiation, elongation, Rho-dependent and independent termination of transcription. Eukaryotic transcription- Initiation, promoter elements, RNA polymerases, transcription factors, regulatory sequences in eukaryotic protein –coding genes, CpG islands, enhancers.Translation – organization of the ribosome, the genetic code, evidence for a triplet code, deciphering the genetic code, wobble hypothesis, deviation in the genetic code, Mitochondrial and chloroplast genetic codons, unusual codons. Activation, initiation, elongation and termination of translation in E. coli. The role of tRNA and rRNA, suppressor tRNAs and inhibitors of protein synthesis, Comparison of prokaryotic translation with eukaryotic translation.

Unit IV **15 Hrs**

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

Unit V **15 Hrs**

Post transcriptional modifications in eukaryotes- RNA processing- mRNA 5' capping and 3'poly-adenylation, introns and exons, RNA splicing,- spliceosome assembly, alternative splicing, processing of tRNA and rRNA, self -splicing, ribozymes,RNA editing- substitution and insertion/deletion editing, Genome editing-CRISPR- Cas technologyPost translational modification of proteins- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation, Protein sorting – signal peptides, transport of secretory proteins, Golgi and post-golgi sorting, coated vesicles, targeting of mitochondrial, lysosomal and nuclear proteins, Protein degradation-Ubiquitination of proteins, Protein folding-chaperones.

TEXT BOOKS

1. Lewin's Genes XII : 12thedition, Krebs JE, Goldstein ES, Kilpatrick ST ; Prentice Hall, Delhi
2. Molecular Biology of the Gene : 6th edition, Watson JD , Baker TA, Bell S, Gann A, Levine M, Losick R; Cold Spring Harbor Laboratory Press, New York
3. Essential Cell Biology:3rdedition, Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P ; Garland Science, New York

REFERENCE BOOKS

1. Molecular Cell Biology : 8 th edition , Lodish H, Arnold Berk; W.H.Freeman & Co, New York
2. Karp's Cell and Molecular Biology: Concepts and Experiments, 8 th Edition; Wiley, India
3. An Introduction to Genetic Analysis 12 th edition,, Griffith A. F, Doebley J, Peichel C, David A, Wassarman DA; Albion Press.W.H.Freeman & Co ,New York

WEB REFERENCES:

1. Molecular Biology Free Online Course by MIT Part 3: RNA Uploaded by edX
2. https://mooc.es/course/molecular-biology/
3. https://onlinecourses.swayam2.ac.in/cec20_ma13/preview
4. https://learn.genetics.utah.edu/
5. https://www.cellbio.com/education.html
6. https://lifescienceinteractive.com/category/molecular-biology/

GENE EDITING, CELL AND GENE THERAPY

Paper	: Core IX	Total Hours	: 75
Hours/Week	: 4	Exam Hours	: 03
Credit	: 4	Internal	: 25
Paper Code	: **23P3BCC09**	External	: 75

SUBJECT DESCRIPTION:

To introduce students molecular basis of cell gene therapy; viral and nonviral gene transfer techniques and gene therapy applications in hereditary and acquired diseases.

OBJECTIVES

1. To train the student in techniques related to the molecular basis of genetic diseases and to incorporate skills essential for various types ofsequencing.
2. To inculcate practical knowledge on comparing the animal models used to model genetic diseases
3. To introduce and also elaborate knowledge about wide varieties of vectors and their features in addition to their applications and to identify the viral and nonviral gene transfer techniques
4. To educate about the characteristics of cell culture, therapeutic strategies in gene therapy with relevant safety/ethics involved and patents aswell.

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Ability to read, and evaluate scientific articles within the subjects of immune therapy, gene therapy and cell therapy.	K1, & K2
CO2	Toclone gene of their interest for several downstream purposes witharobustcomprehensionaboutwidevarietyofapplicablegene delivery vectors.	K1, K2 &K5
CO3	Be able to provide examples of diseases that can be treated with immune therapy, gene therapy and cell therapy.	K2, K3 & K4
CO4	To identify knowledge gaps and need for further research within their chosen topic of immune therapy, gene therapy or cell therapy.	K2, K4 & K5
CO5	To critically discuss and reflect on ethical and social aspects of using immune, gene or cell therapy.The student will be persuaded to contemplate on upcoming technologies for futuristic benefits.	K2, K5 & K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

Gene Editing: Basis of gene editing, DNA repair mechanisms, Double strand DNA breaks, Nonhomologous End-Joining (NHEJ), Homology directed repair, Programmable nucleases for gene editing, Meganucleases, Zinc-Finger nucleases, Transcription Activator-Like Effector Nucleases (TALEN), CRISPR-Cas systems, gene editing using CRISPR-Cas, drawbacks and major challenges to present gene editing techniques, gene editing for human disease therapy

Unit II **15 Hrs**

Gene and cell therapy: Basics of Gene and cell therapy, types of gene therapy, gene therapy strategies, therapeutic targets for gene therapy, choice of the therapeutic target, administration routes, delivery systems, expression of transgene, persistence of the gene therapy, cell targeting, immunological response to the therapy, ethical and legal issues, concerns about gene and cell therapy

Unit III **15 Hrs**

Vectors for Gene therapy: Non-viral and viral vectors for gene therapy, Physical methods of gene delivery, Polymer, Lipid and inorganic material based chemical systems for gene delivery, Viral vectors, Lentiviral, Adenoviral, Adenoassociated virus, Herpes Simplex virus, vaccinia, baculoviral vectors for gene delivery, choice of viral vector and oncolytic virus. Gene therapy applications,Gene therapy for cancer, suicide and oncolytic gene therapy.

Unit IV **15 Hrs**

Stem cells and tissue regeneration: Adult and fetal stem cells, embryonic stem cells, cell reprogramming, induced pluripotent stem cells (iPSC), Chemically induced pluripotent stem cells (CiPSC), reprogramming factors, iPSC derived progenitors 'cells, Organoids, three dimensional (3D) bioprinting.

Unit V **15 Hrs**

Regulatory and Ethical Considerations of stem cell and Gene Therapy, pluripotent stem cell-based cell replacement therapies. Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies.Technological challenges towards development of pluripotent stem cell-based cell replacement therapies.

REFERENCE BOOKS

1.An Introduction to Human Molecular Genetics (2ndEdition), J.J. Pasternak, 2005

2.An Introduction to Molecular Medicine and Gene Therapy 1stEdition by Thomas F. KresinaUpadhyay, S. K. (Ed.). (2021). Human Molecular Genetics (4thEdition), Tom Strachan & Andrew Read, 2010.

3.Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003.

BIOSTATISTICS AND RESEARCH METHODOLOGY

Paper	: Elective IX	Total Hours	: 60
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P3BCDE09	External	: 75

SUBJECT DESCRIPTION:

Basic knowledge of Statistics and Computer Applications

OBJECTIVES

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

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables	K1,K2,K3
CO2	Conditions for the consistency' and criteria for the independence of data based on attributes. Measures of central tendency, Dispersion, Skewness and Kurtosis	K1,K2,K3
CO3	Learning different sampling methods and 69mphibian statistical significance	K1,K2,K3,K4
CO4	Understanding students t test , ANOVA , Chi square test to analyse the significance of various research.	K1,K2,K3,K4
CO5	Learning on data science, algorithm for machine learning, artificial intelligence and big data, their applications in clinical and pharma domain .	(K1,K2,K3,K4 .K6)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **12 Hrs**

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

Unit II **12 Hrs**

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

Unit III **15 Hrs**

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

Unit IV **12 Hrs**

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

Unit V **12 Hrs**

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

TEXT BOOKS

1. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition

2.Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to Biostatistics", 2nd edition,.Prestographik, Vellore, India,.

3.Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1stedition,Springer

REFERENCE BOOKS

1. Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2ndedition Mc Graw Hill,

2. Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press

3. Introducing Data Science, Davy Cielen, Anro DB Meysman, Mohamed Ali.

WEB REFERENCES:

- https://www.ibm.com/docs/en/SSLVMB_28.0.0/pdf/Accessibility.pdf
- https://pure.tue.nl/ws/portalfiles/portal/19478370/20160419_CO_Mzolo.pdf
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5453888/
- https://home.ubalt.edu/ntsbarsh/excel/excel.htm
- https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_spss.pdf
- https://www.ibm.com/support/pages/ibm-spss-statistics-28-documentation

BIOCHEMICAL TOXICOLOGY

Paper	: Elective X	Total Hours	: 75
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: **23P3BCDE10**	External	: 75

SUBJECT DESCRIPTION:

The student should have a basic knowledge of pharmacology of drug action and understanding on their biochemical pathways.

OBJECTIVES

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

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	To appreciate and understand the role of toxicological biomarkers to assess drug toxicities.	K1, & K2
CO2	To conceive the role of disposition of drug in human system and their metabolism and methodologies pertaining to toxicological studies.	K1, K2 &K5
CO3	To understand and evaluate the functions of different organs on drug disposition and associated drug toxicities.	K2, K3 & K4
CO4	To understand the toxicological response to foreign compounds and their pharmacological, physiological and biochemical effects.	K2, K4 & K5
CO5	To link the mechanism of toxicity and clinical symptoms with underlying physiological disturbances.	K2, K5 & K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

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

Unit II **15 Hrs**

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

Unit III **15 Hrs**

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

Unit IV **15 Hrs**

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

Unit V **15 Hrs**

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

TEXT BOOKS

1. Preclinical Safety Evaluation of Biopharmaceuticals: A Science-Based Approach to Facilitating Clinical Trialsby Joy A. Cavagnaro

2. A Comprehensive Guide to Toxicology in Nonclinical Drug Development 2 Nd Editionby Ali S. Faqi

REFERENCE BOOK

1.Principles Of Toxicology by: Karen E Stine, Thomas M Brown 2006Publisher. Crc Press

2. Principles of Biochemical Toxicology by John A. Timbrell Publisher:Informa Healthcare

3. Environmental Toxicology by Sigmund F. Zakrzewski, (2002) Publisher: Oxford University Press, USA

DEVELOPMENTAL BIOLOGY

Paper	: Elective XI	Total Hours	: 60
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P3BCDE11	External	: 75

SUBJECT DESCRIPTION:

Comprehensive Knowledge of Cell Biology

OBJECTIVES

The candidates undertaking this course will understand the concepts of developmental biology.

- To understand the background of developmental biology
- To gain in-depth knowledge of various model organisms
- To gain insight into aspects of stem cell technology
- To gain insights into morphogenesis and 83mphibian83sis
- To acquire in-depth understanding of cell death mechanisms and cell fate Decision

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Grasp knowledge about the background of developmental biology	K1,K2,K3
CO2	Gain abundant knowledge about model oraganisms and gametogenesis	K1,K2,K3
CO3	Gain knowledge about stem cells and their applications in regenerative	K1,K2,K3,K4
CO4	Good knowledge about organogenesis	K1,K2,K3,K4
CO5	Learn the basics of cell death mechanisms and cel l fate decision.	K2,K3,K4

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **12 Hrs**

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

Unit II **12 Hrs**

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

Unit III **12 Hrs**

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

Unit IV **12 Hrs**

Morphogenesis & Organogenesis: Cell aggregation and differentiation inDictyostelium; axes and pattern formation in Drosophila, 83mphibian and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens formation, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Unit V **12 Hrs**

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

TEXT BOOKS

1. Developmental biology: VIII edition, Gilbert, SF; Sinauer Associates, Inc, 2022
2. R. L. Kotpal, Rastogi Publications Comparative Anatomy And Developmental Biology (Z-72) Paperback – 2019
3. M.A. Subramanian Developmental Biology Hardcover –2021
4. Michael J. F. Barresi (Author), Scott F. Gilbert, Developmental Biology Hardcover –2019

WEB REFERENCES:

http://bgc.org.in/pdf/study-material/developmental-biology-7th-ed-sfgilbert.pdf

MEDICAL CODING

Paper	: Elective XII	Total Hours	: 60
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	: 23P3BCDE12	External	: 75

SUBJECT DESCRIPTION:

Basic Knowledge of Human Physiology, Metabolism and Clinical Biochemistry

OBJECTIVES

The objectives of this course are to

- Understand the basic concept of Medical coding
- Familiarize the student about medical terminology
- Understand about the classification of diseases based on WHO/AHA
- Understand about the CPT code used for diseases as per American Medical Association

(AMA)

COURSE OUTCOMES

Course No	Course Outcome	Knowledge Level
CO1	Explaining the basic concept of coding and its application. Possess the knowledge about the First aid and CPR	K1,K2,K3
CO2	Possess the knowledge about medical terminology used in Medical coding industry	K1,K2,K3
CO3	Possess the knowledge about the ICD-10 CM international classification of diseases based on WHO	K1,K2,K3,K4
CO4	Possess the knowledge about the CPT codes used for diseases as per American Medical Association (AMA)	K1,K2,K3,K4
CO5	Understand CPT coding and its types	K2,K3,K4

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **12 Hrs**

Introduction to Medical coding, coding theory, Health care Common Procedure Coding, First Aid and CPR.

Unit II **12 Hrs**

Introduction to Medical Terminology, specialization I & II, Diagnostic coding, factors affecting diagnostic coding.

Unit III **12 Hrs**

Documenting medical records - Importance of Documentation, Types of dictation formats.

Unit IV **12 Hrs**

Introduction to Human Anatomy and Coding, ICD-10- CM classification system.

Unit V **12 Hrs**

Introduction to CPT coding, types of CPT coding Medical Law and Ethics.

TEXT BOOKS

1. Understanding Medical Coding, A comprehensive guide Sandra L Johnson Robin Linker

2.Buck's Step – by – step Medical Coding Elsevier reference

REFERENCE BOOKS

1. Terry Tropin M Shai, RHIA, CCS-P, AHIMAICD-10-CMcoding guidelines made easy2017.

2. Besty J Shiland- Medical terminology and anatomy for ICD-10.

PHARMACEUTICAL BIOCHEMISTRY

Paper	: Core X	Total Hours	: 75
Hours/Week	: 5	Exam Hours	: 03
Credit	: 5	Internal	: 25
Paper Code	: **23P4BCC10**	External	: 75

SUBJECT DESCRIPTION:

The student should have a basic knowledge of drug discovery and development. Student should possess basic knowledge of bioinformatics to understand and correlate the drug development process.

OBJECTIVES

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

Course No	Course Outcome	Knowledge Level
CO1	To understand and explain the basic concepts of drug discovery and drug development process.	K1, & K2
CO2	To review the different software and computational tools which aid in the design of drugs and its rationalization.	K1, K2 &K5
CO3	To analyze the different stages of the drug discovery process with the target & hit identification, assays for drug screening and preclinical studies.	K2, K3 & K4
CO4	To understand the various phases of the clinical trails and the method of conduct of clinical trails.	K2, K4 & K5
CO5	Main features of clinical trials, including methodological and organizational considerations	K2, K5 & K6

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	M	L	M	L	M	S	L	S	S	M	M	S	L	L
CO2	M	L	M	S	S	S	L	M	M	M	S	L	M	S	M
CO3	L	M	L	M	L	L	S	L	S	S	M	M	L	L	L
CO4	S	L	M	S	S	L	L	S	L	L	S	L	M	S	S
CO5	M	M	L	M	L	M	S	L	S	S	M	M	L	L	L

S- Strong; M-Medium; L-Low

CONTENT:

Unit I **15 Hrs**

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

Unit II **15 Hrs**

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

Unit III **15 Hrs**

Drug-receptor interactions, receptor theories and drug action, Xenobiotics, xenobiotics phases (Phase-I, Phase-II and Phase-III), role of cytochrome P450 oxidases and glutathione S-transferases in drug metabolism, factors affecting drug metabolism, Enzymes as a drug target, Kinase inhibitors, ATPase inhibitors, drug protein interaction, DrugDNA interaction. Basic ligand concepts-agonist, antagonist, partial agonist, inverse agonist, efficiency and potency. Forces involved in drug-receptor complexes. Receptor classification – the four super families. Receptor binding assays- measurement of Kd, Bmax and IC50.

Unit IV **15 Hrs**

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

Unit V **15 Hrs**

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

TEXT BOOKS

1. Textbook of Drug Design. Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.
2. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA, 2005

REFERENCE BOOKS

1.Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc.
2.3D QSAR in Drug Design: Theory, Methods and Applications, Ed. Kubinyi H., Ledien
3.Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns, EH, Lipinski CA, Thakker DR and Wang B, AAPS Press, 2004
4.Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1stedition 2006.
5.Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1stEdition 2012.

DIAGNOSTIC BIOCHEMISTRY

Paper	: EDC	Total Hours	: 60
Hours/Week	: 3	Exam Hours	: 03
Credit	: 3	Internal	: 25
Paper Code	:**23P4BCED01**	External	: 75

SUBJECT DESCRIPTION:

This course presents about the techniques, diagnostic values and significance and the interpretation of various enzymes, bio-chemical parameters, hormones and immunoglobulins.

COURSE OUTCOME:

Course No	Course Outcome	Knowledge Level
CO1	Remember the approaches to clinical quality control, accuracy, collection and preservation of biological samples such as blood, urine and fluids	K1 & K2
CO2	Understand the blood cell and explain the different cell count such as PVC, ESR, RBC and WBC	K1 & K2
CO3	Apply the knowledge on abnormal constituents of urine such as protein, keton bodies, bile pigments and their clinical interpretation	K1,K2 & k3
CO4	Analyse and describe the to know about the critical based stool collection, preservation, and analyse the abnormal constituent of stools and microscopy studies.	K1 & K2
CO5	Evaluate and discuss clinical significance of the biochemical GTT, SGOT, SGPT and LDH etc	K1 & K2

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	S	L	L	S	M	M	M	M	L	S	L	M	S	M	L
CO2	L	M	M	S	L	L	L	M	M	S	S	M	L	S	M
CO3	S	M	M	M	M	S	L	M	S	L	L	M	L	S	M
CO4	S	M	L	M	S	M	L	M	S	S	L	M	L	M	M
CO5	S	L	M	M	M	S	S	L	S	M	L	L	S	M	S

S- Strong; M-Medium; L-Low

UNIT – I **12 Hours**

Approaches to clinical biochemistry: Quality control: Concepts of accuracy, precision, sensitivity and reproducibility, Collection of clinical specimens, preservatives for blood and urine, transport of biological samples. Fid aid equipment in laboratory accident- Precausions and first aid equipment sensitivity, linearity, calibration , Biomedical waste disposals

UNIT – II **12 Hours**

Hematology: Composition and functions of blood, Haemoglobin, Differential count-PCV, ESR, RBC, WBC and Platelet count. Fully automated and semi automated analysers.

UNIT – III **12 Hours**

Physical examination of urine: Volume, colour, odour, appearance, specific gravity and pH. Chemical examination of urine: Qualitative tests for Reducing sugar, protein, ketone bodies, Bile pigment, bile salt, Urobilinogen, and mucin. Microscopic Examination of urine.

UNIT – IV **12 Hours**

Stool examination: Collection of fecal specimen, preservation, physical examination:- volume, colour, odour and appearance. Chemical examination:- reducing sugar, occult blood test, detection of steatorrhoea. Microscopic examination of stool.

UNIT – V **12 Hours**

Estimation of Biochemical components in Blood: Glucose, GTT, Glycosylated haemoglobin, Protein, cholesterol, Urea, Uric acid and Creatinine. Determination of enzyme activity: SGOT, SGPT and LDH.

TEXT BOOK

1. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.
2. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8th edition, 2013, Jaypee publications.
3. Sabitri Sanyal, Clinical pathology, B.I.Churchill Livingstone(P)Ltd, New Delhi.2000.

3. Tietz Fundamentals of Clinical Chemistry- (5th edition) C.A. Burtis, E.R. Ashwood (eds) Saunders WB Co.

REFERENCE BOOK

1. Textbook of medical physiology by C. Guyton, John E. Hall.—12th ed, 2011, Saunders, an imprint of Elsevier Inc.

2. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8th edition, 2013, Jaypee publications.