University of Kerala

Four Year Under Graduate Programme
(UoK FYUGP)

Syllabus

Major Discipline Biochemistry

May 2024

CONTENT

About Discipline

B. Sc. – Honours in Biochemistry/ B. Sc. Honours with Research in Biochemistry

Introduction

Biochemistry is one of the most fascinating subjects as it deals with the chemical language of Life, be it human, animal, plant or microorganism. Biochemistry is one of the most upcoming and highly in demand subject in the Indian as well as the foreign universities. The basic foundation in Biochemistry is a necessary pre-requisite for any kind of life science, biotechnological, medical, paramedical and biological research activity. In the vibrant academic landscape of Kerala, a four-year undergraduate program (FYUGP) in Biochemistry of Kerala University offers a comprehensive journey into this interdisciplinary field, encompassing a wide scope, defined aims, and abundant job opportunities.

Scope:

The scope of Biochemistry is expansive, touching upon various facets of life sciences and industry. From understanding the intricate workings of cells and organisms to elucidating the molecular basis of diseases, Biochemistry plays a pivotal role. In FYUGP, students delve into diverse areas such as nutrition, enzymology, immunology, metabolism, nanobiotechnology, forensics genetics, and molecular biology. They explore how biomolecules function, interact, and regulate biological processes, paving the way for innovations in healthcare, agriculture, biotechnology, and environmental sciences.

Aim:

The aim of a FYUGP in Biochemistry in Kerala University is to equip students with a strong foundation in theoretical knowledge and practical skills essential for a career in this dynamic field. Through rigorous coursework, laboratory experiments, and research projects, students develop critical thinking abilities, analytical skills, and a deep understanding of biochemical principles. They are prepared to tackle real-world challenges, contribute to scientific advancements, and make meaningful contributions to society.

Job Opportunities:

The FYUGP in Biochemistry opens doors to diverse and rewarding career opportunities. Graduates are sought after in both academic and industrial sectors. They can pursue roles in research institutions, universities, government agencies, and biotechnology companies. Moreover, the program lays a solid foundation for further education and specialization in fields such as medicine, biotechnology, pharmacology, and bioinformatics.

Biochemistry is a career oriented, high demand fundamental course with applications in all biological research, be it plants, animal, human and microbes. It provides opportunity to students to develop their career in the following areas:

- Biochemical research
- pharmaceuticals
- Healthcare industry
- Diagnostics research
- Food and packaging industries
- Food and beverage industries,
- Medical Instrument companies
- Research Companies and Laboratories
- Drug manufacturing industries
- Public Health Entities
- Blood research and Services
- Industrial Laboratories
- Cancer research institutes
- Research Departments
- Educational Institutes
- Environmental Pollution Control
- Agriculture and fisheries
- Forensic Science
- Hospitals
- Public Health Laboratories
- Cosmetic Industries etc.
- Genomics Industries
- Diagnostics and testing Industries

Students passionate about their job to study structures and functions of proteins, carbohydrates, fats, lipids, process of metabolism, molecular basis of the action of genes, biochemical pathways, and diagnosis of different ailments can make a career in the Biochemistry field after pursuing this course.

Graduate Attributes

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

Programme Outcomes (PO)

No.	Programme Outcomes (POs)
PO-1	**Critical thinking** ○ analyze information objectively and make a reasoned judgment ○ draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions ○ identify logical flaws in the arguments of others ○ evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific
PO-2	**Complex problem-solving** ○ solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations ○ analyze a problem, generate and implement a solution and to assess the success of the plan ○ understand how the solution will affect both the people involved and the surrounding environment
PO-3	**Creativity** ○ produce or develop original work, theories and techniques ○ think in multiple ways for making connections between seemingly unrelated concepts or phenomena ○ add a unique perspective or improve existing ideas or solutions ○ generate, develop and express original ideas that are useful or have values
PO-4	**Communication skills** ○ convey or share ideas or feelings effectively ○ use words in delivering the intended message with utmost clarity ○ engage the audience effectively ○ be a good listener who are able to understand, respond and empathize with the speaker ○ confidently share views and express himself/herself
PO-5	**Leadership qualities** ○ work effectively and lead respectfully with diverse teams ○ build a team working towards a common goal ○ motivate a group of people and make them achieve the best possible solution. ○ help and support others in their difficult times to tide over the adverse situations with courage

PO-6	**Learning 'how to learn' skills** ○ acquire new knowledge and skills, including 'learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning ○ work independently, identify appropriate resources required for further learning ○ acquire organizational skills and time management to set self-defined goals and targets with timelines ○ inculcate a healthy attitude to be a lifelong learner
PO-7	**Digital and technological skills** ○ use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources ○ use appropriate software for analysis of data ○ understand the pitfalls in the digital world and keep safe from them
PO-8	**Value inculcation** ○ embrace and practice constitutional, humanistic, ethical, and moral values in life including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values ○ formulate a position/argument about an ethical issue from multiple perspectives ○ identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights ○ adopt an objective, unbiased, and truthful actions in all aspects of work

Programme Specific Outcomes (PSO)

No.	Upon completion of the programme the graduate will be able to	PO No.
PSO-1	Students will demonstrate a comprehensive understanding of fundamental biochemical principles, including the structure and function of biomolecules, enzymes, metabolic pathways, and the molecular basis of cellular processes.	2

PSO-2	Students will possess advanced laboratory skills necessary for employability, analysis, biochemical research and application of clinical biochemistry in disease diagnosis.	6
PSO-3	Students will be able to communicate and critically evaluate scientific literature and apply biochemical principles to solve real- world problems in areas such as medicine, nutrition and dietetics, forensics, nanobiotechnology, agriculture and environmental science.	1,2,4
PSO-4	Students will acquire core knowledge in the basic areas of biochemistry, as well as horizontal knowledge in related life science fields to pursue either higher education or employment in various fields, or entrepreneurship.	2,4

Members of the Board of studies in Biochemistry and teachers participated in the syllabus preparation in FYUGP 2024

1. Prof. A. Helen. Chairperson, Department of Biochemistry, University of Kerala
2. Prof. Annie Abraham, Rtd. Professor, University of Kerala
3. Prof. Ganga Prasad A, Rtd. Professor, University of Kerala
4. Prof. Padmakumaran Nair KG, Professor, NSS College, Panthalam
5. Dr. Sindhu Rani JA, Associate Professor, NSS College, Nilamel
6. Dr. Arun A Rauf, Associate Professor, University of Kerala
7. Dr. Biju PG, Assistant Professor, University of Kerala
8. Dr. Radhika A, Associate Professor, Govt. College, Kariavattom
9. Dr. Arun U, Assistant Professor, Govt. Arts & Science College, Kulathoor
10. Mr. Vishnu SL, Assistant Professor, SN College for Women, Kollam
11. Dr. Rejiya CS, Academic Council Member, Assistant Professor, Sree Ayyappa College, Eramallikkara
12. Dr. C. R. Dhanya, Associate Professor, Govt. College, Kariavattom
13. Dr. Chithra V, Assistant Professor, NSS College, Panthalam
14. Dr. Anila L, Associate Professor, NSS College, Nilamel
15. Dr. Sini H, Associate Professor, Govt. College, Kariavattom
16. Dr. Boban PT, Associate Professor, Govt. College, Kariavattom
17. Dr. Hari Sankar HS, Assistant Professor, TKM College of Arts & Science, Kollam
18. M.S. Soumya, Assistant Professor, TKM College of Arts & Scinece, Kollam
19. Dr. Vinod BS, Assistant Professor, S.N. College, Kollam
20. Dr. Ambili S, Assistant Professor, S.N. College, Kollam
21. Dr. Sheena Philip, Assistant Professor, University College, Palayam

22. Dr. Reji Susan Biju AS, A J College of Science & Technology, Thonnakkal
23. Dr. Joicy Abraham, A J College of Science & Technology, Thonnakkal
24. Dr. Swathy SS, A J College of Science & Technology, Thonnakkal
25. Dr. Manju L, Assistant Professor, St. Xaviers College, Thumba
26. Dr. Jisha S, Assistant Professor, Bishopmore College, Mavelikara, Alappuzha
27. Dr. Lekshmi Vijayanath, Assistant Professor & HOD, Emmanuel College, Vazhichal
28. Ms. Bijila V.X, Assistant Professor, Emmanuel College, Vazhichal
29. Ms. Reni Christabel HP, Assistant Professor, Emmanuel College, Vazhichal
30. Ajitha Nair VA, Assistant Professor, Emmanuel College, Vazhichal
31. Dr. Nisha V R, Assistant Professor, Emmanuel College, Vazhichal
32. Ms. Anupama SS, Assistant Professor, Women's College, Thiruvananthapuram
33. Dr. Remya, Assistant Professor, Assistant Professor, SN College for Women, Kollam
34. Dr. Manju C.S, Assistant Professor, Govt. Arts & Science College, Kulathoor

COURSE CONTENT

Year of Admission : 2024
Discipline : FYUGP Biochemistry

Sl No	Semester	Course code	Course Title	L: T: P : HOURS
1.	I	UK1DSCBCH100	Basic elements of biochemistry	3: 0: 1, 75 hrs
2.	I	UK1DSCBCH101	Foundations of biochemistry	3: 0: 1, 75 hrs
3.	I	UK1DSCBCH102	Origin of life	3: 0: 1, 75 hrs
4.	I	UK1DSCBCH103	Biochemical and biophysical aspects of life	3: 0: 1, 75 hrs
5.	I	UK1DSCBCH104	Physical aspects of biochemistry	3: 0: 1, 75 hrs
6.	I	UK1DSCBCH105	Cellular biochemistry	3: 0: 1, 75 hrs
7.	I	UK1MDCBCH100	Biochemistry of contagious diseases: current scenario	3: 0: 0, 45 hrs
8.	I	UK1MDCBCH101	Nutritional biochemistry for health & fitness	3: 0: 0, 45 hrs
9.	I	UK1MDCBCH102	Biochemical applications in forensics	3: 0: 0, 45 hrs
10.	II	UK2DSCBCH100	Introduction to biomolecules	3: 0: 1, 75 hrs
11.	II	UK2DSCBCH101	Structure of biomolecules	3: 0: 1, 75 hrs
12.	II	UK2DSCBCH102	Biomolecules in living organisms	3: 0: 1, 75 hrs
13.	II	UK2DSCBCH103	Biochemistry of health and diseases	3: 0: 1, 75 hrs
14.	II	UK2DSCBCH104	Biochemical aspects of metabolic regulators	3: 0: 1, 75 hrs
15.	II	UK2DSCBCH105	Molecules of life	3: 0: 1, 75 hrs
16.	II	UK2MDCBCH100	Biochemistry of lifestyle diseases	3: 0: 0, 45 hrs
17.	II	UK2MDCBCH101	Biochemistry of food adulteration	3: 0: 0, 45 hrs

18.	**II**	**UK2MDCBCH102**	**Application of Artificial intelligence in Biomedical science**	**3: 0: 0, 45 hrs**
19.	**II**	**UK2MDCBCH103**	**Biochemical aspects of emerging and remerging diseases**	**3: 0: 0, 45 hrs**
20.	**III**	**UK3DSCBCH200**	**Properties of biomolecules**	**3: 0: 1, 75 hrs**
21.	**III**	**UK3DSCBCH201**	**Enzymes and enzyme kinetics**	**3: 0: 1, 75 hrs**
22.	**III**	**UK3DSCBCH202**	**Sports Nutrition**	**4: 0: 0, 60 hrs**
23.	**III**	**UK3DSCBCH203**	**Biosafety, bioethics and IPR**	**4: 0: 0, 60 hrs**
24.	**III**	**UK3DSCBCH204**	**Functional foods and nutraceuticals**	**3: 0: 1, 75 hrs**
25.	**III**	**UK3DSCBCH205**	**Phytochemistry**	**3: 0: 1, 75 hrs**
26.	**III**	**UK3DSCBCH206**	**Properties of Biomolecules and Enzymology**	**3: 0: 1, 75 hrs**
27.	**III**	**UK3DSEBCH200**	**Nutrition for Human Health**	**4: 0: 0, 60 hrs**
28.	**III**	**UK3DSEBCH201**	**Introduction to nanobiotechnology**	**4: 0: 0, 60 hrs**
29.	**III**	**UK3DSEBCH202**	**Nanobiotechnology**	**4: 0: 0, 60 hrs**
30.	**III**	**UK3VACBCH200**	**Basic dietetics**	**3: 0: 0, 45 hrs**
31.	**III**	**UK3VACBCH201**	**Drug Abuse and Prevention**	**3: 0: 0, 45 hrs**
32.	**III**	**UK3VACBCH202**	**Fermentation technology**	**2: 0: 1, 60 hrs**
33.	**IV**	**UK4DSCBCH200**	**Enzymology**	**3: 0: 1, 75 hrs**
34.	**IV**	**UK4DSCBCH201**	**Cell Biology**	**4: 0: 0, 60 hrs**
35.	**IV**	**UK4DSCBCH202**	**Specialized tissues and membranes**	**4: 0: 0, 60 hrs**
36.	**IV**	**UK4DSCBCH203**	**Plant Biochemistry**	**3: 0: 1, 75 hrs**
37.	**IV**	**UK4DSCBCH204**	**Techniques in Biochemistry**	**3: 0: 1, 75 hrs**
38.	**IV**	**UK4DSEBCH200**	**Lifestyle diseases and dietary management**	**4: 0: 0, 60 hrs**
39.	**IV**	**UK4DSEBCH201**	**Industrial enzymes**	**3: 0: 1, 75 hrs**

40.	**IV**	**UK4SECBCH200**	**Enzyme: Isolation and analysis**	**2:0:1, 60 hrs**
41.	**IV**	**UK4SECBCH201**	**Diagnostic Biochemistry**	**2:0:1, 60 hrs**
42.	**IV**	**UK4VACBCH200**	**Play of hormones**	**3: 0: 0, 45 hrs**
43.	**IV**	**UK4VACBCH201**	**Science journalism**	**3: 0: 0, 45 hrs**
44.	**IV**	**UK4VACBCH202**	**Ecology and environmental studies**	**3: 0: 0, 45 hrs**
45.	**IV**	**UK4INTBCH200**	**Internship**	**1/2 months**
46.	**V**	**UK5DSCBCH300**	**Bioenergetics and carbohydrate metabolism**	**3: 0: 1, 75 hrs**
47.	**V**	**UK5DSCBCH301**	**Nucleic acid, lipid and amino acid metabolism**	**3: 0: 1, 75 hrs**
48.	**V**	**UK5DSCBCH302**	**Human physiology and immunology**	**3: 0: 1, 75 hrs**
49.	**V**	**UK5DSCBCH303**	**Molecular Biology**	**3: 0: 1, 75 hrs**
50.	**V**	**UK5DSCBCH304**	**Environmental Biochemistry**	**4: 0: 0, 60 hrs**
51.	**V**	**UK5DSCBCH305**	**Cancer biology**	**4: 0: 0, 60 hrs**
52.	**V**	**UK5DSEBCH300**	**Inborn errors of metabolism**	**3: 0: 1, 75 hrs**
53.	**V**	**UK5DSEBCH301**	**Food and Diary Science**	**3: 0: 1, 75 hrs**
54.	**V**	**UK5DSEBCH302**	**Intermediary Metabolism and Bioenergetics**	**3: 0: 1, 75 hrs**
55.	**V**	**UK5SECBCH300**	**Basic Techniques in Biochemistry**	**2: 0: 1, 60 hrs**
56.	**V**	**UK5SECBCH301**	**QAQC**	**2: 0: 1, 60 hrs**
57.	**VI**	**UK6DSCBCH300**	**Classical and molecular genetics**	**3: 0: 1, 75 hrs**
58.	**VI**	**UK6DSCBCH301**	**Clinical biochemistry and molecular diagnostics**	**3: 0: 1, 75 hrs**
59.	**VI**	**UK6DSCBCH302**	**Endocrinology**	**4: 0: 0, 60 hrs**

60.	**VI**	**UK6DSCBCH303**	**Clinical biochemistry**	**3: 0: 1, 75 hrs**
61.	**VI**	**UK6DSCBCH304**	**Advanced biochemistry**	**4: 0: 0, 60 hrs**
62.	**VI**	**UK6DSCBCH305**	**General Informatics and Bioinformatics**	**3: 0: 1, 75 hrs**
63.	**VI**	**UK6DSEBCH300**	**Microbial Biochemistry**	**3: 0: 1, 75 hrs**
64.	**VI**	**UK6DSEBCH301**	**Molecular Immunology**	**3: 0: 1, 75 hrs**
65.	**VI**	**UK6DSEBCH302**	**Physiology, Nutrition and Endocrinology**	**3: 0: 1, 75 hrs**
66.	**VI**	**UK6SECBCH300**	**Analytical biochemistry**	**2: 0: 1, 60 hrs**
67.	**VI**	**UK6SECBCH301**	**Cell culture techniques**	**2: 0: 1, 60 hrs**
68.	**VII**	**UK7DSCBCH400**	**Cell Signalling**	**4: 0: 0, 60 hrs**
69.	**VII**	**UK7DSCBCH401**	**Advanced techniques in biochemistry**	**3: 0: 1, 75 hrs**
70.	**VII**	**UK7DSCBCH402**	**Research Methodology**	**4: 0: 0, 60 hrs**
71.	**VII**	**UK7DSCBCH403**	**Genetic Engineering**	**3: 0: 1, 75 hrs**
72.	**VII**	**UK7DSCBCH405**	**Neurobiochemistry and Sensory Physiology**	**4: 0: 0, 60 hrs**
73.	**VII**	**UK7DSCBCH406**	**Omics**	**4: 0: 0, 60 hrs**
74.	**VII**	**UK7DSEBCH400**	**Tissue Engineering and 3D printing**	**4: 0: 0, 60 hrs**
75.	**VII**	**UK7DSEBCH401**	**Plant tissue culture**	**4: 0: 0, 60 hrs**
76.	**VIII**	**UK8DSCBCH400**	**Developmental Biology**	**4: 0: 0, 60 hrs**
77.	**VIII**	**UK8DSCBCH401**	**Pharmacology**	**3: 0: 1, 75 hrs**
78.	**VIII**	**UK8DSCBCH402**	**Nanomaterials for Biomedical Applications**	**3: 0: 1, 75 hrs**
79.	**VIII**	**UK8RPHBCH400**	**Research Project**	**6 MONTHS**

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Discipline	BIOCHEMISTRY				
Course Code	UK1DSCBCH100				
Course Title	**BASIC ELEMENTS OF BIOCHEMISTRY**				
Type of Course	DSC1 (Major)				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in biology and chemistry				
Course Summary	The course provides an overview of the biochemical and biophysical aspects within living organisms. It also delivers concepts of laboratory procedures & practices to document, implement and maintain good laboratory practice.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**FUNDAMENTAL UNITS OF LIFE**	**8**
	1	Basic experiments- Miller Urey Experiment, Joseph Priestley experiment	
	2	Discovery of Cell, Cell theory (elementary ideas)	
	3	General Structure of Virus, Bacteria, Plant and Animal cell	
	4	Characteristics that distinguish prokaryotic and eukaryotic cell (diagrammatic illustration)	
II		**FOUNDATIONS OF LIFE**	**12**
	5	Properties of water, water as a universal solvent, chemistry of water.Bronsted theory of acids and bases, concepts of pH, pOH, and calculations based on pH and pOH.	
	6	Buffer (mention biological buffers). Henderson Hasselbalch equation (derivation and significance only)	
	7	Macroelements - C, H, O, N, S, Na, Mg, Ca, P, K, Cl (Occurence in biomolecules with an example each)	
	8	Microelements - Cu, I, Fe, Zn, Se (Occurence in biomolecules with an example each)	
III		**CHEMICAL LINKAGES**	**6**
	9	Biological significance of non-covalent- ionic, electrostatic, van der Waals force, hydrogen and hydrophobic interaction	

	10	Biological significance of covalent bonds- Peptide, glycosidic, ester, phosphodiester and disulfide linkages	
IV	**COLLOIDS AND SOLUTIONS**		**7**
	11	Properties and types of colloids (lyophobic and lyophilic colloids)	
	12	Diffusion, osmosis and types of solutions-hypotonic, hypertonic and isotonic solutions (definition only) Donan membrane equilibrium	
	13	Biological significance of osmosis, diffusion, colloids and emulsifying agents	
V	**GENETIC MATERIAL**		**12**
	14	Nature of genetic material (DNA and RNA)	
	15	Basic types and functions of DNA and RNA	
	16	Classical experiments to prove DNA as genetic material (Griffith's Experiment, Avery-MacLeod-McCarty experiment, Hershey Chase experiment)	
	17	Experiment in Tobacco mosaic virus to prove RNA as genetic material	
	18	Examples of microorganisms containing DNA & RNA as genetic material	
		PRACTICALS	**30**
	19	**Introduction to Lab Safety** ● Awareness of good laboratory practice ● General lab safety rules ● Laboratory safety and management of hazards in the laboratory ● Familiarization with glassware/equipment (light microscope, pH, electronic balance, distillation unit, thermostatic & boiling water bath)	**15**
	20	**Activities** ● Logbook/register maintenance ● Labeling of chemicals/glasswares ● Preparing SOP of equipments ● Preparation of solutions (percentage, normal, molar solutions) ● Preparation of dilute solutions from stock solutions ● Determination of pH ● Laboratory visit to a recognized institute *Lab records to be maintained	**15**

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the basic aspects of cells and distinguish different types of cell	R, U	1
CO-2	Explain the significance of water and buffers and calculate acidity and basicity of buffers and solutions	R, U, Ap	1,2
CO-3	Illustrate the importance of macro- and micro-elements, chemical linkages, diffusion, osmosis and colloids in the biological system	R, U	2,3
CO-4	Compare and contrast the different genetic materials in living organisms	R, U	2.3.4
CO-5	Restate good laboratory practices, carry out safe laboratory experiments and prepare solutions & buffers.	R,U, Ap	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: BASIC ELEMENTS OF BIOCHEMISTRY

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R, U	F,C	L,T	
2	2	1,2	R, U, Ap	F,C	L,T	
3	3	2,3	R, U	F,C	L,T	
4	4	2,3,4	R, U	F,C	L,T	
5	5	3,4	R,U, Ap	C,P	L,T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PS O6	PO 1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-			2	2				
CO 2	2	3	-	-			2	2		2		3
CO 3	-	2	3				2	2		2		
CO 4		1	2	3			2	2				2
CO 5			2	3			2	2		2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		

REFERENCES

- Nelson D. L., Cox M. M. (2021) Lehninger Principles of Biochemistry, (8th ed.) W.H. Freeman &. Co Ltd.
- Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.2.
- J L Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry Paperback – 1 January 2016; ISBN : 9788121924535
- Jonathan B. Losos, Peter H. Raven, Susan R. Singer, Kenneth A. Mason, Biology, 2022, ISBN 9781260169614
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Despande(ed). I.K International Pvt. LTD, NewDelhi. ISBN 81-88237-41-8.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1DSCBCH101				
Course Title	FOUNDATIONS OF BIOCHEMISTRY				
Type of Course	**DSC2**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in biology and chemistry				

Course Summary	Students will be able to investigate the chemical reactions and molecular interactions that take place within living things after completing the course. It looks at the minute aspects of the molecules that comprise life, particularly nucleic acids. Additionally, they will be able to comprehend and interpret good laboratory practice (GLP) and advance their knowledge and abilities in the areas of documenting, putting into practice, and maintaining a technical and quality management system for laboratories that is based on GLP.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**FUNDAMENTAL UNITS OF LIFE**		**15**
	1	Definition of Biochemistry and how it explores the molecular logic of life.	
	2	Cell as the structural and functional unit of living organisms,	
	3	Differences between prokaryotic and eukaryotic cell	
	4	Outline of the different prokaryotic and eukaryotic cells' organelles	
II	**CHEMICAL BONDS & FOUNDATIONS OF LIFE**		**15**
	5	Definition & Types of molecular bonds	
	6	Bonds common in biomolecules- Characteristics of ester, hydrogen, ionic, van der Waals, and covalent bonds	
	7	Water's special qualities, its use as a universal solvent, Water's chemical composition	
	8	Bronsted theory of acids and bases, pH and pOH principles, computations based on pH and pOH, and the	
	9	Elements in various combinations comprise all matter on Earth, including living things (carbon, hydrogen, nitrogen, oxygen, sulfur, and phosphorus).	
III	**GENETIC FOUNDATION**		**15**
	10	Definition of genetic material, the central dogma	
	11	Properties, Types (DNA & RNA)	
	12	General introduction without structure	
	13	Classical experiments to prove DNA as genetic material (Griffith's Experiment, Meselson-Stahl experiment, Hershey Chase Blender experiment.	
	14	Examples of microorganism containing DNA & RNA as genetic material	
IV	**INTRODUCTION TO LABORATORY AND LAB EQUIPMENT**		**15**
	15	Awareness of good laboratory practices.	
	16	Familiarization with glassware and equipment used in biochemistry student's laboratory, (study the functions of light microscope)	
	17	Use of balances-common, analytical, and electronic balances- Preparation of standard solutions	
V	**GENERAL LABORATORY PRACTICES**		**15**
	18	General lab safety rules	

	19	Laboratory safety and management of hazards in the laboratory.	
	20	Laboratory visit to a recognized institute	
	PRACTICALS		30
	21	Introduction to Lab Safety ● Awareness of good laboratory practice ● General lab safety rules ● Laboratory safety and management of hazards in the laboratory ● Familiarization with glassware/equipment (light microscope, pH, electronic balance, distillation unit, thermostatic & boiling water bath)	
	22	**ACTIVITIES** **Activities** ● Logbook/register maintenance ● Labeling of chemicals/glasswares ● Preparing SOP of equipments ● Preparation of solutions (percentage, normal, molar solutions) ● Preparation of dilute solutions from stock solutions ● Determination of pH ● Laboratory visit to a recognized institute *Lab records to be maintained	

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe cell organelles and describe their structure and function.	U	1,2
CO-2	Describe the basic chemical and biological foundations that lead to origin of life on Earth	R, U	1,2
CO-3	Identify the genetic and evolutionary foundations of Biochemistry	U,	3
CO-4	Know appropriate methods in the laboratory	Ap	3
CO-5	Develop the knowledge necessary to conduct accurate and secure laboratory experiments.	U, Ap	4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Fundamentals of Biochemistry

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	U	F, C	LT	
2	2	1,2	R U	F, C	LT	
3	3	3	U	F, C	LT	
4	4	3	Ap	P	LT	P
5	5	4	U,Ap	F, C	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	-		2				
CO 2	2	3	-	-	-	-		2				
CO 3	-	-	1	-	-	-	2					
CO 4	-	-	2	3	-	-	1	2				
CO 5	-	1	-	-	-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

- Nelson D. L., Cox M. M. (2021) Lehninger Principles of Biochemistry, (8th ed.) W.H. Freeman &. Co Ltd.
- Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.2.
- J L Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry Paperback – 1 January 2016; ISBN : 9788121924535
- Jonathan B. Losos, Peter H. Raven, Susan R. Singer, Kenneth A. Mason, Biology, 2022, ISBN 9781260169614.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1DSCBCH102				
Course Title	**Origin of Life**				
Type of Course	DSC3				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in biology and chemistry				
Course Summary	The course provides a brief overview of the molecular logic & evolution of life. The course outlines fundamentals of cell, genetic material and chemical interactions in the living system.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**MOLECULAR LOGIC OF LIFE**	**10**
	1	Oparin-Haldane hypothesis, Miller-Urey experiment	
	2	Priestley's experiment on photosynthesis	
	3	Basic aspects of biochemistry as the molecular logic of living organisms (Elementary concept)	
	4	Characteristics of living matter	
II		**EVOLUTION**	**9**
	5	Brief overview of Lamarckism and Darwin's theory	
	6	Natural selection- examples: DDT resistant mosquitoes, Metal tolerance in grasses, Industrial melanism	
	7	Phylogenetic tree (basic concept)	
III		**CELL**	**10**
	8	Fundamentals of cell theory	
	9	Basic structure of virus, bacteria, plant and animal cell	
	10	Function of cell organelles (Mitochondria, chloroplast, nucleus). Basic concept of endosymbiosis	
IV		**BIOLOGICAL INTERACTIONS**	**6**
	11	Covalent interactions: Peptide bond, glycosidic bond, ester bonds	
	12	Non-covalent interactions: Ionic, van der Waals, hydrogen and hydrophobic interaction	

V	**GENETIC MATERIAL**		**10**
	13	RNA world, types and functions of RNA	
	14	Types and functions of DNA	
	15	RNA and DNA viruses in emerging infections (brief overview)	
		PRACTICAL	**30**
	16	**Introduction to Lab Safety** ● Awareness of good laboratory practice ● General lab safety rules ● Laboratory safety and management of hazards in the laboratory ● Familiarization with glassware/equipment (light microscope, pH, electronic balance, distillation unit, thermostatic & boiling water bath)	
	17	**Activity** ● Logbook/register maintenance ● Spot test-Identification and brief explanation of different subcellular organelles ● Book review of Darwins 'Origin of Life' ● Laboratory visit to a recognized lab ● Visit to Natural History Museum ● Preparation of charts/models of cell, DNA, RNA, virus *Lab records to be maintained	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the chemical and molecular logic of life	R, U	1
CO-2	Summarize the basic concepts of origin of life and evolution	R, U	1,3
CO-3	Compare the structural and functional aspects of different types of cells and cellular organelles	R, U	1
CO-4	Explain the significance of chemical interactions and genetic material in the living system.	R, U	3,4
CO-5	Discuss good laboratory practices	Ap	3.4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Creat*e*

Name of the Course: Origin of Life Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
	1	1	R, U	F, C	LT	
	2	1,3	R, U	F, C	LT	
	3	1	R, U	F, C	LT	
	4	3,4	R, U	F, C	LT	
	5	3,4	Ap	p	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-		2				
CO 2	2		3	-	-	-	2	3				
CO 3	2	-	-	-	-	-		2				
CO 4	-	-	2	3	-	-	3	2		2		
CO 5	-	-	2	3	-	-		2		3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

- Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M.Cox. Publisher: W. H. Freeman; Fourth Edition (April 23, 2004).
- Priciples of Biochemistry by Albert Lehninger, David L. Nelson, Michael M.Cox. Second edition
- Cell and Molecular Biology-Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- A textbook of practical physiology Eighth Edition CL Ghai MBBS MD

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1DSCBCH103				
Course Title	**Biochemical and Biophysical Aspects of Life**				
Type of Course	DSC 4				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in biology and chemistry				
Course Summary	The course gives an outline of the biochemical and biophysical aspects within the living system. It also delivers concepts of laboratory procedures & practices to document, implement and maintain good laboratory practice.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**ACIDS, BASES AND BUFFERS**	**6**
	1	Definition of acids and bases (Arrhenius, Bronsted-Lowry and Lewis concept	
	2	Concept of pH and pOH, pH scale	
	3	Buffers- Definition and biologically important buffers	
		COLLOIDS AND SOLUTIONS	**12**
	4	Colloids- Definition and properties-kinetic, electric, optical and physical, Types of colloids- lyophobic and lyophilic, Emulsions and emulsifying agents, Biological applications of colloids	
	5	Methods of expressing concentration-Normality, Molarity, Molality and percentage solution	
	6	Osmosis- Definition and biological significance	
	7	Diffusion- Definition and biological significance	
	8	Types of solutions- hypotonic, hypertonic and isotonic solutions (definition only)	
III		**CHEMICAL INTERACTIONS**	**7**
	9	Intra and inter-molecular interactions in biological system- Non-covalent- ionic, electrostatic, Van der Waals force, hydrogen and hydrophobic interaction (Biological significance)	

	10	Covalent bonds- Peptide, glycosidic, ester, phosphodiester and disulfide linkages (Biological significance)	
IV	**CELL**		**10**
	11	Discovery of Cell, Cell theory (elementary ideas)	
	12	Structural organization of virus, bacteria, plant and animal cell (basics only)	
	13	Characteristics that distinguish prokaryotic and eukaryotic cell (diagrammatic illustration)	
V	**BIOCHEMICAL SPLENDORS**		**10**
	14	Bioluminescence- firefly, marine organisms and glow worm (basic aspects only)	
	15	Biopigments- Pigments in skin, hair, eye and blood, plant pigments- photosynthetic pigments & accessory pigments, algal bloom (basic aspects only)	
	16	Green fluorescent protein (elementary aspects only)	
		PRACTICAL	**30**
	17	**Introduction to Lab Safety** ● Awareness of good laboratory practice ● General lab safety rules ● Laboratory safety and management of hazards in the laboratory ● Familiarization with glassware/equipment (light microscope, pH, electronic balance, distillation unit, thermostatic & boiling water bath)	
	18	**Activities** ● Logbook/register maintenance ● Labeling of chemicals/glasswares ● Preparation of solutions (percentage, normal, molar solutions) ● Preparation of dilute solutions from stock solutions ● **Laboratory visits to a recognized institute** *Lab records to be maintained	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Summarize the significance of pH and buffers in biological system	R, U	1
CO-2	Illustrate the importance of chemical linkages, diffusion, osmosis and colloids in the biological system	R, U	1,2

CO-3	Review the basic aspects of cells and distinguish different types of cell	R, U	1,2
CO-4	Discuss the interesting biochemical phenomenon in the living world	R, U	3
CO-5	Illustrate good laboratory practices, carry out safe laboratory experiments and prepare solutions & buffers.	R, U, Ap	2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biochemical and Biophysical Aspects of Life

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R, U	F, C	LT	
2	2	1,2	R, U	F, C	LT	
3	3	1,2	R, U	F, C	LT	
4	4	3	R, U	F, C	LT	
5	5	2,3	R, U, Ap	P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-		2				
CO 2	2	3	-	-	-	-		2				3
CO 3	1	2	-	-	-	-		3				3
CO 4	-	-	3	-	-	-	2	2				
CO 5	-	-	2	3	-	-	2	2		3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		

References

1. Essentials of Physical Chemistry by Arun Bahl, and BS Bahl and GD Tuli.S. Chand & Company Ltd.ISBN-81-219-2978-4.
2. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.
3. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M.Cox.Publisher: W. H. Freeman; Fourth Edition (April 23, 2004).
4. Handbook of medical laboratory technique

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1DSCBCH104				
Course Title	**PHYSICAL ASPECTS OF BIOCHEMISTRY**				
Type of Course	**DSC 5**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in biology and chemistry				
Course Summary	The course lays a foundation of basic biochemistry and outlines the concepts of water, buffer systems, colloids, basic separation methods and radiation biology.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Colloids and solutions**	**10**
	1	Classification and biological significance of colloids	
	2	Osmosis and diffusion (Definition and biological significance) Basics of Donnan Membrane Equilibrium	
	3	Isotonic, hypotonic, hypertonic and Iso-osmotic solutions, surface tension and viscosity	
	4	Structure and properties of water, Ionization of water, Concepts of acids and bases. pH & pOH	
	5	Buffers, Henderson Hasselbalch equation, Buffers in biological system and its biomedical importance	
II		**Bio-organic chemistry**	**8**
	6	Introduction to major biomolecules and classification	
	7	Major types of Covalent bonds in biomolecules: Disulphide bonds, Peptide Bonds, Glycosidic bonds, Phosphodiester bonds	
	8	Non covalent bonds and its biological significance: Hydrogen bond, Ionic bond, Hydrophobic bond, van der Waals forces)	
	9	Common Functional groups in biomolecules and their significance, Isomerism in biomolecules	
III		**Biochemical Separation techniques**	**9**
	10	Dialysis: Principle and procedure	

	11	Chromatography : Principle and procedure (Paper and TLC)	
	12	Electrophoresis: Principle and procedure (Agarose gel electrophoresis and SDS PAGE)	
	13	Centrifugation: Principle and applications of Differential and density gradient, Svedberg constant.	
IV	**Colorimetry and spectrophotometry**		**9**
	14	Beer Lambert's law, Molar extinction coefficient and absorption spectra.	
	15	Principle and instrumentation of Colorimetry and Spectrophotometry.	
	16	Applications of colorimetry and spectrophotometry in the field of biochemistry	
V	**Basics of radiobiology**		**9**
	17	Radioactive isotopes- half life, important stable isotopes used in biochemical research (^{32}P, ^{125}I, ^{131}I, ^{60}Co, ^{14}C, etc)	
	18	Classification of radiation damage , Effects of radiation in humans	
	19	Harmful effects of radiation, Stochastic and deterministic (non-stochastic) effects	
		Practical	**30**
	20	• Basic laboratory practices • Weighing in chemical balance • Preparation of solutions (Molar, Normal and Percentage solutions) • Dilution from stock solution • Preparation of Buffers and determination of pH. • Demonstration of paper chromatography • Verification of Beer Lambert's law and colorimetric estimation of concentration of unknown solution. • Lab/Institution Visit	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the basics aspects and biological significance colloids and solutions	R, U	1
CO-2	Describe the concepts of important linkages in biomolecules	R, U	2
CO-3	Demonstrate and explain the basic techniques used in the field of biochemistry	R, U, Ap	3,4

CO-4	Explain the concepts of radiation biology	R, U	3,4
CO-5	Restate good laboratory practices, carry out safe laboratory experiments and prepare solutions & buffers.	R, U, Ap	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Physical Aspects of Biochemistry

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	1	1	R, U	F, C	LT	
2	2	2	R, U	F, C	LT	
3	3	3,4	R, U, Ap	F, C	LT	
4	4	3,4	R, U	F, C	LT	
5	5	3,4	R, U, Ap	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	-	-	-	-		2				
CO 2	3	-	-	-	-	-		2				
CO 3	-	-	2	3	-	-	2	2		2		3
CO 4	-	-	1	3	-	-	2	2		2		3
CO 5	-		2	3	-	-		2		3		3

Correalation Levels:

Level	Correlation
	Nil
1	Slightly/Low
2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1DSCBCH105				
Course Title	**Cellular Biochemistry**				
Type of Course	**DSC** 6				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in biology and chemistry				
Course Summary	The course is designed to provide fundamental ideas about the structure and functions of cells and their components. The course covers the basic aspects of membrane transport, cell cycle, cancer and cell culture techniques.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Cell**		**7**
	1	Discovery of cell, Cell theory (elementary ideas)	
	2	Structural organization of virus, bacteria, plant and animal cell (basics only)	
	3	Basic structure and function of cell organelles - nucleus, mitochondria, chloroplast, lysosome and Golgi complex.	
II	**Transport across Membrane**		**7**
	4	Basic structure of cell membrane-Fluid Mosaic Model	
	5	Functions of plasma membrane	
	6	Composition of plasma membrane (elementary ideas)	
	7	Passive transport (diffusion, facilitated diffusion), Active transport, Exocytosis and endocytosis. (Definition and basic concepts only)	
III	**Cell Cycle**		**12**
	8	Cell cycle events	

	9	Significance of cell division	
	10	Mitosis: Phases involved	
	11	Meiosis: Phases involved	
	Cell Biology of Cancer		**10**
	12	Hallmarks of cancer	
	13	Different between normal cells and cancer cells	
	14	Benign tumor vs malignant tumor	
	15	Types and stages of cancers (basic ideas only)	
V	**Basics of Cell Culture**		**9**
	16	Basic requirements in a cell culture lab	
	17	Aseptic conditions, basic sterilization methods and common cell culture contaminants	
	18	Cell culture media and supplements (basic ideas only)	
	19	Primary cell culture (definition) and example	
	20	Brief concept of cell lines- HeLa as example	
		Practicals	**30 hrs**
	21	● Blood Smear Preparation, ● Identification of mitotic stages (slide/figure) ● Familiarisation with equipments and culture wares related to cell culture ● Demonstration of sterilization techniques used in cell culture lab (any one).	
	22	Activities ● Preparation chart for cell division ● Visit to cell culture lab * Lab record has to be maintained	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the basic structural and functional aspects of cell	R,U	1
CO-2	Describe the structure and function of plasma membrane and basic types of transport across the membrane	R, U	1,4
CO-3	Summarise the basic concepts of cell division and cancer	R, U	3
CO-4	Illustrate the elementary concepts in cell culture	R, U	3,4
CO-5	Explain the concept of cell lines and cell culture media	R, U	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Cellular Biochemistry
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R,U	F, C	LT	
2	2	1,4	R,U	F, C	LT	
3	3	3	R,U	F, C	LT	
4	4	3,4	R,U	F, C	LT	
5	5	3,4	R,U	F, C	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-		2				
CO 2	2		-	3	-	-		2				3
CO 3	-	-	2	-	-	-	1	2				
CO 4	-	-	2	3	-	-	1	2		2		3
CO 5	3	-	-	-	-	-		2				

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Cell and Molecular Biology-Gerald Karp, John Wiley & Son, Inc. New York ISBN 9780470-16961-2, 5th Edition.
- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc.,ISBN 0-471-44180-5, 3rd Edition.
- Cell and Molecular Biology by De Robertis & De Robertis, jr.
- Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky ST, Matsudaira P, Darnell J.
- The cell: A molecular approach by Geoffrey M Cooper and Robert E Hausman.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1MDCBCH100				
Course Title	**Biochemistry of Contagious Diseases: Current Scenario**				
Type of Course	MDC1				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	1 hours	3
Pre-requisites	Nil				
Course Summary	The course outlines the common contagious diseases prevalent in the society and strategies employed for the prevention and management of the disease				

Detailed Syllabus

Module	Unit	Content	Hrs
I	**Viral Diseases**		**6**
	1	Chickenpox, Hepatitis (A, B and C), Nipah, Covid, Bird flu, Dengue, Mumps and AIDS: Cause, symptoms, mode of transmission (Elementary ideas only)	
II	**Bacterial Diseases**		**6**
	2	Cause, symptoms, mode of transmission of tuberculosis, leptospirosis and typhoid (Elementary ideas only)	
III	**Parasitic Diseases**		**6**
	3	Malaria- causative agent, symptoms, vectors, mode of transmission and diagnosis (Elementary ideas only)	
	4	Filariasis– causative agent, symptoms, vector, mode of transmission and diagnosis (Elementary ideas only)	

	5	Pinworm, Roundworm and Tapeworm infection- cause, symptoms and mode of transmission (Elementary ideas only)	
IV	**Fungal Diseases**		**6**
	6	Candidiasis - cause, symptoms and mode of transmission	
	7	Ringworm infection- cause, symptoms and mode of transmission	
V	**Strategies For Management Of Infectious Diseases**		**6**
	8	Role of drugs, vaccines, hygiene and sanitation in prevention and transmission of infectious diseases mentioned above.	
		Practicals	15
	9	● Conducting awareness classes/campaign on infectious disease in community ● Survey based on contagious diseases in local community ● Student seminar on Zoonosis, bioweapons	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Classify the types of pathogens and disease caused by them	R, U	1
CO-2	Explain the cause, symptom and mode of transmission of contagious diseases	R, U	2,3
CO-3	Identify the different diagnostic markers of contagious diseases	R,U	2
CO-4	Describe the strategies for management of infectious diseases.	R, U	3,4
CO-5	Examine the prevalence of common contagious diseases in society	R, U, Ap, An	3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-

Create Name of the Course: Biochemistry of Contagious Diseases:

Current Scenario Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R,U	F, C	LT	
2	2	2,3	R,U	F, C	LT	
3	3	2	R,U	F, C	LT	
4	4	3,4	R,U	F, C	LT	
5	5	3	R,U,Ap,An	F, C	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-		2				
CO 2		2	3	-	-	-	2	2		2		3
CO 3	-	3	-	-	-	-						3
CO 4	-	-	2	3	-	-	3	2		3		3
CO 5	-	-	3	-	-	-	2	2		3		
CO 6	-	-	-	-	-	-						

Correlation Levels:

Level	Correlation

-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

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2. Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.

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4. Jawetz, Melnick & Adelbergs (27th ed.), Medical Microbiology. McGraw Hill Education. ISBN-10: 0071790314; ISBN-13: 978-007179031.

5. Biochemistry With Clinical Concepts And Case Studies: Satyanarayana, U & Chakrapani, U, Elsevier India PVT LTD, 4th Ed. 2016.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1MDCBCH101				
Course Title	**Nutritional Biochemistry for Health & Fitness**				
Type of Course	MDC2				
Semester	I				
Academic Level	100 -199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Nil				
Course Summary	The course outlines a general introduction to metabolism, role of nutrition in health, biochemical response to exercise and dietary management of health and disease.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Metabolism**		**6**
	1	Definition and significance of Metabolism	
	2	Anabolism and Catabolism	

	3	Basic awareness about energy yielding metabolic pathways (Reaction sequence not required).	
	4	Significance of ATP as energy currency	
	5	Phosphocreatine system (basic idea)	
II	**Nutrition for Health**		**6**
	6	Basic concept and definition of balanced diet, calorific value, SDA and RDA	

	7	Macronutrients: Requirement of carbohydrates, proteins and lipids for health and fitness. Glycemic index, biological value of protein (definition).	
	8	Micronutrients (vitamins and minerals): Sources and functions	
	9	Water: Hydration and electrolyte balance.	
	10	Food guide pyramid, seasonal foods and traditional foods	
III	**Biochemical Response in Exercise**		**6**
	11	Physiological responses to exercise and physical activity.	
	12	Glycolytic system and oxidative system: as primary energy source	
	13	Role of carbohydrates, fats, and proteins in exercise metabolism	
	14	Metabolic adaptations to aerobic and anaerobic exercise.	
	15	Impact of exercise on hormones and neurotransmitters: dopamine, serotonin, oxytocin and endorphins (feel good hormones)	
IV	**Nutritional Management in Health and Disease**		**6**
	16	Nutritional considerations for weight management and body composition goals	
	17	Role of nutrition in metabolic syndrome, diabetes, and cardiovascular health	
	18	Dietary approaches for managing inflammation	
	19	Nutritional interventions for common sports injuries and musculo-skeletal health	

V	**Gut Microbiome**		**6**
	20	Gut microbiome	
	21	Gut brain axis	
	22	Prebiotics and probiotics (artificial and natural)	
	23	Microbial dysbiosis, Disorder associated with gut microbiome	
	24	Recent advance in microbiome research: Pharma biotics and Poop pill	
		Activities	**15**
	25	1. Diet chart preparation 2. Study of impacts of exercise on emotions (questionnaire method) Questionnaire on nutritional status in community (maintenance of record)	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Summarize the basic concepts of metabolism related to energy production	R, U	1
CO-2	Associate the major proximate principles of food to health and fitness	R, U	2,3
CO-3	Describe the physiological and biochemical response of the body to exercise	R, U	3
CO-4	Recognise the importance of nutrition in the management of health and disease	R, U	2,3

CO-5	Discuss the latest developments in the concepts of gut microbiome.	R, U	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Nutritional Biochemistry for Health and Fitness

Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R, U	F, C	LT	
2	2	2,3	R, U	F, C	LT	
3	3	3	R, U	F, C	LT	
4	4	2,3	R, U	F, C	LT	
5	5	2	R, U	F, C	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-		2				
CO 2	-	2	3	-	-	-	2	2		2		3
CO 3	-	-	3	-	-	-	2	3		2		
CO 4	-	3	-	3	-	-		2				3
CO 5	-	2	-	-	-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Textbook of Human Nutrition. Anjana Agarwal and Shobha A Udipi. Jaypee Brothers Medical Publishers (P) Ltd.
2. Nutrition (4th edition). Insel P, Ross D, McMahon K and Bernsteind M. Jones and Bartlett Publishers. Boston 2012 , 387-502.
3. Eastwood, M. (2003). Principles of Human Nutrition. Atlantic Publishers & Distributors.
4. Vitamins in Health and Disease.Kulkarni ML. Jaypee Brothers Medical Publishers (P) Ltd
5. Krause, L., & Mahan, S. (Eds.). (1992). Food, nutrition, and diet therapy (6th ed.). W.B. Saunders Company.
6. Handbook of Foods And Nutrition. Blank, F. C. (2007). Agrobios (India)
7. Srilakshmi, B. (2014). Food Science. New Age International Publishers (India).
8. Health, Nutrition And Diseases.Chatterjee, G. (2000). Rajat Publication

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1MDCBCH102				
Course Title	**Biochemical Applications in Forensics**				
Type of Course	MDC3				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites	Nil				
Course Summary	The course provides an understanding of the applications of biochemistry in forensic sciences through analysis of evidence, which will help students develop analytical and problem solving skills for real life situations. The course also deals with all recent developments and emerging trends in forensic science thus helping interested students take up forensic science as future course of study.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Forensic Sciences**		**6**
	1	Basic Principles and Significance; History and Development of Forensic Science	
	2	Defining the scene of investigation; Collection, Packaging, Labelling and Forwarding of biological exhibits to forensic laboratories	
	3	Preservation of biological evidence	
	4	Importance of Health and Safety Protocols in sample collection and analysis.	
II	**Biological Science and its Application in Investigation**		**6**
	5	Biochemical analysis of various biological evidences like blood, semen & other biological fluids, viscera, bite marks, hair (animal and human), fibers & fabrics, pollen and soil	
	6	Establishment of identity of individuals - fingerprints, footprints, blood and DNA analysis	
	7	Anthropology – skeletal remains, Odontology; Time of death - rigor mortis, liver mortis, algor mortis, forensic entomology.	

	8	Biochemical basis for determination of cause of death, case studies	
III	**Chemical Science And Its Application In Investigation**		**7**
	9	Detection of drugs of abuse and narcotics in biological samples;	
	10	Toxicological examination of viscera, detection of petroleum products	
	11	Food adulteration; Analysis of inks and their use in questioned document identification	
	12	Blood spatter analysis, stain analysis, case studies.	
IV	**Recent Advances in Forensics**		**8**
	13	Narco analysis: theory, forensic significance, future prospect	
	14	Brain mapping: introduction, EEG, P-3000 wave, forensic applications, limitation of technique	
	15	Polygraph: Principle and technique, polygraph as forensic investigative tool	
	16	Use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test	
	17	Facial reconstruction: Method and technique, facial reconstruction in forensic identification	
V	**Case studies**		**3**
	18	DNA Fingerprinting; DNA-Introduction, source of DNA in Forensic case work, Extraction of DNA	
	19	Techniques of DNA fingerprinting RFLP, STR, PCR	
	20	DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, case studies.	
		Practicals/Activities	15
	21	1. TLC method for differentiation of ink/drugs 2. Microscopic examination of hair/fiber/pollen/diatom 3. Examination of blood samples: Blood grouping, 4. Field trip to a forensic laboratory. 5. Guest lectures from forensic scientists or practitioners	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand Basic Principles and Significance along with History and Development of Forensic Science & Importance of Health and Safety Protocols in sample collection and analysis.	U	1,2
CO-2	Analyse various biological evidences & evaluate establishment of identity of individuals & Biochemical basis for determination of cause of death	E, An	3
C0-3	Understand the role of Chemical science and its application in investigation & detection of drugs of abuse and narcotics & about food adulteration	U,Ap	2,3
CO-4	Understand recent advances in forensics	U	3,4
CO-5	Apply various techniques in the field of forensics for Case studies	U, Ap	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biochemical Applications in Forensics

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	U	F, C	LT	
2	2	3	E, An	F, C	LT	
3	3	2,3	U,Ap	F, C	LT	
4	4	3,4	U	F, C	LT	
5	5	3,4	U, Ap	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6

CO 1	2	-	-	-	-	-	-	-	-	-	-	2
CO 2	-	2	3	-	-	-	1	2	-	-	-	-
CO 3	-	-	2	3	-	-	-	-	-	-	-	3
CO 4	-	-	2	3	-	-						
CO 5	-	1	3	2	-	-	-	-	-	-	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam- Multiple choice/case studies
- Programming Assignments
- Final Exam- Multiple choice/case studies

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. James, S. H., Nordby, J. J. & Bell, S. (2014). Forensic Science: An Introduction to Scientific and Investigative Techniques, Fourth Edition: Taylor & Francis. ISBN 9781439853832

2. Jones, P., & Williams, R. E. (2009). Crime Scene Processing and Laboratory Workbook First Edition: CRC Press. ISBN 9780429249976

3. Lee, H., Palmbach, T. & Miller, M. (2001). Henry Lee's crime scene handbook, First Edition: Academic Press ISBN 9780080507989

4. Parikh, C. K. (2016). Parikh's textbook of medical jurisprudence, forensic medicine and toxicology : for classrooms and courtrooms, Seventh Edition: CBS Publishers and Distributors. ISBN 9788123926469

5. Saferstein, R. (2018). Criminalistics: An Introduction to Forensic Science, Twelveth edition: Pearson Education. ISBN 10:0134477596, ISBN 13: 9780134477596

6. Tewari, R. K., Sastry P. K., Ravikumar, K. V. (2002). Computer Crime and Computer Forensic, First Edition: Selective & Scientific Books

7. Veeraraghavan, V. (2009). Handbook of Forensic Psychology, First Edition: Selective & Scientific Books.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK1DSCBCH100				
Course Title	**INTRODUCTION TO BIOMOLECULES**				
Type of Course	**DSC7**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in Biology and Chemistry				
Course Summary	Students will get an understanding of the different types of biomolecules that make up living things. The structure, characteristics, and significance of lipids, cholesterol, proteins, carbohydrates, and DNA/RNA in biological systems will all be taught to the students.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**NUCLEIC ACID**	**6**
	1	Chemical nature of nucleic acids- nitrogenous bases-purines and pyrimidines, nucleosides, nucleotides. Phosphodiester linkages.	
	2	Watson-Crick model of DNA, Chargaff rule of base pairing,	
	3	Different types & structure of RNA	
II		**CARBOHYDRATES**	**12**
	4	Classification of carbohydrates	
	5	Monosaccharides (glucose & fructose- Open & Haworth structure), disaccharides- lactose and sucrose- Haworth structure), trisaccharide - trehalose, Polysaccharide- starch & glycogen- Haworth structure)	
	6	Epimers, enantiomers, diastereomers	
	7	Anomerism and mutarotation	
III		**LIPIDS**	**10**
	8	Classification of lipids- Simple, Compound, Derived lipids -with one example (structure of triglycerides, lecithin, cephalin), Basic structure of sphingolipids-significance of sphingomyelin	
	9	Structure and classification of fatty acids- saturated, unsaturated; essential and non-essential, PUFA (one example each).	

	10	Sterol- (structure and functions of cholesterol)	
IV	**AMINO ACIDS**		**10**
	11	Nomenclature and classification of amino acids based on the chemical nature of R groups (structure not needed), polarity, metabolic fate and nutritional classification	
	12	Single letter and three letter representation (Alanine, Serine, Cystein, Glutamate, Lysine, Phenylalanine and Proline)	
	13	Isoelectric pH, Zwitter ion (cite example-alanine)	
	14	Non protein amino acids- significance of ß-alanine, homocysteine. Rare amino acids-hydroxy proline, hydroxylysine (structure not needed)	
	15	Peptide- significance of glutathione, aspartame, gramicidin (structure not needed)	
V	**PROTEINS**		**7**
	16	Classification of proteins	
	17	Different levels of protein organization- Primary (Significance citing Sickle cell anaemia as an example), Secondary- alpha, beta, triple helix, Tertiary and Quaternary-(elementary ideas only- structure not needed)	
		Practical (Identification of Biomolecules: Preliminary tests)	**30**
	18	Preparation of reagents	
	19	Qualitative analysis of Carbohydrates- Solubility test, Molisch's test, reduction test (Benedicts, Fehlings, Barfoeds, Picric acid test) and starch (Iodine test).	
	20	Qualitative analysis of Amino acids and protein: Amino acids: Solubility test, ninhydrin test. Protein: Solubility, Xanthoproteic test, Biuret, Folin's test	
	21	Qualitative analysis of fatty acids: Solubility test, test for unsaturation	
Students must maintain a rough record for practicals.			

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand thorough explanations of the chemistry, function and classification of nucleic acids	U	1
CO-2	Describe the general reactions, structure and classification of carbohydrates and lipids	R,U	1,2
CO-3	To acquire knowledge on classification, physicochemical properties and characterization of amino acids and proteins	U,E	2
CO-4	Familiarize and distinguish the biomolecules through specific colour reactions	U,A	3,4
C0-5	To differentiate different biomolecules	An	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Introduction to Biomolecules

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	U	F, C	LT	
2	2	1,2	R, U	F, C	LT	
3	3	2	U, E	F, C	LT	
4	4	3,4	U, Ap	F, C	LT	
5	5	2	An	P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of Cos with PSOs and Pos :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-		3				
CO 2	2	3	-	-	-	-						3
CO 3	-	-	1	-	-	-	1	2		2		
CO 4	-	-	2	3	-	-		2		2		2
CO 5	-	3	-	-	-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

REFERENCES

- Nelson D. L., Cox M. M. (2021) Lehninger Principles of Biochemistry, (8th ed.) W.H. Freeman &. Co Ltd.
- Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.2.
- J L Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry Paperback – 1 January 2016; ISBN : 9788121924535
- Thomas M. Devlin (Editor) Textbook of Biochemistry with Clinical Correlations, 7th Edition, ISBN, 9789354641558. Publisher, Wiley Blackwell. Year, 2022.
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana, ISBN 81-7663-067-5.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK2DSCBCH101				
Course Title	**STRUCTURE OF BIOMOLECULES**				
Type of Course	**DSC**8				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. 2.				
Course Summary	Students will acquire an insight into various biomolecules that constitute the living organisms. Students will learn the structure and properties of carbohydrates, amino acids, proteins, lipids, cholesterol, DNA, RNA, and their importance in biological systems.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Nucleic acids**		**8**
	1	Structure of Ribose, deoxyribose and Nitrogenous Bases (A, G, C, T, U)	
	2	Structure of nucleoside and nucleotide (AMP, ATP)	
	3	Double helical structure of DNA	
	4	Structure of tRNA	
II	**Amino acids**		**10**
	5	Structure of aliphatic amino acids (Alanine, valine)	
	6	Structure of aromatic amino acids (Tyrosine, Tryptophan)	
	7	Structure of Sulphur containing amino acids (Cysteine, Methionine)	
	8	Structure of hydroxy amino acids (Serine, threonine)	
	9	Structure of basic and acidic amino acids (Lysine, Glutamate)	
	10	Structure of Imino acids (Proline)	
III	**Proteins**		**8**
	11	Structure of Insulin	
	12	Structure of Myoglobin	
	13	Structure of Hemoglobin	

IV	**Carbohydrates**		**9**
	14	Structure of Monosaccharides (Glucose, Fructose)	
	15	Structure of Disaccharides (Sucrose, Lactose)	
	16	Structure of Trisaccharides (Trehalose)	
		Structure of Polysaccharides (Glyocogen, Starch)	
V	**Lipids**		**10**
	17	Structure of Triglycerides (Simple. Mixed)	
	18	Structure of Fatty acids (Palmitic acid, Oleic acid)	
	19	Structure of Phospholipid (Lecithin, Cephalin)	
	20	Structure of Cholesterol	
		Practical	**30**
	21	Preparation of reagents	
	22	Qualitative analysis of Carbohydrates- Solubility test, Molisch's test, reduction test (Benedicts, Fehlings, Barfoeds, Picric acid test) and starch (Iodine test).	
	23	Qualitative analysis of Amino acids and protein: Amino acids: Solubility test, ninhydrin test. Protein: Solubility, Xanthoproteic test, Biuret, Folin's test	
	24	Qualitative analysis of fatty acids: Solubility test, test for unsaturation	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To acquire knowledge on the structure of nucleic acids , aminoacids and proteins	R, U	1,2
CO-2	Describe the general reactions, structure and classification of carbohydrates and lipids	R,U	1,2
CO-3	To acquire knowledge on classification, physicochemical properties and characterization of amino acids and proteins	U,E	2
CO-4	Familiarize and distinguish the biomolecules through specific colour reactions	U,A	3,4
C0-5	To differentiate different biomolecules	An	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Structure of Biomolecules

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	R, U	F, C	LT	
2	2	1,2	R,U	F, C	LT	
3	3	2	U,E	F, C	LT	
4	4	3,4	U,A	F, C	LT	
5	5	2	An	P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-		3				
CO 2	2	3	-	-	-	-						3
CO 3	-	-	1	-	-	-	1	2		2		
CO 4	-	-	2	3	-	-		2		2		2
CO 5	-	3	-	-	-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M.Cox. Publisher: W. H. Freeman; Fourth Edition (April 23, 2004).
2. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.
3. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
4. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana, ISBN 81-7663-067-5

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK2DSCBCH102				
Course Title	**BIOMOLECULES IN LIVING ORGANISMS**				
Type of Course	**DSC**9				
Semester	II				
Academic Level	100-199**.**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	Students will acquire an insight into various biomolecules that constitute the living organisms. Students will learn the structure and properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, and their importance in biological systems				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**NUCLEIC ACID, AMINO ACIDS AND PROTEINS**		**15**
	1	Chemical nature of nucleic acids- nitrogenous bases- purines and pyrimidines, Nucleosides, Nucleotides; Phosphodiester linkages, Nucleotides as Energy carriers, Enzyme cofactors and Chemical messengers	

	2	Watson-Crick model of DNA, Chargaff rule of base pairing, Different types & structure of RNA	
	3	Nomenclature and classification of amino acids based on the chemical nature of R groups (structure not needed), Essential and non-essential amino acids	
	4	Physical & chemical properties of amino acids- isoelectric pH, transamination, oxidative deamination, decarboxylation & peptide bond formation	
	5	Classification, Structure and Physicochemical properties; Peptide bond, Peptides of biological importance, Different levels of protein organization with one example	
II	**CARBOHYDRATES**		**15**
	6	Classification, Physicochemical properties; Chemistry, Biological roles Monosaccharides (glucose & fructose- Open & Haworth structure), oligosaccharide (disaccharides- lactose, sucrose & maltose- Haworth structure) Polysaccharide- homo and heteropolysaccharides, (starch & glycogen- Haworth structure)	
	7	Hemiacetal formation, Anomers, Epimers, mutarotation, Chemical reactions of monosaccharides taking glucose as example (enediol formation, oxidation with acids (mild and strong), oxidation with metal hydroxides (Fehling's, Benedicts & Barfoeds tests), reduction reactions (with sodium amalgam, strong mineral acids & dilute alkali), reaction of different carbohydrates with phenyl hydrazine (ozazone formation)	
III	**LIPIDS**		**15**
	8	Classification of lipids- Simple. Compound, Derived with one example (structure needed- triglycerides, lecithin, cephalin), significance of sphingomyelin- structure is not needed)	
	9	Classification; Structure, Properties and Biological roles of Phospholipids and Sphingolipids; Fatty acids and their physicochemical properties; Fats and Waxes -Physicochemical properties and characterization of fats and oils; Classification of fatty acids- saturated, unsaturated; essential and non-essential, PUFA, general structure of fatty acids	
	10	Sterol- (structure and functions of cholesterol)	5
IV	**AN INTRODUCTION TO BIOCHEMISTRY LABORATORY**		**15**
	12	Preparation of solution- normality, molarity, percentage, dilution of solutions	
	13	General reactions of Carbohydrates, and lipids	
	14	General reactions of Amino acids, Proteins	

V	**QUALITATIVE ANALYSIS OF BIOMOLECULES**		**15**
	15	Specific reactions of sugars (glucose, fructose, lactose, sucrose), amino acids (cysteine, proline, tyrosine, tryptophan)	
	16	Analysis of protein & cholesterol	
	17	Analysis of saturated and unsaturated fatty acids	
	18	Systematic analysis of biomolecules	

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To understand the structure of DNA and RNA and their types & To present fundamental ideas about the structural arrangement and categorization of proteins	U	PSO-1,2
CO-2	Explain the structure, classification, and general reactions of carbohydrates.	R, U	1,2
CO-3	to learn about the physicochemical characteristics and attributes of fats and oils	U,	1,3
CO-4	to impart to the students all the knowledge they require regarding the laboratory	U,R	2,3,4
CO-5	Learn about and differentiate the biomolecules using a particular colour reaction.	U, Ap	2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biomolecules in living Organisms

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	U	F, C	LT	
2	2	1,2	R, U	F,C	LT	
3	3	1,3	U,	F,C	LT	
4	4	2,3,4	U,R	F,C	LT	
5	5	2,3,4	U, Ap	F,C,P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of Cos with PSOs and Pos :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-			1	2		2		3
CO 2	2	3	-	-				2				3
CO 3	2	-	1	-			1	2		3		
CO 4	-	1	2	3				2				3
CO 5	-	1	2	3			1	2		3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of Cos to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

REFERENCES

1. Nelson D. L., Cox M. M. (2021) Lehninger Principles of Biochemistry, (8th ed.) W.H. Freeman &. Co Ltd.
2. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
3. Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.2.
4. J L Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry Paperback – 1 January 2016; ISBN : 9788121924535
5. Thomas M. Devlin (Editor) Textbook of Biochemistry with Clinical Correlations, 7th Edition, ISBN, 9789354641558. Publisher, Wiley Blackwell. Year, 2022.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK114DSCBCH				
Course Title	**BIOCHEMISTRY OF HEALTH AND DISEASES**				
Type of Course	**DSC**10				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NIL				
Course Summary	The course is intended to give the student an understanding of biochemical testings done in a clinical laboratory that will aid in diagnosis thus facilitating accurate, efficient monitoring and treatment of various diseases				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Elements of Clinical Biochemistry**	**9**
	1	Clinical Biochemistry: Scope and applications in diagnosis	
	2	Clinical implications of biomolecules: Glucose; Hyper and hypoglycemia. Lipids; Hyperlipidemia. Proteins; hypoalbuminemia, Bence jones proteins	
	3	Quality control in a clinical laboratory: Basics	
II		**Biochemistry of metabolic diseases**	**9**
	4	Atherosclerosis, Diabetes mellitus	
	5	Obesity and metabolic syndrome	
	6	Metabolic diseases leading to hyperbilirubinemia	
	7	Inborn errors of metabolism (carbohydrates and amino acid)	
	8	Instrumentation in clinical biochemistry (Basic study)	
III		**Endocrine diseases**	**9**
	9	Principal endocrine glands, hormones and their physiological functions: Hypothalamic, pituitary, Thyroid, parathyroid, adrenal, pancreas, Testis, Ovary and GI hormones	
	10	Diseases of the hypothalamus – pituitary system; Biochemical features of Prader-Willi syndrome, acromegaly, Diabetes insipidus	

	11	Thyroid diseases: Hypo and hyperthyroidism, biochemical features, T3,T4, TSH values in health and disease conditions.	
	12	Adrenal diseases and hormone assays	
IV	**Organ function tests and detoxification**		**9**
	13	Liver: major functions and LFT	
	14	Kidney: Structure of nephron, Urine formation and RFT	
	15	Xenobiotics, Major reactions for detoxification in liver	
V		**Molecular diagnostics**	**9**
	16	Advantages and features of molecular diagnostics	
	17	Important molecular tests for diagnosis: PCR,FISH,ELISA	
	18	Isoenzymes and their clinical significance, Enzymes as therapeutic agents	
	Practicals: Biomolecules		**30**
	19	Qualitative analysis of abnormal constituents in urine and blood. Quantitative estimation of glucose and protein in blood	
	20	Institute/Lab visit	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the fundamental aspects of a clinical laboratory	U, R An	1,2
CO-2	Interpret and analyse blood analysis of various biochemical parameters	E, An, U	1,2,3
CO-3	Evaluate the results of LFT, RFT and endocrine parameters which will help to identify and monitor various diseases	E, Ap, An	2,3,4
CO-4	Attain proficiency in various molecular diagnosis methods	R, U, Ap	4
CO-5	Analysis of abnormal constituents in urine and blood	An	2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: BIOCHEMISTRY OF HEALTH AND DISEASES

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

1	1	1,2	U, R An	F, C	LT	
2	2	1,2,3	E, An, U	F, C	LT	
3	3	2,3,4	E, Ap, An	F, C	LT	
4	4	4	R, U, Ap	F, C	LT	
5	5	2,4	An	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	3	-	-	-	-						3
CO 2	1	2	3	-	-	-	2	3				
CO 3		1	2	3	-	-		2		2		2
CO 4	-	-	-	3	-	-		2		2		
CO 5	-	2	-	2	-	-		2		2		2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	**Moderate** / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

REFERENCES

1. "Tietz Textbook of Clinical Chemistry and Molecular Diagnostics" by Nader Rifai, Andrea Rita Horvath, and Carl T. Wittwer - Latest edition: 2017
2. "Marks' Basic Medical Biochemistry: A Clinical Approach" by Michael Lieberman and Alisa Peet - Latest edition: 2020
3. "Textbook of Biochemistry with Clinical Correlations" by Thomas M. Devlin - Latest edition: 2010
4. "Clinical Chemistry: Principles, Techniques, Correlations" by Michael L. Bishop, Edward P. Fody, and Larry E. Schoeff - Latest edition: 2018
5. "Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications" by Lela Buckingham and Maribeth L. Flaws - Latest edition: 2017

Discipline	BIOCHEMISTRY				
Course Code	UK115DSCBCH				
Course Title	Biochemical aspects of metabolic regulators				
Type of Course	**DSC**10				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in Biology and Chemistry				
Course Summary	The course helps to understand the fundamental biochemical aspects of enzymes vitamins, minerals and hormones exploring their roles in maintaining physiological balance and supporting essential cellular functions.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Enzymes-I**		**6**
	1	Definition and classification of enzymes	
	2	Definition of apoenzyme, holoenzyme, prosthetic group and coenzymes	
	3	Features of active site	
	4	Theories of enzyme-substrate binding (Lock and key hypothesis, Koshland's induced fit model	
II	**Enzymes-II**		**8**
	5	Factors affecting enzyme catalysed reaction	
	6	Km value and its significance	
	7	Enzyme inhibition (reversible-competitive, non-competitive and uncompetitive and irreversible with one example each)	
III	**Vitamins**		**12**
	8	Sources, RDA, functions and deficiency manifestations of fat-soluble vitamins	
	9	Sources, RDA, functions and deficiency manifestations of water-soluble vitamins	
IV	**Minerals**		**9**
	10	Sources, RDA, functions and deficiency manifestations of Sodium, Potassium, Calcium, Phosphorous, Iron, Iodine and Zinc	
V	**Hormones**		**10**
	11	Classification and mechanism of action of hormones (outline only)	
	12	Site of biosynthesis and functions of thyroid hormones, pituitary hormones (TSH, ACTH, oxytocin and vasopressin), hormones of adrenal gland and pancreatic hormones (insulin and glucagon)- Structure not needed	

	13	Common hormonal imbalances- hyperthyroidism, hypothyroidism, Addison's diseases, Cushing's disease, Diabetes mellitus, Diabetes insipidus and PCOD.	
		Practicals	30
	14	Preparation of stock and working standard solutions	
	15	Isolation of amylase from sweet potato	
	16	Estimation of solid ash in milk.	
	17	Estimation of ascorbic acid in orange juice	
	18	Estimation of iron in Amaranthus leaves	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Definition, classification , active site and theories of enzyme activity	R,U	1
CO-2	Factors of enzyme activity, types of enzyme inhibition and regulation	R.U	1,2
CO-3	Elaborate the importance of human nutrition	R,U	1,3,4
CO- 4	Classify hormones and explain the functions of hormones	R,U	1,3,4
CO-5			

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-

Create Name of the Course: Biochemical aspects of metabolic regulators

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R,U	F, C	LT	

2	2	1,2	R.U	F, C	LT	
3	3	1,3,4	R,U	F, C	LT	
4	4	1,3,4	R,U	F, C	LT	
5	5			F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	-	-	-	-		2				
CO2	2	3	-	-	-	-						3
CO3	1	-	2	3	-	-	2	2		3		
CO4	1	-	2	3	-	-		2				2
CO5	-	-	-	-	-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

- Arthur Vander, James Sherman, and Dorothy Luciano Vander et al. Human Physiology: The Mechanism of Body Function, Eighth Edition , The McGraw-Hill Companies.
- Granner, Robert K. Murray Darryl K., and Peter A. Mayes Victor W. Rodwell. Harper's Illustrated Biochemistry (Harper's Biochemistry).McGraw-Hill Medical, 2006
- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.
- Advanced Text Book on Food and Nutrition, Vol I and II, Dr. M Swaminathan.2nd edition. The Bangalore Printing and Publishing Co Ltd.
- Food Safety and Standards Authority of India. Ministry of Health and Family Welfare, Government of India
- Food Science. 2nd edition, SR Mudambi, SM Rao and MV Rajagopal (2006). New Age International Pvt.Ltd. ISBN-81-224-1779-5
- Laboratory Handbook on Biochemistry. S.Shanmugam, J.Satish Kumar,K. Paneer Selvan Publisher: PHI Learning Private Limited New Delhi ISBN 976-81-2030-4103-

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK2DSCBCH105				
Course Title	**MOLECULES OF LIFE**				
Type of Course	**DSC**12				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	This course will help to create a strong foundation in biochemistry for students, with a focus on basic biomolecules. The course also covers the basics of qualitative analysis of biomolecules.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Amino acids and proteins**	**10**
	1	General Structure and Function of aminoacids	
	2	Standard and non protein amino acids (2 examples each)	
	3	Single letter and three letter representation (Alanine, Serine, Cysteine, Glutamate, Lysine, Phenylalanine and Proline)	
	4	Zwitter ionic form and isoelectric pH (significance)	
	5	Essential and non-essential aminoacids	
	6	Classification of Proteins (Structural, Functional and nutritional)	
	7	Structural organization of proteins (basics only)	
	8	Basic functions of Plasma proteins	
		Carbohydrates	**10**
	9	Monosaccharides – glucose and fructose (Open and Haworth projection formula). D & L isomerism, epimers, anomers and mutarotation	
	10	Disaccharides – lactose, sucrose (Components, bond involved and occurrence)	
II	11	Polysaccharide: Structural and storage polysaccharides (Cellulose, glycogen and starch-Components, bond involved and occurrence)	

III		**Lipids**	**9**
	12	Basic functions of lipids	
	13	Essential and non-essential fatty acids	
	14	Structure and function of triglycerides (simple triglyceride)	
	15	Structure and function of phospholipids (Lecithin)	
	16	Structure and functions of cholesterol.	
IV		**Nucleic acids**	**6**
	17	Base composition, Purines and pyrimidines (names only)	
	18	Nucleosides & Nucleotides (Basic structure)	
	19	Basic structural features of B-DNA	
	20	Basic function of mRNA, tRNA and rRNA	
V		**Enzymes**	10
	21	Basic difference between chemical and biological catalyst	
	22	Concept of holoenzyme, apoenzyme, prosthetic group (with suitable example) and active site of enzyme	
	23	Lock and Key hypothesis, Koshland hypothesis	
	24	Units of enzyme activity-IU	
	25	Competitive inhibition-significance (with reference to Ethanol in methanol poisoning)	
	26	Therapeutic enzymes (Basic idea on application of Urokinase and Lipase)	
	27	Industrial enzymes (Basic idea on application of Lipase and pectinase)	
		Practicals: Biomolecules	**30**
	28	Qualitative analysis of Carbohydrates- Solubility test, Molisch's test, reduction test (Benedicts, Fehlings, Barfoeds, Picric acid test) and starch (Iodine test). Qualitative analysis of Amino acids and protein: Amino acids: Solubility test, ninhydrin test. Protein: Solubility, Xanthoproteic test, Biuret, Folin's test Qualitative analysis of fatty acids: Solubility test, test for unsaturation	
		Rough record for Practical work has to be maintained	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basic molecules that make up life	U	1
CO-2	Evaluate the structure of carbohydrates, lipids, amino acids , proteins and nucleic acids	R, U,E	1,2
CO-3	Acquire an understanding of enzymes, activity and applications	U, A, E	3,4

CO-4	Analyse qualitatively some important biomolecules in the laboratory	U,A,C	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Molecules of Life Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	U	F, C	LT	
2	2	1,2	R, U,E	F, C	LT	
3	3	3,4	U, A, E	F, C	LT	
4	4	3,4	U,A,C	F, C	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-	2	3		2		
CO 2	2	3	-	-	-	-						3
CO 3	-	-	2	3	-	-	2	3		2		
CO 4	-	-	2	3	-	-	2	3		2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

REFERENCES

1. Nelson D. L., Cox M. M. (2021) Lehninger Principles of Biochemistry, (8th ed.) W.H. Freeman &. Co Ltd.
2. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
3. Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.2.
4. J L Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry Paperback – 1 January 2016; ISBN : 9788121924535
5. Thomas M. Devlin (Editor) Textbook of Biochemistry with Clinical Correlations, 7th Edition, ISBN, 9789354641558. Publisher, Wiley Blackwell. Year, 2022.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK2MDCBCH100				
Course Title	**Biochemistry of Lifestyle Diseases**				
Type of Course	MDC4				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	1	3
Pre-requisites	NIL				
Course Summary	The course covers fundamental concepts of lifestyle-related diseases such as cardiovascular diseases, diabetes, cancer, and chronic respiratory diseases, including their causes, diagnosis, prevention, and management. Specific topics include obesity classification, coronary artery diseases, cancer types and risk factors, diabetes mellitus types and diagnostic methods, and chronic respiratory disease prevention. Course activities include surveys on modern lifestyle and visits to Primary Health Centers for practical understanding.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**LIFE STYLE: BASIC CONCEPTS**		**6**
	1	Definition of health, Definition of lifestyle diseases/noncommunicable diseases - four major types of diseases-CVD, Diabetes, Cancer, and Chronic Respiratory diseases.	
	2	Obesity: classification according to BMI (brief description) symptoms, Causes, treatment Prevention and management Sedentary life style	

	3	Significance of diet and exercise: Role of antioxidants and fibre containing food- PUFA- impact of junk foods	
II	**CORONARY ARTERY DISEASES**		**6**
	4	Coronary Artery diseases - Angina, myocardial infarction, congenital heart disease, CVD (definition).	
	5	Causes (confirmed & indirect risk factors – brief description only),	
	6	Diagnosis (electrocardiography, exercise stress test, coronary angiography -brief description only)	
	7	Prevention (lifestyle, diet, drugs), Management (drugs, angioplasty, stenting, bypass surgery- brief description only): Normal value of cholesterol in blood	
III	**CANCER**		**7**
	8	Cancer - Types of cancer, benign and malignant tumor	
	9	Risk factors-tobacco and alcohol abuse, lack of physical activity and unhealthy food habits : GTT	
	10	Diagnosis- blood tests, X-rays, CT scans & endoscopy - brief description only	
	11	Prevention - dietary, medication, vaccination, Periodic Health Check ups , Significance of diet and exercise	
	12	Treatment modalities (name only) -surgery, chemotherapy, radiation, Management :Palliative care (brief description only).	
IV	**DIABETES MELLITUS**		**7**
	13	Diabetes mellitus: Four types of diabetes: Type 1, Type 2, Gestational, and Pre-Diabetes. Symptoms (polyuria, polydypsia, polyphagia),	
	14	Modifiable and non-modifiable risk factors.	
	15	Definition of fasting blood sugar, post prandial blood sugar, random blood sugar and their normal values.	
	16	Significance of glucose tolerance test, Drugs lowering blood glucose level (names only).	
	17	Diagnosis, prevention and management of diabetes	
V	**CHRONIC RESPIRATORY DISEASE**		**4**
	18	Definition: Chronic respiratory disease	

	19	Effect of smoking to lungs. Modifiable and Non modifiable risk factors. Prevention and management of the disease.	
	20	Activities 1. Survey of family members/ neighbors on modern lifestyle and public health issues discussed during the course. Analysis of data and its interpretation. 2. Visit to near by PHC	**15**

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify healthy and unhealthy life habits and adopt better life style.	U	1,3,4
CO-2	Enumerae the different causes and risk factors of life style diseases	R, U	1,2,3
CO -3	List out the methods to diagnose the diseases and gain a knowledge regarding interpretation of the test result.	R,U	2,3
CO -4	Spell out the methods of prevention, treatment and management of the diseases	R,U	3
CO-5	Gain knowledge about the normal levels of different clinical parameters.	R,U	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biochemistry of Lifestyle Diseases

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,3,4	U	F, C	LT	
2	2	1,2,3	R, U	F, C	LT	
3	3	2,3	R,U	F, C	LT	
4	4	3	R,U	F, C	LT	
5	5	2	R,U	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	2	3	-	-		2				
CO 2	1	2	3	-	-	-	2	2				3
CO 3	-	2	3	-	-	-	2	2				2
CO 4	-	-	3	-	-	-		2				
CO 5	-	3	-	-	-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam Multiple choice questions

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.

2. Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.

3. Cell and Molecular Biology by Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.

4. Guyton, A., & Hall, J. E. (1996). Textbook of Medical Physiology (9th edition). Prism Saunders.

5. Satyanarayana, U., & Chakrapani, U. (2021). Essentials of Biochemistry (3rd ed.).

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK2MDCBCH101				
Course Title	**Biochemistry of Food Adulteration**				
Type of Course	MDC5				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Nil				
Course Summary	The course on food adulteration provides an overview of common adulterants and their toxic effects, covering categories such as physical, chemical, and biological hazards. Students learn to identify adulterants in various food items, including milk, edible oils, spices, and condiments, and				

	understand the ill effects they may cause, ranging from gastrointestinal disorders to diabetes and cardiovascular diseases. Additionally, the course delves into food safety management systems .

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**FOOD ADULTERATION**		**6**
	1	FSSAI definition of an adulterant, Familiarisation of common adulterants	
	2	Basic concepts of toxicity and hazard (physical, chemical and biological) in food	
II	**COMMON FOOD ADULTERANTS**		**6**
	3	Adulterants in milk, edible oils, fats, cereal flour, sugar, pulses, cereals, green vegetables and honey	
	4	Adulterants in Spices and condiments (turmeric powder, chilli powder, coriander powder, black pepper powder, asafoetida, cinnamon)	
III	**TOXICITY OF ADULTERANTS**		**8**
	5	Ill effects of adulterants- Diarrhea and nausea	
	6	Gastrointestinal and kidney disorders	
	7	Skin and allergic reactions	
	8	Diabetes and cardiovascular disorders	
IV	**FOOD SAFETY AND QUALITY MANAGEMENT**		**10**
	9	Food quality and safety management systems: Good Manufacturing Practices (GMP) and Good Handling Practices (GHP)	
	10	Product certification/grading – BIS and AGMARK (basic approach only)	
	11	Brief study of the following: FSSAI, PFA 1954, FSSA 2006, FPO and essential commodities act.	
V	**DETECTION OF ADULTERANTS [With demonstration]**		**15**
	12	Adulterants in milk – cane sugar, starch, urea, ammonium compounds, NaCl	
	13	Detection of metanil yellow in condiments and jaggery	
	14	Detection of sodium bicarbonate (in flour & jaggery)	
	15	Detection of added sugar (in honey)	

	16	Detection of prohibited colors in edible oil	
	17	Detection of rhodamine-B (in chilli powder)	
	18	Detection of lead chromate in pulses	
	19	Detection of starch in ghee	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the definition of adulterants and basic concepts of hazard	U	1
CO-2	Identify the common adulterants in food.	U	1,2,3
CO-3	understand the harmful effects caused by food adulterants	R, U	3
CO-4	Explain the importance of food safety and management systems	R.U	3,4
CO-5	perform some of the basic test to find out common adulterants	R,U,E	4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-

Create Name of the Course: Biochemistry of Food Adulteration

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	U	F, C	LT	
2	2	1,2,3	U	F, C	LT	

3	3	3	R, U	F, C	LT	
4	4	3,4	R.U	F, C	LT	
5	5	4	R,U,E	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	3	-	-	-	-	-		2				
CO 2	1	2	3	-	-	-	1	2		2		
CO 3	-	-	3	-	-	-						
CO 4	-	-	2	3	-	-		2		2		
CO 5	-	-	2	3	-	-	2	2		2		

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar

- Midterm Exam
- Programming Assignments
- Final Exam Multiple choice questions

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Food Safety and Standards Authority of India. Ministry of Health and Family Welfare, Government of India

2. Food Science. 2nd edition, SR Mudambi, SM Rao and MV Rajagopal (2006). New Age International Pvt.Ltd. ISBN-81-224-1779-5

3. Food Science- Chemistry and Experimental Foods. Dr. M Swaminathan, The Bangalore Printing and Publishing Co. Ltd.

4. Food Science-Experiments and Applications. Mohini Sethi and Eram S Rao. CBS Publishers and Distributors. ISBN-81-239-0747-8.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK2MDCBCH102				
Course Title	**Application of Artificial intelligence in Biomedical Science**				
Type of Course	MDC 3				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites	NIL				
Course Summary	The course covers the basics of Artificial Intelligence (AI) showing how they're used in biomedical science. Students will see how AI helps manage Alzheimer's Disorder, diabetes, and breast cancer, and aids in drug discovery and medical imaging. It also looks at how AI is used in healthcare and what challenges it faces				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**AI Foundation**		**10**
	1	AI fundamentals, Forms of AI-Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), Artificial Super Intelligence (ASI) (Definition only)	
	2	Introduction to machine learning, deep learning, and natural language processing. (Definition only)	
	3	Significance of AI in biomedical science.	
II	**Artificial Intelligence in Noncancerous and Cancerous Diseases**		**10**
	4	Management of Alzheimer's Disorder with Artificial intelligence	
	5	Management of Diabetes with Artificial Intelligence	
	6	Diagnosis of Neurological Pathologies	
	7	Artificial Intelligence in cancer detection (Breast cancer, lung cancer)	
III	**Applications of Artificial Intelligence in Biochemistry**		**12**
	9	Prediction of Long Non-Coding RNAs Based on Deep Learning	

	10	Artificial Intelligence in Protein Secondary Structure Prediction	
	11	Artificial Intelligence in Drug Discovery	
	12	Machine Learning in Enzyme Engineering	
IV	**AI in Medical Imaging and Diagnostics**		**7**
	13	Application of AI in medical imaging techniques such as MRI, CT scan, and X-ray.	
	14	Challenges and limitations of AI-based medical imaging systems.	
V	**AI in Healthcare Delivery and Patient Care**		**6**
	18	Implementation of AI in electronic health records (EHRs), clinical decision support systems, and telemedicine.	
	19	AI-based tools for monitoring patient health, detecting anomalies, and predicting health outcomes.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Recall fundamental concepts of Artificial Intelligence (AI) and its applications in biomedical science	R	1,2
CO-2	Comprehend the significance of AI in managing various medical conditions as well as its role in drug discovery and medical imaging.	U	2
C0-3	Apply AI techniques to analyze biomedical data and diagnose diseases, demonstrating their understanding of how AI can be used in real-world scenarios	Ap	2,3
CO-4	Evaluate the effectiveness and limitations of AI-based systems in healthcare delivery, identifying challenges and proposing potential solutions	An	2
CO-5	Explain approaches for using AI in biomedical research and patient care, demonstrating creativity and critical thinking skills in addressing complex healthcare challenges.	U,C	2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Application of Artificial intelligence in Biomedical Science

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	R	F, C	LT	
2	2	2	U	F, C	LT	
3	3	2,3	Ap	F, C	LT	
4	4	2	An	F, C	LT	
5	5	2,3,4	U,C	C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	-	-	2					
CO 2	-	3	-	-	2					
CO 3	-	2	3	-		2				
CO 4	-	2				3				
CO 5	-	1	3	3			3			

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium

3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam -Multiple choices/oral test
- Programming Assignments
- Final Exam -Multiple choice questions

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. James, S. H., Nordby, J. J. & Bell, S. (2014). Forensic Science: An Introduction to Scientific and Investigative Techniques, Fourth Edition: Taylor & Francis. ISBN 9781439853832
2. Jones, P., & Williams, R. E. (2009). Crime Scene Processing and Laboratory Workbook First Edition: CRC Press. ISBN 9780429249976
3. Lee, H., Palmbach, T. & Miller, M. (2001). Henry Lee's crime scene handbook, First Edition: Academic Press ISBN 9780080507989
4. Parikh, C. K. (2016). Parikh's textbook of medical jurisprudence, forensic medicine and toxicology : for classrooms and courtrooms, Seventh Edition: CBS Publishers and Distributors. ISBN 9788123926469
5. Saferstein, R. (2018). Criminalistics: An Introduction to Forensic Science, Twelveth edition: Pearson Education. ISBN 10:0134477596, ISBN 13: 9780134477596
6. Tewari, R. K., Sastry P. K., Ravikumar, K. V. (2002). Computer Crime and Computer Forensic, First Edition: Selective & Scientific Books

7. Veeraraghavan, V. (2009). Handbook of Forensic Psychology, First Edition: Selective & Scientific Books.

University of Kerala

Discipline	Biochemistry				
Course Code	UK2DSCBCH103				
Course Title	**Biochemical Aspects of Emerging and Re-emerging diseases**				
Type of Course	MDC7				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites	1. Nil				
Course Summary					

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Emerging and Reemerging infectious diseases**		**9**
	1	Definition of Emerging and Reemerging infectious diseases	
	2	Epidemiological triad of disease	
	3	Factors contributing to emergence – agents, hosts, resistance to drugs and resistance of vectors to pesticides and breakdown of public health measures	
II	**Emerging Diseases in the World**		**9**
	4	Causes, signs and symptoms, mode of transmission and preventive measures of – SARS, Swine Flu (H1N1). Zika Fever, Ebola, Viral Fever	
III	**Emerging Diseases in India**		**9**
	5	Causes, signs and symptoms ,mode of transmission and preventive measures of - Viral hepatitis, Enteric Fever, Acute encephalitis syndrome, Measles, Rubella fever, Chicken pox, Crimean-Congo Haemorrhagic Fever and Kyasanur Forest Disease	
IV	**Emerging and Re-emerging Diseases Related to Tourism**		**9**
	6	Causes, signs and symptoms, mode of transmission and preventive measures of - Lyme disease, Falciparum Malaria, Yellow Fever, Cyclosporidosis	

V	**Re-emerging Infectious Diseases**		**9**
	7	Causes, signs and symptoms ,mode of transmission and preventive measures of - Plague, Leptospirosis, Anthrax, Cholera, Dengue fever, Nippah and Chikungunya	
		Activities	
		• Presentation or group discussion about the topic • Awareness campaign for the community • Survey in local comunity	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain knowledge about the factors that contribute to the emergence of diseases	R,U	1,2
CO-2	Identify different types of emerging and re-emerging diseases in the World and in India.	R, U	1,2
CO-3	Acquire awareness about the mode of transmission, signs and symptoms and preventive measures of these diseases.	R, U	3
CO-4	Adopt preventive measures of diseases	R, U, Ap	3.4
CO-5	Apply the knowledge by creating awareness in the society	R, U, Ap	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biochemical Aspects of Emerging and Reemerging diseases
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PS O	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	R,U	F, C	LT	
2	2	1,2	R, U	F, C	LT	
3	3	3	R, U	F, C	LT	
4	4	3.4	R, U, Ap	F, C	LT	
5	5	2	R, U, Ap	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	-	-	-		2				2
CO2	2	3	-	-	-	-		2		2		2
CO3	-	-	1	-	-	-	2	3		2		
CO4	-	-	2	3	-	-	3	2		2		
CO5	-	1	-	-	-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam Multiple choice questions

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignm ent	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.

2. Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.

3. Cell and Molecular Biology by Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.

4. Guyton, A., & Hall, J. E. (1996). Textbook of Medical Physiology (9th edition). Prism Saunders.

5. Satyanarayana, U., & Chakrapani, U. (2021). Essentials of Biochemistry (3rd ed.).

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSCBCH200				
Course Title	**Properties of Biomolecules**				
Type of Course	DSC13				
Semester	III				
Academic Level	200 -299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					
Course Summary	The course is designed to provide an overview of the physical properties, chemical properties and colour reactions of major biomolecules like nucleic acids, amino acids, proteins, carbohydrates and lipids. The course will enable the students to identify different biomolecules from a given sample through schematic qualitative analysis.				

Detailed Syllabus:Properties of Biomolecules

Module	Unit	Content	Hrs
I		**Nucleic acids**	**8**
	1	Denaturation of nucleic acids, hyper chromic effect, Tm-values, cot values, cot curve (significance)	
	2	Introduction to circular DNA, supercoiling	
	3	Repetitive and single copy DNA	
	4	Helix to random coil transition (brief aspects only)	
II		**Amino acids**	**10**
	5	Physical properties of amino acids- solubility, melting point	
	6	Isoelectric pH, zwitterion, optical property, amphoteric nature of amino acids	
	7	Chemical properties- transamination, deamination, decarboxylation and peptide bond formation	
	8	Colour reactions of amino acids- Reaction with Ninhydrin, Xanthoproteic reaction, Biuret reaction, Folin's test, Millon's test, Hopkins-Cole reaction, Sakaguchi reaction, Lead acetate test, Nitroprusside test, Pauly's test, and Isatin test (Structure not required)	

III	**Proteins**		**8**
	9	Physical properties of proteins- Solubility, molecular weight, shape, Isoelectric pH	
	10	Denaturation of proteins- agents of denaturation and characteristics of denatured protein	
	11	Precipitation reactions of proteins- precipitation at pI, salting in and salting out, precipitation by salts of heavy metals, anionic or alkaloidal reagents, and organic solvents.	
	12	Colour reactions of proteins- Xanthoproteic test, Biuret test and Folins test (Structure not required)	
IV	**Carbohydrates**		**10**
	13	Optical activity of sugars	
	14	Reducing and non-reducing sugars with structure- open chain and Haworth formula (glucose, fructose and sucrose), Anomers, epimers, enantiomers, and mutarotation.	
	15	Physical properties- Optical isomerism, stereoisomerism	
	16	Chemical properties- Chemical reactions of carbohydrates (with reference to glucose): reaction with alcohol (glycosides), reaction with acetic anhydride (esterification), reaction with methyl iodide (etherification), oxidation with acids (mild and strong), oxidation with metal hydroxides (Fehling's, Benedicts & Barfoeds tests), reduction reactions (with sodium amalgam, strong mineral acids & dilute alkali), reaction with hydrogen cyanide, reaction with alanine, reaction of different carbohydrates with phenylhydrazine (osazone formation), reaction with hydroxyl amine and fermentation reaction. (Structure not required)	
V	**Lipids**		**9**
	17	Properties of fatty acids - solubility, properties based on chain length and unsaturation.	
	18	Reactions of lipids - hydrolysis, hydrogenation, rancidity, emulsification and peroxidation reaction.	
	19	Definition and significance of iodine number, saponification value, acid value and Reichert-Meissel number.	
	Practical		**30**
	20	Qualitative analysis of glucose, fructose, lactose, sucrose and starch	
	21	Qualitative analysis of lipids- solubility, translucent spot tests, test for saturation/unsaturation, Salkowski test and Zaks test.	
	22	Qualitative analysis of Amino acids- Tests- Biuret test, Folin's test, Xanthoproteic test, Millon's test, Morner's test, Hopkin-Cole test (Glyoxylic acid test), Ehrlich's test, Sodium nitroprusside test, Pauly's test, Aldehyde test, Basic Lead acetate test, Test for Methionine, and Isatin test.	

	23	Qualitative analysis of Proteins- Biuret test, Folin's test, Picric acid test, Heat denaturation, Heller's Nitric acid test, Metal precipitation, Alcohol precipitation and Heller's- nitric acid test.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Memorize the physical, chemical, and other general properties of biomolecules like Nucleic acids, Amino acids, Proteins, Carbohydrates, and lipids.	R, U	1
CO-2	Classify major biomolecules based on their properties	U, An	1, 4
CO-3	Evaluate the significance of various reactions of major biomolecules	E	1, 2, 4
CO-4	Illustrate various experiments for qualitative analysis of biomolecules	Ap	1, 2, 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Properties of Biomolecules

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Memorize the physical, chemical, and other general properties of biomolecules like Nucleic acids, Amino acids, Proteins, Carbohydrates, and lipids	1	R, U	F, C	L/T	
CO-2	Classify major biomolecules based on their properties	1, 4	U, An	F, C	L/T	

CO-3	Evaluate the significance of various reactions of major biomolecules	1, 2, 4	E	C, P, M	L/T	P
CO-4	Illustrate various experiments for qualitative analysis of biomolecules	1, 2, 4	Ap	C, P	L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-		2				
CO 2	2	3	-	-	-	-		2				3
CO 3	-	-	1	-	-	-	2	2		3		
CO 4	-	-	2	3	-	-	2	2		3		3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

References

- Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M.Cox. Publisher: W. H. Freeman; Fourth Edition (April 23, 2004).
- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana, ISBN 81-7663-067-5.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSCBCH201				
Course Title	**Enzymes and Enzyme Kinetics**				
Type of Course	DSC14				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					
Course Summary	This course offers an understanding of basic concepts of enzymes and its role in various biochemical processes. This course also envisages to give students the critical analytical ability of the scientific phenomena involving enzymes and proficiently work with enzyme systems in both academia and industry.				

Detailed Syllabus: Enzymes and Enzyme Kinetics

Module	Unit	Content	Hrs
I		**Introduction to Enzymes**	**9**
	1	Models of enzyme substrate complex formation: Induced fit, Lock and key, transition state models. Enzyme specificity.	
	2	Enzyme classification and nomenclature. (Class and subclass with one example).	
	3	Units of enzyme activity- IU, Specific activity Katal, and Turnover number.	
	4	Coenzymes and their biochemical roles (CoA, TPP, PLP, NAD/NADP, FAD, FMN, Biotin, folic acid, Vitamin B12)	
	5	Concept of ES complex and features of active site	
II		**Enzyme Kinetics**	**9**
	6	Factors affecting the velocity of enzyme catalyzed reaction - enzyme concentration, substrate concentration, temperature, pH, inhibitors and activators (explanation with graphical representation)	
	7	Michaelis Menten equation; Km and Vmax values and their significance	
	8	Lineweaver-Burk plot, derivation of LB equation and its importance.	
	9	Allosteric enzymes: Regulation, mechanism and examples (ATCase and Glycogen phosphorylase)	
III		**Enzyme Inhibition and Regulations**	**9**

	10	Enzyme inhibition – competitive, non-competitive, uncompetitive and feedback inhibitions.	
	11	Allosteric inhibition, suicide inhibition, role in drug design	
	12	Zymogens and their activation, Multi enzyme systems: FAS as example	
IV	**Industrial Enzymology**		**9**
	13	Isolation and purification of enzymes and criteria of purity.	
	14	Enzyme technology: Methods for large scale production of enzymes, immobilized enzymes and their comparison with soluble enzymes	
	15	Application of immobilized and soluble enzymes in health and industry	
V	**Clinical Enzymology**		**9**
	16	Diagnostic enzymes in different diseases: Liver, pancreatic and muscle enzymes in diagnosis	
	17	Isoenzymes definition, clinical applications	
	18	Enzymes as reagents, analytical agents and therapeutic agents.	
		Practicals	30
		● Demonstration of factors affecting enzyme activity. ○ pH ○ temperature ○ substrate concentration ○ enzyme concentration ● Estimation of AST and ALT ● Extraction and assay of urease, acid phosphatase & beta amylase.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the fundamental concepts of enzymes, catalytic mechanisms, specificity	R,U	1, 4
CO-2	Differentiate types of enzyme inhibitions and regulations	R, U, E	1, 3
CO-3	Understand and analyse industrial applications of enzymology	R,U, Ap	1, 3, 4
CO-4	Understand and analyse clinical applications of enzymology	R, U, Ap	1, 3, 4
CO-5	Develop basic skills in isolation of enzymes, assays, and related experimental techniques	R, U, An, E	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe the fundamental concepts of enzymes, catalytic mechanisms, specificity	1, 4	R,U	F, C	L/T	
CO-2	Differentiate types of enzyme inhibitions and regulations	1, 3	R, U, E	F, C	L/T	
CO-3	Understand and analyse industrial applications of enzymology	1, 3, 4	R,U, Ap	C, M	L/T	
CO-4	Understand and analyse clinical applications of enzymology	1, 3, 4	R, U, Ap	C, M	L/T	
CO-5	Develop basic skills in isolation of enzymes, assays, and related experimental techniques	2	R, U, An, E	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1			2	-	-		2				
CO 2		2	3		-	-	2			2		3
CO 3		2	3	2	-	-	2			2		3
CO 4		2	3	2	-	-	2	2		2		3
CO 5		2			-	-						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Nelson D. L., Cox M. M. (2021) Lehninger Principles of Biochemistry, (8th ed.) W.H. Freeman &. Co Ltd.
2. Berg J.M., Gatto G.J., Hines J, Tymoczko J.L., Stryer L. (2023) Biochemistry (10th ed.) W.H. Freeman &. Co Ltd.
3. West E.S., Todd W.R., Mason H.S., Van Bruggen J.T., (2017) TextBook of Biochemistry (4th ed.)
4. Voet D., Voet J., Pratt C.W., (2018) Voet's Principles of Biochemistry (5th ed.)
5. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi.
6. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi.
7. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSCBCH202				
Course Title	**Sports Nutrition**				
Type of Course	DSC15				
Semester	III				
Academic Level	200 -299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hrs	-	-	4 hours
Pre-requisites					
Course Summary	The course focuses on the basic concepts of nutrition, significance of balanced diet, dietary health supplements, importance of types of exercise and physical activity levels to maintain fitness, short term effects of exercise on important body systems, role of macro and micro nutrients in exercise and sports, importance of diet in sports and ergogenic aids.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Basics of Nutrition**		**9**
	1	Calorific value of food. BMR and factors affecting BMR, BMI and obesity.	
	2	Significance of measurement of BMI, waist-hip ratio, and skin fold thickness. SDA of food, balanced diet, RNI and RDA.	
	3	Concept of health supplements, food supplements and dietary supplements with examples.	
II	**Types of Exercises and Physical Activity Levels**		**9**
	4	Types of exercise -isometric, isotonic, isokinetic, strength building, aerobic, resistance and weight bearing, flexibility, balancing and stretching, warm up and cool down and cardiac exercises.	
	5	Levels of physical activity-moderate and vigorous. Benefits of physical activities.	
	6	Physiological changes during exercise -body composition, aerobic capacity, glycogen reserves, water and electrolyte balance, timing of ingestion of nutrients, ATP production, energy expenditure, and free radical generation.	

III	**Short term Effects of Exercise on Body Systems**		**9**

	7	Response of CVS to exercise- basic information about changes in heart rate, stroke volume, cardiac output, blood flow, and blood pressure.	
	8	Response of Respiratory system to exercise- basic information about changes in tidal volume, minute rate respiratory rate and pulmonary ventilation	
	9	Response of muscular system to exercise	
IV	**Nutrition for Sports**		**9**
	10	Role of carbohydrates in sports. Carbohydrate loading. Factors influencing selection of carbohydrates.	
	11	Role of proteins and fat in sports	
	12	Role of vitamins and minerals in sports	
	13	Role of water and electrolytes in sports	
V	**Nutritional Requirement during Sports**		**9**
	14	Pre-event requirements	
	15	Requirements during events	
	16	Post event requirements	
	17	Ergogenic aids in sports	
		Activity	**15**
	18	Measurement and understanding the significance of BMI, skin fold thickness and waist-hip ratio.	
	19	Measurement of vital capacity, heart rate and blood pressure in response to physical activity.	
	20	Preparation of dietary charts for general physical fitness and for sports requirements.	
	21	Basic physical activity training in gymnasium.	
	22	Visit to a physical education training institution	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Relate and analyse the basic concepts in nutrition and health	U, An	1
CO-2	Outline, classify and plan the types of exercise and physical activity levels required to maintain health and to explain the physiological changes in response to physical activity.	R, U, Ap	1, 3
CO-3	Relate and explain the short term effects of physical activity on major body systems	R, U	1

CO-4	Relate and explain the role of macro and micronutrients in sports nutrition	R, U	1

CO-5	Relate and plan the nutritional requirements at different stages of events in sports	R, Ap	1, 3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Sports Nutrition Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	U, An	F, C	LT	
2	2	1, 3	R, U, Ap	F, C	LT	
3	3	1	R, U	F, C	LT	
4	4	1	R, U	F, C	LT	
5	5	1, 3	R, Ap	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	-	-	-	2	2		2		
CO2	2	-	1	-	-	-	2	2		2		
CO3	2	-	-	-	-	-		3				
CO4	2	-	-	-	-	-		3				
CO5	2	-	1	-	-	-	2	2		2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Sports Nutrition and Balance Diet - BPES Physical Education Course Book .Dr. Alok Mishra .Sports Publication; 2022nd edition.
2. Nutritional Guidelines for Sportspersons. Geetanjali Bhide and Subhadra Mandalika. Jaypee Brothers Medical Publishers; First Edition. ISBN-13 : 978-9352703456.
3. Practical Applications in Sports Nutrition.Heather Hedrick Fink (Author). Jones and Bartlett Publishers, Inc. ISBN-13 : 978-0763726577.
4. Sports Nutrition And Weight Management. Prof. V. Satyanarayana. Sports Publication; ISBN-13- 978-8178798998.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSCBCH203				
Course Title	Biosafety, Bioethics and IPR				
Type of Course	DSC16				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites					
Course Summary	The course introduces biosafety principles, regulations, and guidelines, and explores bioethical considerations in genetic research, GMOs, and medical experimentation. Course provides an understanding of IPR, including patents, trademarks, and international treaties, with a focus on patent filing procedures and infringement issues. The course offers case studies on women's health ethics, medical errors, and radioactive waste disposal, providing practical applications of the concepts taught.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Biosafety**	**10**
	1	Historical background; introduction to biological safety cabinets; primary containment for biohazards.	
	2	Biosafety levels; recommended biosafety levels for infectious agents and infected animals.	
	3	Biosafety guidelines - government of India, roles of IBSC, RCGM, GEAC etc. for GMO applications in food and agriculture; environmental release of GMOs.	
	4	Risk assessment; risk management and communication; national regulations and international agreements.	
II		**Bioethics**	**10**
	5	Introduction to bioethics, human genome project and its ethical issues, genetic manipulations and their ethical issues	

	6	Ethical issues in GMOs, foods and crops in developed and developing countries, environmental release of GMOs	
	7	Ethical issues involved in stem cell research and use, use of animals in research experiments	
	8	Animal cloning, human cloning and their ethical aspects, testing of drugs on human volunteers	
III	**Intellectual Property Rights (IPR)**		**10**
	9	Introduction to patents, types of patents, process involved in patenting in India.	
	10	Trademarks, copyright, industrial design, trade secrets, traditional knowledge,and geographical indications.	
	11	History of national and international treaties and conventions on patents, WTO, GATT, WIPO, Budapest Treaty, Patent Cooperation Treaty (PCT) and TRIPS.	
	12	Patent databases: Searching international databases; analysis and report formation. Indian Patent Act 1970.	
	13	Recent amendments; filing of a patent application; precautions before patenting disclosure/non-disclosure; procedure for filing a PCT application.	
IV	**Patent Filing and Infringement**		**10**
	14	Patent application- forms and guidelines, fee structure, time frames.	
	15	Types of patent applications: provisional and complete specifications; PCT and convention patent applications, International patenting-requirement.	
	16	Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US.	
	17	Research Patenting: Patenting by researchers and scientists-University/organizational rules in India and abroad.	
	18	Detailed information on patenting biological products, Case studies on patents (basmati rice, turmeric, neem etc.), and patent infringement.	
V	**Case Study on Women Health Ethics**		**5**
	19	Case study on medical errors and negligence	
	20	Case study on handling and disposal of radioactive waste	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the working principles in a laboratory taking all safety measures, handling of live cultures, disposal of infectious waste, care of the equipment requiring safety audit and get an insight into Biosafety guidelines.	U,R	1
CO-2	Understand the International Agreements and Regulations with respect to Biosafety and Analyse to Manage the Risks involved with GMOs.	U, A	2,3
C0-3	Understand about different treaties, rights and duties of Patent owner and Gain Knowledge about Intellectual Property Rights.	U,R	3,4
CO-4	Understand and apply the process of filing a patent.	U , A	4
CO-5	Understand and evaluate Case study on health ethics.	U, E	4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biosafety, Bioethics and IPR

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	U,R	F, C	LT	
2	2	2,3	U, A	F, C	LT	
3	3	3,4	U,R	F, C	LT	
4	4	4	U , A	F, C	LT	
5	5	4	U, E	F, C	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :Correlation Levels

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-		2				
CO 2	2	3	-	-	-	-		2		2		3
CO 3	-	-	1	-	-	-	2	2		2		
CO 4	-	-	2	3	-	-	2	2		2		
CO 5	-	1	-	-	-	-						3

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations

CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. World Health Organization (WHO) Biosafety Manual, Third Edition, 2004. Centers for Disease Control and Prevention (CDC) Biosafety Guidelines.

2. Indian Biosafety Rules and Guidelines, issued by the Ministry of Environment, Forest and Climate Change, Government of India.

3. Guidelines for Safety in Academic Institutions, issued by the Department of Biotechnology (DBT), Government of India

4. Fleming D.A., Hunt D.L., (2002), Biological safety Principles &practices(3rd Ed.) ASM Press, Washington.

5. Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani.

6. P Ganguly, Intellectual Property Rights, Tata McGraw Hill, 2007.

7. Thomas J.A., Fush R.L., (2002), Biotechnology & safety Assessment (3rdEd.), Academic press.

8. World Intellectual Property Organization (WIPO) Intellectual Property Handbook: Policy, Law and Use, 2008

9. Indian Patent Act, 1970

10. National Bioethics Advisory Commission (NBAC). Ethical Issues in Human Stem Cell Research, Volume I: Report and Recommendations of the National Bioethics Advisory Commission, 1999

11. UNESCO Universal Declaration on Bioethics and Human Rights

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSCBCH204				
Course Title	Functional Foods and Nutraceuticals				
Type of Course	DSC17 (Minor)				
Semester	III				
Academic Level	200 -299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3	-	2	5
Pre-requisites					
Course Summary	The course aims to provide a comprehensive knowledge about the significance of functional foods and nutraceuticals in human health. It provides information about the different types of functional foods, their sources and possible health benefits. Course highlights the importance of nutraceuticals in terms of food as medicine in various disease conditions.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Basics of Functional Foods & Nutraceuticals**		**9**
	1	Introduction to Functional Foods and Nutraceuticals	
	2	History and Classification	
	3	Perceived Effects of Functional Foods and Nutraceuticals	
II	**Probiotics, Prebiotics & Synbiotics**		**9**
	4	Definition of Probiotics, Prebiotics and Synbiotics	
	5	Sources and health benefits of Probiotics	
	6	Sources and health benefits of Prebiotics	
	7	Synbiotics and its health benefits	
III	**Carotenoids, Fatty acids & Flavonoids**		**9**
	8	Sources and health benefits of carotenoids -β-carotene, lycopene and Lutein	
	9	Sources and health benefits of fatty acids - MUFA, omega-3 and omega-6 (EPA, DHA)	
	10	Sources and health benefits of flavonoids-Anthocyanins, Flavanols and Flavanones	
IV	**Phytoestrogens, Minerals & Dietary Fibers**		**9**

	18	Sources and health benefits of Phytoestrogens-Stilbenes (Resveratrol), Lignans (Medioresinol and Sesamin) and Isoflavones (Daidzein and Genistein).	
	19	Sources and health benefits of minerals-Calcium, Magnesium, Potassium and Selenium.	
	20	Sources and health benefits of dietary fibers- soluble fiber, β-glucan and insoluble fibers.	
V	**Food as Medicine**		**9**
	23	Nutraceutical remedies for cognitive disorders – source and potential benefit of carnosine, DHA, soy isoflavones and green tea.	
	24	Nutraceutical remedies for arthritis- source and potential benefits of capsaicin, bromelain, curcumin and Boswellia Serrate.	
	25	Nutraceutical remedies for cardiovascular diseases-Dietary fibers, tocotrienols and pantethine.	
		Practical/Activity (30 hr)	**30**
		● Qualitative analysis of phytochemicals from different plant sources used in our daily life (two/three sources) ● Identification of plants and plant products rich in phytoestrogens, carotenoids and flavonoids. ● Identification of plants and plant products rich in minerals and fiber content. ● Familiarization of nutraceuticals available in the market and understanding its potential health benefits. *Lab record to be maintained.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Outline the importance of functional foods and nutraceuticals in human health	R, U	1
CO-2	Identify the sources of different functional foods in day today life	R, U, Ap	1, 3
CO-3	Describe the health benefits of functional foods	R, U	1
CO-4	Apply knowledge of functional foods and plan daily diet to ensure maximum health benefits.	R, U, Ap	1, 3
CO-5	Relate the significance of different nutraceuticals used as remedy for disease conditions.	R, U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Functional Food and Nutraceuticals

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R, U	F, C	LT	
2	2	1, 3	R, U, Ap	F, C	LT	
3	3	1	R, U	F, C	LT	
4	4	1, 3	R, U, Ap	F, C	LT	
5	5	1	R, U	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-			2				
CO2	2	-	1	-	-		2	2		2		
CO3	1	-	-	-	-			2				
CO4	2	-	2	-	-		2	2		2		
CO5	1	-	-	-	-			2				

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Textbook of Human Nutrition. Anjana Agarwal and Shobha A Udipi. JAYPEE Brothers Medical Publishers (P) Ltd.
2. Krause, L., & Mahan, S. (Eds.). (1992). Food, nutrition, and diet therapy (6th ed.). W.B. Saunders Company.
3. Robert E.C. Wildman; Handbook of Nutraceuticals and Functional Foods, Second Edition; CRC Press.
4. Nutraceuticals and Dietary Supplements: Applications in Health Improvement and Disease Management .Anil K. Sharma, Raj K. Keservani, Rajesh K. Kesharwani. Apple Academic Press Inc.; 1st edition. ISBN-13: 978-1774638903.
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8. Vattem, Dhiraj A. and Vatsala Maitin. 2016. Functional Foods, Nutraceuticals and Natural Products, Concepts and Applications. USA: DEStech Publications, Inc.
9. Aluko, Rotimi E. 2012. Functional Foods and Nutraceuticals. Germany:Springer.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSCBCH205				
Course Title	**PHYTOCHEMISTRY**				
Type of Course	**DSC18**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3		2	5
Pre-requisites	NIL				
Course Summary	The course provides an understanding of the methods used for the extraction, purification and isolation of bioactive compounds from medicinal plants. Government policies and quality standards for herbal medicine preparation are covered in the syllabus				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Phytochemicals**	**5**
	1	Plant secondary metabolites,	
	2	Chemical nature of phytoconstituents	
	3	Major classes – Polyphenols, Terpenoids, Phytosterols and Alkaloids. Therapeutic applications in ethnomedicine.	
II		**Phytochemical Extraction**	**10**
	5	Solvents used in extraction, Polarity, Properties, Factors to be considered in solvent selection	
	6	Extraction methods – Soxhlet extraction, maceration, decoction, infusion, percolation, sonication and microwave-assisted extraction.	
	7	Screening for phytochemicals – Qualitative tests to detect the presence of alkaloids, glycosides, phenolics, tannins and phytosterols.	

III	**Purification of Phytoconstituents**		**15**
	10	Separation Techniques – TLC, Paper chromatography & HPLC	
	11	Quantification of phytoconstituent GC-MS, HPTLC & OPLC	
	12	Spectroscopy for compound identification – UV, IR and Mass spectroscopy	
	13	Structure elucidation of isolated compound– LCMS, FTIR & NMR	
IV	**Sustainable Herbal Medicine Policies**		**5**
	14	Conservation of Medicinal plants – in situ & ex-situ	
	15	Good quality gene pool sources, Good agriculture practices [GAP], Good field collection practices for medicinal plants[GFCP], Quality standardization	
	16	Biological diversity Act, Medicinal plant conservation areas, National Medicinal Plants Board [NMPB], National AYUSH Mission [NAM]	
V	**Phytochemicals in disease prevention**		**10**
	19	Anticancer effect of phytochemicals	
	20	Herbal medicine for liver diseases	
	21	Herbal drugs for the management of infectious diseases	
	22	Phytotherapeutics for COVID-19	
	23	Antiviral activity of phytochemicals	
VI	**Practical**		30
	25	Familiarization of laboratory instruments – Soxhlet apparatus, Hot air oven, Desiccator & Rotary evaporator	
	26	Extraction of methods- Soxhlet Maceration	
	27	Preliminary phytochemical screening tests	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the methods for extraction of phytochemicals	R, U, An	2
CO-2	Techniques for purification and isolation of active components from medicinal herbs	R, U, Ap	2
CO-3	Recall the Government policies in phytochemical research and manufacturing of herbal medicines	R, U,Ap	3
CO-4	To explain Chronic disease management employing the therapeutic efficacy of phytochemicals	R, U	2
CO-5	Expertise in extraction and purification of compounds from plants	R, U, Ap	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYTOCHEMISTRY

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	2	R, U, An	F, C	LT	
2	2	2	R, U, Ap	F, C	LT	
3	3	3	R, U,Ap	F, C	LT	
4	4	2	R, U	F, C	LT	
5	5	2	R, U, Ap	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO6	PO 1	PO2	PO3	PO4	PO5	PO6
CO 1	-	3	-	-	-	-	2	2		2		
CO 2	1	3	-	-	-	-		2				3
CO 3	-	-	3	-	-	-	2	2		2		
CO 4	-	2	-	-	-	-						3
CO 5	-	3	-	-	-	-						6

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Arnason, J. T., Mata, R., & Romeo, J. T. (Eds.). (1995). *Phytochemistry of medicinal plants* (Vol. 34). Springer Science & Business Media.
2. Harborne, A. J. (1998). *Phytochemical methods a guide to modern techniques of plant analysis*. springer science & business media.
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5. Pengelly, A. (2020). *The constituents of medicinal plants: an introduction to the chemistry and therapeutics of herbal medicine*. Routledge.
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University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSCBCH206				
Course Title	Properties of Biomolecules and Enzymology				
Type of Course	**DSC** 19				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. 2.				
Course Summary	This course provides a thorough understanding of the properties of biomolecules and enzymology. This course will help to create a strong foundation in biochemistry for students, with a focus on basic biomolecules. The course also covers the basics of qualitative analysis of biomolecules.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Amino acids and Proteins**	**10**
	1	Physical properties of amino acids- solubility, melting point	
	2	Isoelectric pH, zwitterion, optical property, amphoteric nature of amino acids	
	3	Chemical properties- transamination, deamination, decarboxylation and peptide bond formation	
	4	Colour reactions of amino acids- Reaction with Ninhydrin, Xanthoproteic reaction, Biuret reaction, Folin's test, Millon's test, Hopkins-Cole reaction, Sakaguchi reaction, Lead acetate test, Nitroprusside test, Pauly's test, and Isatin test (Structure not required)	
	5	Proteins: Physical properties of proteins- Solubility, molecular weight, shape, Isoelectric pH, Denaturation of proteins- agents of denaturation and characteristics of denatured protein, Precipitation reactions of proteins- precipitation at pI, salting in and salting out, precipitation by salts of heavy metals, anionic or alkaloidal reagents, and organic solvents. Colour reactions of proteins- Xanthoproteic test, Biuret test and Folins test	
II		**Carbohydrates**	**10**
	6	Reducing and non-reducing sugars with structure- open chain and Haworth formula (glucose, fructose and sucrose), Anomers, epimers, enantiomers, and mutarotation.	
	7	Physical properties- Optical activity Optical isomerism, stereoisomerism,	
	8	Chemical properties- Chemical reactions of carbohydrates (with reference to glucose): reaction with alcohol (glycosides), reaction with acetic anhydride (esterification), reaction with methyl iodide (etherification), oxidation with acids (mild and strong), oxidation with metal hydroxides (Fehling's,	

		Benedicts & Barfoeds tests), reduction reactions (with sodium amalgam, strong mineral acids & dilute alkali), reaction with hydrogen cyanide, reaction of different carbohydrates with phenylhydrazine (osazone formation), reaction with hydroxyl amine and fermentation reaction. (Structure not required)	
III	**Lipids and Nucleic acids**		**10**
	9	Properties of Lipids: Fatty acids - solubility, properties based on chain length and unsaturation. Reactions of lipids - hydrolysis, hydrogenation, rancidity, emulsification and peroxidation reaction. Definition and significance of iodine number, saponification value, acid value and Reichert-Meissel number.	
	10	Properties of Nucleic acids: Denaturation of nucleic acids, hyper chromic effect, Tm-values, cot values, cot curve (significance). Introduction to circular DNA, supercoiling, repetitive and single copy DNA, Helix to random coil transition (brief aspects only)	
IV		**Enzymology**	15
	11	Properties ,nomenclature and classification of enzymes, Holoenzyme ,apoenzyme, prosthetic group,cofactor metalloenzymes ,coenzymes and their functions (one reaction involving TPP,FMN, FAD, NAD, NADP, PLP, Biotin). Enzyme units -IU, Katal, turnover number and specific activity. Enzyme specificity characteristic features of active site, activation energy.	
	12	Hypotheses of enzyme substrate binding -Fischer hypothesis-lock and key model, Koshland hypothesis - induced fit theory. Factors affecting velocity of enzyme catalyzed reaction- enzyme concentration, substrate concentration, temperature, pH, inhibitors and activators.	
	13	Derivation of Michaelis- Menten equation, significance of Vmax and Km value, Derivation of Lineweaver- Burk equation and LB-plot (for single enzyme catalyzed reaction)	
	14	Enzyme inhibition- Irreversible and reversible (competitive, noncompetitive and uncompetitive inhibition. Enzyme Regulation - Covalent modification (Glycogen phosphorylase as example), Allosteric regulation (ATCase as example)	
		Zymogens (trypsinogen, chymotrypsinogen and pepsinogen), Isozymes (LDH, Creatine kinase), Designer enzymes - Abzymes, Ribozymes	
V	**Practical**		**30**
	15	Qualitative analysis of glucose, fructose, lactose, sucrose and starch	
	16	Qualitative analysis of lipids- solubility, translucent spot tests, test for saturation/unsaturation, Salkowski test and Zaks test.	
	17	Qualitative analysis of Amino acids- Tests- Biuret test, Folin's test, Xanthoproteic test, Millon's test, Morner's test, Hopkin-Cole test (Glyoxylic acid test), Ehrlich's test, Sodium nitroprusside test, Pauly's test, Aldehyde	

		test, Basic Lead acetate test, Test for Methionine, and Isatin test.	
	18	Qualitative analysis of Proteins- Biuret test, Folin's test, Picric acid test, Heat denaturation, Heller's Nitric acid test, Metal precipitation, Alcohol precipitation and Heller's- nitric acid test.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Evaluate the properties of carbohydrates, lipids, amino acids , proteins and nucleic acids	R, U, E	PSO-1,4
CO-2	Describe nomenclature , classification of enzymes, mechanism of enzyme catalysis and inhibition	R, U,	PSO-1
CO-3	Acquire an understanding of enzymes activity and enzyme kinetics	R, U	PSO-1
CO-4	Analyse qualitatively some important biomolecules in the laboratory	U, An, E	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe the physical and chemical properties of standard aminoacids and Proteins	1	R, U	F, C	L/T	
CO-2	Explain the Physiochemical properties and structure of carbohydrates	1,3	R,U	F, C	L/T	
C0-3	Understand the properties and	1	R, U	F, C	L/T	

	significance of nucleic acids and also the properties used to characterize lipid molecules					
C0-4	A thorough understanding of enzymes with their properties, types and kinetics.	1,2	R, U	F, C	L/T	
CO-5	Expertise in the qualitative identification of major biomolecules	1,2	R, U, Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	3	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	1		-	-	1	-	-	-	-	-
CO 3	2	-	1	-	-	-	1	-	-	-	-	-
CO 4	3	-	-	-	-	-	1	-	-	-	-	-
CO 5	1	3	-	-	-	-	1	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M.Cox. Publisher: W. H. Freeman; Fourth Edition (April 23, 2004).
2. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.
3. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
4. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana, ISBN 81-7663-067-5

5. Biochemistry by U. Satyanarayana, U. Chakrapani , third edition, ISBN 81-87134-80 1Enzymes-M.DixonandECWebb.LongmanPublication.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UKDSEBCH200				
Course Title	**Nutrition for Human Health**				
Type of Course	DSE1 (Elective)				
Semester	**III**				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites					
Course Summary	The course offers a basic understanding of nutrition, empowering students with insights into various nutritional concepts and the significance of each food component. The course provides an overview of the connection between diet and deficiency/lifestyle-related diseases. The course outlines the recent advancements in nutrition and their application in promoting a healthy lifestyle. Basic education on nutrition provides students with practical skills that find application throughout their life.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Basic Concepts in Nutrition**		**6**
	1	Definition of nutrition, health, nutrients, malnutrition – undernutrition, and overnutrition. Proximate principles of food. Calorific value of food and its determination (Bomb calorimeter), Respiratory Quotient of carbohydrate, lipid and protein.	
	2	BMR and factors affecting BMR, BMI, Significance of BMI range and obesity. Significance of skin fold thickness measurement.	
	4	Definitions and concept of balanced diet, bland diet, RNI and RDA	
II	**Role of Dietary Components in Health**		**12**
	5	Types of nutrients: macronutrients (carbohydrates, lipids and protein), micronutrients (vitamins and minerals) nutritional supplements.	
	6	Carbohydrates: General functions, dietary sources, role of dietary fibers in lipid metabolism, colon function, maintenance of blood glucose level and gastric motility.	

	7	Lipids**:** General functions, dietary sources, nutritional significance of major dietary lipids (triglyceride, phospholipids, cholesterol). Essential fatty acids, PUFA (omega-3/omega-6 fatty acids, EPA and DHA).	
	8	Protein: General functions, dietary sources and RDA for different age groups, essential amino acids, limiting amino acids, nitrogen balance-positive and negative, biological value of protein. Protein-calorie malnutrition (Kwashiorkor and marasmus)	
III	**Vitamins and Minerals**		**12**
	9	Classification of vitamins (Fat soluble and water soluble), minerals (macro and trace)	
	10	Sources and biological functions of water soluble vitamins (B complex vitamins and Vitamin C)	
	11	Sources and biological functions of fat-soluble vitamins (A, D, E and K). Hypervitaminosis and deficiency diseases of A, D, E and K.	
	13	Sources and biological functions of minerals (Ca, P, Na, K,F, Cl, I, Cu, Zn and Fe). Deficiency diseases of Ca,F, I, Fe, Cu.	
IV	**Functional Foods & Dietary Management of Diseases**		**9**
	18	Basic concepts of dietary supplements, antinutritional factors, functional foods, and nutraceuticals.	
	19	Nutritional significance of functional foods (probiotics, prebiotics, antioxidants, bran fiber and fish oil).	
	20	Dietary management of lifestyle diseases (diabetes, obesity, hypertension and cardiovascular diseases)	
V	**Advanced Trends in Health & Nutrition**		**6**
	23	Gut health: Maintenance of a healthy gut microbiome	
	24	Personalized nutrition planning based on genetics & lifestyle - apps and digital platforms	
	25	Balanced diet and Sustainable nutrition	
		Practical (30hr)	
		● Measurement and understanding the significance of BMI, skin fold thickness and waist-hip ratio. ● Preparation of dietary charts. ● Case study based on deficiency of Ca, I, Fe, Cu and F. ● Case study based on deficiency of Vit A, D, B1 and C.	30

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	**Recall and relate the basics concepts in nutrition**	**R, U**	**1**

CO-2	**Outline the significance and identify the importance of each component of food in maintaining health.**	**R, U, Ap**	**1, 3**
CO-3	**Identify the different types of nutritional deficiency diseases**	**R, U**	**1, 3**
CO-4	**Apply diet and nutrition for management of lifestyle diseases**	**R, U, Ap**	**1,3, 4**
CO-5	**Point out recent advancements in the field of nutrition and to extend the applications of digital platforms and apps for health maintenance.**	**R, U, Ap**	**3, 4**

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Nutrition for Human Health

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	1	**1**	**R, U**	F, C	LT	
2	2	**1, 3**	**R, U, Ap**	F, C	LT	
3	3	**1, 3**	**R, U**	F, C	LT	
4	4	**1,3, 4**	**R, U, Ap**	F, C	LT	
5	5	**3, 4**	**R, U, Ap**	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-				3				
CO2	2	-	2	-			2	2		2		
CO3	2	-	2	-			2	2		2		
CO4	2	-	2	1			2	2		2		
CO5	-	-	3	1			2	2		2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓		✓

References

i. Textbook of Human Nutrition. Anjana Agarwal and Shobha A Udipi. Jaypee Brothers Medical Publishers (P) Ltd.
ii. Nutrition (4th edition). Insel P, Ross D, McMahon K and Bernsteind M. Jones and Bartlett Publishers. Boston 2012 , 387-502.
iii. Eastwood, M. (2003). Principles of Human Nutrition. Atlantic Publishers & Distributors.
iv. Vitamins in Health and Disease.Kulkarni ML. Jaypee Brothers Medical Publishers (P) Ltd
v. Krause, L., & Mahan, S. (Eds.). (1992). Food, nutrition, and diet therapy (6th ed.). W.B. Saunders Company.

vi. Handbook of Foods And Nutrition. Blank, F. C. (2007). Agrobios (India)
vii. Srilakshmi, B. (2014). Food Science. New Age International Publishers (India).
viii Health, Nutrition And Diseases.Chatterjee, G. (2000). Rajat Publicat

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University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSEBCH201				
Course Title	**Introduction to Nanobiotechnology**				
Type of Course	DSE2				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	NIL				
Course Summary	This course provides a basic overview of different types and properties of nanomaterials, basic methods of synthesis and characterization and general applications of nanobiotechnology in the field of healthcare and agriculture with special reference to crop improvement.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Nanomaterials**		**12**
	1	Introduction to nanomaterials; Various types of nanomaterials, Three-dimensional, two dimensional, one-dimensional and zero-dimensional nanomaterials.	3
	2	Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, metal oxide-based nanomaterials, semiconductor nanomaterials, quantum dots, hybrid nanoparticles, Bio-nanomaterials, polymer nanoparticles, lipid nanoparticles etc.	4
	3	Synthesis methodologies, Top down and bottom up approaches for nanomaterial synthesis.	5
II	**Properties of Nanomaterials**		**12**

	4	Structural properties, chemical properties, surface functionalization, physical properties.	3

	5	Characterization of nanomaterials by various analytical methods, optical characterization and spectroscopy such as FTIR, UV-Vis, DLS, Zeta Potential.	4
	6	Structural characterization by X-Ray Diffraction, XPS and advanced microscopy (TEM, SEM, AFM) etc.	5
III	**Nanobiotechnology in Healthcare**		**12**
	7	Role of nanobiotechnology in the area of infectious & noninfectious diseases.	4
	8	Nano pharmaceuticals, Diagnosis, sensors and biosensors Delivery vehicles.	4
	9	Biomedical applications of nanomaterials. Multimodal nanoparticles, targeted drug delivery, theranostics.	4
IV	**Nanobiotechnology for Agriculture**		**12**
	10	Nanotechnology based tools to enhance agricultural productivity Nano Based Agri and Food Products, food preservation and toxicity.	4
	11	Nanopesticides and Nanofertilizers. Nano-biostimulants and soil enhancers.	4
	12	Nano-enabled technologies and abiotic stress management.	4
V	**Nanobiotechnology for Crop Improvement**		**12**
	13	Precision Delivery Systems, Diagnostics and sensing.	3
	14	Nanotechnology for environment: contamination detection and remediation.	3
	15	Activities: i. Visit to Centre for Nanotechnology in Kerala/India ii. Brainstorming lectures	6

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To compare the different types of nanomaterials and understand the basic methods involved in the synthesis of nanomaterials.	R, U	2
CO-2	To familiarize with the basic properties of nanomaterials and the approaches undertaken to characterize the nanomaterial.	R,U,Ap	1,2

C0-3	To analyze the applications of nanotechnology in the healthcare field.	R,U,An, Ap	2,4
CO-4	To relate the role of nanobiotechnology in the field of agriculture.	R, U	3
CO-5	Point out the applications of nanotechnology in crop improvement.	R, U,An	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Introduction to Nanobiotechnology

Credits: 4:0:0 (Lecture:Tutorial)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	1	2	R, U	F, C	LT	
2	2	1,2	R,U,Ap	F, C	LT	
3	3	2,4	R,U,An, Ap	F, C	LT	
4	4	3	R, U	F, C	LT	
5	5	3,4	R, U,An	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PS O2**	**PS O3**	**PS O4**	**PO 1**	**P O2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	2	-	-	-				2		-
CO 2	2	-	-	-				2		
CO 3	-	2	-	-						3
CO 4	-	3	1	2						3
CO 5	-	-	-	3						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. A. L. Rogach, Semiconductor nanocrystal quantum dots synthesis, assembly, spectroscopy and applications (Springer, Wien; London, 2008).

2. G. E. J. Poinern, A laboratory course in nanoscience and nanotechnology (CRC Press, Taylor & Francis Group, Boca Raton, 2015).

3. C. A. Mirkin, C. M. Niemeyer, Eds., More concepts and applications (Wiley-VCH, Weinheim, 2007), Nanobiotechnology.

4. A. K. Mishra, Ed., Application of nanotechnology in water research (Wiley, Scrivener Publishing, Hoboken, New Jersey, 2014).

5. K. R. Nill, Glossary of biotechnology and nanobiotechnology terms (Taylor & Francis, Boca Raton, 4th ed., 2006).

6. J. Kim, Ed., Advances in nanotechnology and the environment (Pan Stanford, Singapore, 2012).

7. P. N. Prasad. Nanophotonics (Wiley, New York, 2003).

8. E. Gazit, Plenty of room for biology at the bottom: an introduction to bionanotechnology

(Imperial College Press ; Distributed by World Scientific Pub. in the USA, London : Hackensack, NJ, 2007).

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3DSEBCH202				
Course Title	**Nanobiotechnology**				
Type of Course	DSE3				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2	5
Pre-requisites	NIL				
Course Summary	This course provides a basic overview of different types and properties of nanomaterials, basic methods of synthesis and characterization and general applications of nanobiotechnology in the field of healthcare and agriculture with special reference to crop improvement.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Nanomaterials**		**9**
	1	Introduction to nanomaterials; Various types of nanomaterials, Three-dimensional, two dimensional, one-dimensional and zero-dimensional nanomaterials.	

	2	Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, metal oxide-based nanomaterials, semiconductor nanomaterials, quantum dots, hybrid nanoparticles, Bio-nanomaterials, polymer nanoparticles, lipid nanoparticles etc.	
	3	Synthesis methodologies, Top down and bottom up approaches for nanomaterial synthesis.	
II	**Properties of Nanomaterials**		**9**
	4	Structural properties, chemical properties, surface functionalization, physical properties.	
	5	Characterization of nanomaterials by various analytical methods, optical characterization and spectroscopy such as FTIR, UV-Vis, DLS, Zeta Potential.	
	6	Structural characterization by X-Ray Diffraction, XPS and advanced microscopy (TEM, SEM, AFM) etc.	
III	**Nanobiotechnology in Healthcare**		**9**
	7	Role of nanobiotechnology in the area of infectious & noninfectious diseases.	
	8	Nano pharmaceuticals, Diagnosis, sensors and biosensors Delivery vehicles.	
	9	Biomedical applications of nanomaterials. Multimodal nanoparticles, targeted drug delivery, theranostics.	
IV	**Nanobiotechnology for Agriculture**		**9**
	10	Nanotechnology based tools to enhance agricultural productivity Nano Based Agri and Food Products, food preservation and toxicity.	
	11	Nanopesticides and Nanofertilizers. Nano-biostimulants and soil enhancers.	
	12	Nano-enabled technologies and abiotic stress management.	
V	**Nanobiotechnology for Crop Improvement**		**9**
	13	Precision Delivery Systems, Diagnostics and sensing.	
	14	Nanotechnology for environment: contamination detection and remediation.	
	15	Activities: i. Visit to Centre for Nanotechnology in Kerala/India ii. Brainstorming lectures	
		Practicals 1. Synthesis of Ag metal nanoparticles by chemical route 2. Green synthesis of chitosan nanoparticles 3. Synthesis of transition metal oxide nanoparticles by hydrothermal route 4. Analysis of nanoparticles by UV-Vis and FTIR spectroscopy	30hrs

		5. Analysis of the XRD spectrum of a standard sample	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To compare the different types of nanomaterials and understand the basic methods involved in the synthesis of nanomaterials.	R, U	2
CO-2	To familiarize with the basic properties of nanomaterials and the approaches undertaken to characterize the nanomaterial.	R,U,Ap	1,2
C0-3	To analyze the applications of nanotechnology in the healthcare field.	R,U,An, Ap	2,4
CO-4	To relate the role of nanobiotechnology in the field of agriculture.	R, U	3
CO-5	Point out the applications of nanotechnology in crop improvement.	R, U,An	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Nanobiotechnology

Credits: 4:0:0 (Lecture:Tutorial)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	To compare the different types of nanomaterials and understand the basic methods involved in the synthesis of nanomaterials.	2	R, U	F, C,P	L/T	P
CO-2	To familiarize with the basic properties of nanomaterials and the approaches undertaken to characterize the nanomaterial.	1,2	R,U,Ap	F, C	L/T	
C0-3	To analyze the applications of nanotechnology in the healthcare field.	2,4	R,U,An, Ap	F, C	L/T	
CO-4	To relate the role of	3	R, U	F, C	L/T	

	nanobiotechnology in the field of agriculture.					
CO-5	Point out the applications of nanotechnology in crop improvement.	3,4	R, U,An	F, C	L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO2**	**PSO 3**	**PSO4**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	2	-	-	-				2		-
CO 2	2	-	-	-				2		
CO 3	-	2	-	-						3
CO 4	-	3	1	2						3
CO 5	-	-	-	3						3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. A. L. Rogach, Semiconductor nanocrystal quantum dots synthesis, assembly, spectroscopy and applications (Springer, Wien; London, 2008).

2. E. Gazit, Plenty of room for biology at the bottom: an introduction to bionanotechnology (Imperial College Press ; Distributed by World Scientific Pub. in the USA, London : Hackensack, NJ, 2007).

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University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3VACBCH200				
Course Title	**Basic Dietetics**				
Type of Course	VAC1				
Semester	**III**				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hrs	-		3 hrs
Pre-requisites	–				
Course Summary	This course focuses on the basic concepts in dietetics, purpose of diet therapy, diet modifications for common clinical conditions, specific disease conditions, diet for the management of lifestyle diseases and dietetics for metabolic disorders and addictive behaviour.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Basics Concepts in Dietetics**		**9**
	1	Purpose and principle of therapeutic diets	
	2	Modifications of normal diet and classification of therapeutic diets	
	3	Routine hospital diets-regular diet, light diet, soft diet, and full liquid diet.	
	4	Types of feeding – oral feeding, tube feeding, parenteral nutrition and intravenous feeding	
II	**Diet Modifications for Clinical Conditions**		**9**
	5	Modification of diet - Febrile conditions and infections	
	6	Diets for gastrointestinal disorders, constipation, diarrhoea, and peptic ulcer	
	7	Diet for renal diseases - nephritis, nephrotic syndrome, and renal failure.	
III	**Nutritional Requirements in Specific Disease Conditions**		
	8	Nutrition in cancer	
	9	Nutrition in Immune system dysfunction- AIDS	
	10	Nutrition in Allergy.	
IV	**Dietary Management of Lifestyle Diseases**		**9**
	11	Management of diabetes	
	12	Management of Obesity	
	13	Management of Cardiovascular diseases	
	14	Management of liver diseases	
V	**Nutrition in Specific Clinical Situations**		**9**
	15	Nutrition in burns and surgery.	
	16	Nutrition-Addictive behaviour in anorexia, bulimia nervosa	
	17	Nutrition support in metabolic disorders.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Relate the purpose and conditions requiring diet therapy.	R, U	1, 3
CO-2	Relate and apply diet modifications in common illnesses	R, U, Ap	1, 3
CO-3	Relate and plan diets for serious terminal illnesses	R, U, Ap	1, 3
CO-4	Apply the knowledge of management of lifestyle diseases through diet and plan diet accordingly.	R, U, Ap	1, 3
CO-5	Relate and plan nutritional requirements for addictive behaviours, surgery, and metabolic disorders.	R, U, Ap	1, 3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Basic Dietetics Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1, 3	R, U	F, C	LT	
2	2	1, 3	R, U, Ap	F, C	LT	
3	3	1, 3	R, U, Ap	F, C	LT	
4	4	1, 3	R, U, Ap	F, C	LT	
5	5	1, 3	R, U, Ap	F, C,	LT	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	-	-		2	2		3		
CO2	2	-	2	-	-		2	2		2		
CO3	2	-	2	-	-		2	2		2		
CO4	2	-	2	-	-		2	2		3		
CO5	2	-	2	-	-		2	2		2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam Multiple choice questions

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.
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University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3VACBCH201				
Course Title	Drug Abuse and Prevention				
Type of Course	VAC2				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites	NIL				
Course Summary	The course focuses on the basic concept of drug abuse, signs & symptoms, causes & consequences, management & prevention of drug abuse. Course provides knowledge on the practical applications for the successful prevention of drug abuse.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Drugs and Drug Abuse**		**12**
	1	Definition of drugs and their various forms. Prevalence and impact of drug abuse on individuals and society. Prevalence of menace of Drug Abuse.	
	2	Introduction to drugs of abuse: Short Term, Long term effects & withdrawal symptoms. Differentiating Drug Abuse from Drug Dependence. Physical and psychological dependence- concepts of drug tolerance.	
	3	Stimulants: Amphetamines, Cocaine, Nicotine. Depressants: Alcohol, Barbiturates- Nembutal, Seconal, Phenobarbital Benzodiazepines – Diazepam, Alprazolam, Flunitrazepam.	

	4	Narcotics: Opium, morphine, heroin. Hallucinogens: Cannabis & derivatives (marijuana, hashish, hash oil). Steroids. Inhalants.	
II	**Nature of the Problem**		**6**
	5	Vulnerable Age Groups.	
	6	Signs and symptoms of Drug Abuse (a)- Physical indicators (b)- Academic indicators (c)- Behavioral and Psychological indicators	
III	**Causes and Consequences of Drug Abuse**		**4**
	7	Causes -Psychological and Sociological	
	8	Consequences of Drug Abuse -For individuals, For families, For society & Nation.	
IV	**Management & Prevention of Drug Abuse**		**8**
	9	Management of Drug Abuse. Prevention of Drug Abuse	
	10	Narcotic Drugs and Psychotropic substances Act 1985	
	11	Case studies and real-life examples of successful prevention .	
	12	Role of Family, School, Media, Legislation & Deaddiction Centers.	
V	**Activities**		**15**
	13.	● Visit to Deaddiction centre and report submission ● Seminar Presentation ● Collaboration with college Vimukthi club to give awareness class to students and community. ● Discussion on the importance of community involvement and collaboration in prevention efforts. ● Case study and real life examples of successful prevention of drug abuse.	

Course Outcomes

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Understand the basic concepts & overview of drug abuse.	R, U	2
CO-2	Identify the signs & symptoms of drug abuse	R, U	3

C0-3	Differentiate the psychological & sociological causes of drug abuse and its consequences for individuals , family, society & nation.	R, U	3
CO-4	Gain knowledge on the management & prevention of drug abuse or apply through activities	R, U , Ap	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	1	2	R, U	F, C	LT	
2	2	3	R, U	F, C	LT	
3	3	3	R, U	F, C	LT	
4	4	2	R, U , Ap	F, C	LT	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	-	2	-	-			3	-	-	-		3		3
CO2	-	2	-	-					2	-	-	-	-	3
CO3	-	-	2	-			-	3	-	-	-			3
CO4	-	-	-	3			-	-	-	-	-	3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam-Multiple choice/case studies
- Programming Assignments
- Final Exam -Multiple choice/case studies

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

References

1. National Institute on Drug Abuse (NIDA)

2. Substance Abuse and Mental Health Services Administration (SAMHSA)

3. Centers for Disease Control and Prevention (CDC)

4. World Health Organization (WHO)

5. Extent, Pattern and Trend of Drug Use in India, Ministry of Social Justice and Empowerment, Government of India, 2004.

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Journal Articles:

1. McLellan AT, Lewis DC, O'Brien CP, Kleber HD. "Drug dependence, a chronic medical illness: implications for treatment, insurance, and outcomes evaluation." JAMA. 2000.

2. Volkow ND, Koob GF, McLellan AT. "Neurobiologic Advances from the Brain Disease Model of Addiction." N Engl J Med. 2016.

3. Gilman JM, Ramchandani VA, Crouss T, Hommer DW. "Subjective and neural responses to intravenous alcohol in young adults with light and heavy drinking patterns." Neuropsychopharmacology. 2012.

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University of Kerala

Discipline	Biochemistry				
Course Code	UK3VACBCH202				
Course Title	Fermentation Technology				
Type of Course	VAC3				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					
Course Summary	The course is designed to provide a comprehensive understanding of fermentation principles and their applications in industrial processes. The course emphasizes both theoretical concepts and practical applications to ensure that students gain a good understanding of fermentation technology and its industrial applications.				

Detailed Syllabus: FERMENTATION TECHNOLOGY

Module	Unit	Content	Hrs
I	**Basic Concepts of Fermentation**		**6**
	1	Fermentation-Definition, Factors affecting the fermentation process, Biological agents responsible for fermentation (Bacteria,Yeasts, Molds,Enzymes).	
	2	Microbial growth kinetics: Batch culture, Continuous Culture, Fed – Batch culture.	
II	**Media for Industrial Fermentations**		**6**
	5	Media formulation	
	6	Sterilization	
	7	Development of inoculum for industrial fermentations.	
III	**Fermenter**		
	9	Design-Parts	
	10	Functions	
	11	Types-Batch & continuous	
IV	**Recovery of Fermentation Products**		**6**
	18	Methods for cell lysis	
	19	Physical separation, liquid extraction, precipitation, chromatography, drying	
V	**Production of Fermentation Products**		**6**

	23	Production of Alcohol	
	24	Production of Organic acid (Citric acid)	
	25	Production of Antibiotic (Penicillin)	
	26	Production of Amino acid (Glutamic acid)	
	27	Production of Vitamin B_1	

	28	Production of Single Cell Protein	
		Practicals (30 Hours) ● Demonstration of fermentation by yeast ● Preparation of Fermented milk product	**30**

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basic principles of fermentation	R, U	1,4
CO-2	Learn the role of microorganisms in fermentation	R, U	1,4
CO-3	Proficiency in media formulation and sterilization	R, U, Ap	1,4
C0-4	Acquire knowledge about fermentors	R, U	1,4
C0-5	Gain knowledge about the production technologies for different types of fermented food products	R, U, Ap	1,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,4	R, U	F, C	LT	
2	2	1,4	R, U	F, C	LT	
3	3	1,4	R, U, Ap	F, C	LT	
4	4	1,4	R, U	F, C	LT	
5	5	1,4	R, U, Ap	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	2	-	-		2		3		
CO 2	1	-	-	2	-	-		2		3		
CO 3	1	-	-	2	-	-		2		3		
CO 4	1	-	-	2	-	-		2		3		
CO 5	1	-	-	2	-	-		2		3		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker, Stephen J Hall.
2. Industrial Microbiology - L.E. Casida,JR (ISBN 0 85226 1012) .
3. Industrial Microbiology-A.H.Patel (ISBN 0333 90842 2) .
4. Prescott & Dunn's Industrial Microbiology Reed G (Ed) ISBN 81-239-1001-0) (Fourth Edition).
5. Food Microbiology-William C.Frazier Dennis .C Westhoff (ISBN 0-07-46210147).
6. Fermented Foods. Economic Microbiology Vol 7 rose A .

7. Manual of Industrial Microbiology and Biotechnology, Demin & Davis .
8. Applied Microbiology- Musharraffudde .

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK211DSCBCH				
Course Title	**ENZYMOLOGY**				
Type of Course	**DSC16**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	This course provides a thorough understanding of enzymology comprising of nomenclature, classification of enzymes, mechanism of enzyme catalysis, enzyme kinetics, inhibition, regulation, industrial, diagnostic & therapeutic applications of enzymes. It expertise students to analyze enzymes isolated from plant & human sources.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	Introduction to enzymes and coenzymes		**8**
	1	Properties, nomenclature and classification of enzymes.	
	2	Holoenzyme, apoenzyme, prosthetic group,cofactor metalloenzymes, coenzymes and their functions (one reaction involving TPP, FMN, FAD, NAD, NADP, PLP, Biotin)	
	3	Isolation & purification of enzymes- Cell disruption, differential centrifugation & chromatographic techniques (Basic concepts only)	
	4	Enzyme units & criteria of purity of enzyme -IU, Katal, turnover number and specific activity	
II	**Mechanism of Enzyme catalysis**		**6**
	5	Enzyme Substrate interaction- Enzyme specificity characteristic features of the active site, activation energy	
	6	Mechanism of enzyme action – general acid-base catalysis, covalent catalysis, proximity and orientation effect, and metal ion catalysis(Basics only)	
	7	Hypotheses of enzyme-substrate binding -Fischer hypothesis-lock and key model, Koshland hypothesis- Induced fit theory	
III	Enzyme kinetics		**9**
	8	Factors affecting the velocity of enzyme-catalyzed reaction- enzyme concentration, substrate concentration, temperature, pH, inhibitors and activators	
	9	Derivation of Michaelis- Menten equation, significance of Vmax and Km value	
	10	Derivation of Lineweaver- Burk equation and LB-plot (for single enzyme catalyzed reaction)	
IV	Enzyme inhibition & regulation		**10**
	11	Enzyme inhibition- Irreversible and reversible (competitive, noncompetitive and uncompetitive inhibition with an example each	
	12	Covalent modification (Glycogen phosphorylase as example)	
	13	Allosteric regulation (ATCase as example)	

	14	Zymogens (trypsinogen, chymotrypsinogen and pepsinogen).	
	15	Isozymes (LDH, Creatine kinase)	
V	Applied enzymology		**12**
	16	Industrial uses of enzymes-Amylases, cellulose-degrading enzymes, lipases, proteolytic enzymes	
	17	Diagnostic and therapeutic applications,	
	18	Designer enzymes - Abzymes, Ribozymes.	

PRACTICALS (30 hrs)

1. Isolation & assay of Urease from Red gram

2. Analysis of enzyme kinetics-effect of temperature, P^H, concentration of enzyme & concentration of substrate

3. Assay of salivary amylase

Course Outcomes

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Describe nomenclature , classification of enzymes, mechanism of enzyme catalysis and inhibition	R,U	1, 3, 4
CO-2	Understand & analyze enzyme kinetics.	U, An	1, 2, 4
CO-3	Describe the major industrial, diagnostic & therapeutic applications of enzymes	R, U	1, 3, 4
CO-4	Expertise in the isolation & analysis of enzymes	U, Ap	1, 2, 3 , 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe nomenclature, classification of enzymes, mechanism of enzyme catalysis and inhibition	1, 3, 4	R,U	F, C	LT	
CO-2	Understand & analyze enzyme kinetics.	1, 2, 4	U, An	P	LT	P
CO-3	Describe the major industrial, diagnostic & therapeutic applications of enzymes	1, 3, 4	R, U	F, C	LT	
CO-4	Expertise in the isolation & analysis of enzymes	1, 2, 3 , 4	U, Ap	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	2	2	-	-		2		2		
CO 2	2	3	-	2	-	-	2	2		2		3
CO 3	1	-	2	2	-	-	2	2		2		
CO 4	1	2	2	2	-	-	1	2		3		2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	Biochemistry				
Course Code	UK4DSCBCH201				
Course Title	**CELL BIOLOGY**				
Type of Course	**DSC20(Major)**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	The course provides a thorough understanding of cell biology, encompassing fundamental principles, membrane structure, cell division, and cell interactions. It equips students with practical skills in microscopy and subcellular fractionation and microscopy.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of Cells**	**8**
	1	Discovery of Cell and Cell Theory	
	2	Comparison between plant, animal and bacterial cells, prokaryotic and eukaryotic cell	
	3	Subcellular fractionation and marker enzymes	
	4	Subcellular Organelles -Structure and functions (Nucleus, Mitochondria, Ribosomes, Endoplasmic reticulum, Golgi complex, Lysosomes, Microbodies, Vacuoles, Chloroplast), Cytoskeleton – Structure & Functions	
II		**Plasma Membrane**	**10**
	5	Models of membrane structure -Charles Overton, Langmuir, Gorter and Grendel, Danielli and Davson,Robertson, Singer and Nicolson	

	6	Membrane- Composition, fluidity and functions	
	7	Membrane Transport- Simple diffusion, Facilitated diffusion (brief outline of GLUT-1, 2, 3, 4 &5), Ion channels	
	8	Active transport: Primary active transport- P-type (Na^+ K^+ATPase), V-type, F-type pumps & Secondary active transport -Symport, Uniport and Antiport. Transport of macromolecules-Endocytosis & Exocytosis	
III	**Cell Division**		**9**
	9	Cell cycle- Phases, Mitosis	
	10	Meiosis	
	11	Cell death -Apoptosis and Necrosis	
	12	Apoptotic pathways-Intrinsic & Extrinsic, Caspases	
IV	**Cancer**		**9**
	13	**Cancer Cells-** basic properties	
	14	Oncogene & Tumor Suppressor genes, Role of p53 (brief outline only)	
	15	Tumor markers- Alpha-fetoprotein (AFP), Acid Phosphatase, Alkaline phosphatase, Carcino embryonic antigen (CEA), Prostate-specific antigen (PSA) -Clinical significance	
V	**Interaction between Cells and their Environment**		**9**
	16	Extra Cellular Matrix- Basic features, Molecular components & Function	
	17	Interaction of cells with ECM- Integrins	
	18	Cell-cell adherence junctions: Adherence junction, Desmosomes, Tight Junction, Gap Junction (Basic structural organization and function only)	
	19	Cell-cell interaction- Townes and Holtfreter Experiment	
	20	Cell-cell adherence junctions: Adherence junction, Desmosomes, Tight Junction, Gap Junction (Structural organization and function only)	
	21	**Practical (30hr)** ● Basic Microscopy & Instrumentation ● Mitosis –Squash preparation & Staining of Onion root tips to study the different stages of mitosis. ● Subcellular Fractionation	30

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Comprehensive understanding of cell	R, U	1
CO-2	Familiarize with the mechanism of membrane transport	R, U	1, 3, 4
C0-3	Acquire a fundamental understanding of cell division, apoptosis & cancer	U	1, 3, 4
C0-4	Demonstrate a thorough understanding of interaction between Cells and their environment	Ap, An	1, 2
CO-5	Understanding the use of microscopy and its application in studying mitosis	R,U,Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-

Create Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Comprehensive understanding of cell	1	R, U	F, C	LT	
CO-2	Familiarize with the mechanism of membrane transport	1, 3, 4	R, U	F, C	LT	
C0-3	Acquire a fundamental understanding of cell division, apoptosis & cancer	1, 3, 4	U	F, C	LT	
C0-4	Demonstrate a thorough understanding of interaction between Cells and their environment	1, 2	Ap, An	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-		2				
CO2	2		2	2	-	-	2	2		2		
CO3	2		2	2	-	-	2	2		2		
CO4	2	2			-	-		2				3
CO5	2	1	-	-	-	-		2				3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Cell and Molecular Biology-Gerald Karp, John Wiley & Son, Inc. New York ISBN 9780470-16961-2, 5th Edition.
- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc.,ISBN 0-471-44180-5, 3rd Edition.
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- The cell: A molecular approach by Geoffrey M Cooper and Robert E Hausman.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK4DSCBCH202				
Course Title	Specialized tissues and membranes				
Type of Course	DSC21(MAJOR)				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in Biology				
Course Summary	The Course describes anatomy, physiological and biochemical functions of specialised tissues of the body and biological membranes.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Epithelial Tissue and Connective Tissue**	**9**
	1	Epithelial tissue - general character and functions, classification – simple and stratified.	
	2	Connective tissue – areolar tissue, adipose tissue, white fibrous tissue, yellow elastic tissue, reticular tissue, lymphoid tissue, cartilage, – structure and function.	
	3	Reticuloendothelial system.	
II		**Muscle and nervous system**	**9**
	4	Muscle tissue – voluntary, involuntary and cardiac, Ultra structure-overview	
	5	Structure and function of muscle cell	
	6	Muscle proteins-Myosin and Actin, Tropomyosin, Troponin,	
	7	Nervous system-Subdivision	
	8	Structure of neurons, Structural and functional classification of neurons	
	9	Axonal transport, Types of neuroglia, Myelin	
III		**Eye**	**9**
	10	Eye - Structure and functions of rods and cones	
	11	Photochemistry of vision, role of vitamin A, light activation of rhodopsin, biochemical reactions (cycle),	
	12	Origin of nerve impulse in vision, Cone vision- cones, mechanism of color vision, light and dark adaptation.	
IV		**Renal system**	**9**
	13	Structure and function of nephron	
	14	Renal blood flow and its importance	
	15	Formation of Urine- Ultrafiltration, glomerular filtration rate, tubular reabsorption,	
	16	Threshold substances, tubular secretion.	
	17	Composition of urine-normal and abnormal constituents	

V	**Membrane and transport across membrane**		**9**
	18	Membranes - cutaneous, mucous membrane, serous membrane, endothelium, synovial membrane	
	19	Models of membrane structure (Charles Overton, Langmuir, Gorter and Grendel, Danielli and Davson, Robertson, Singer and Nicolson).	
	20	Common features, functions and composition of membrane, membrane fluidity and factors affecting fluidity.	
	21	Transport across membranes: exocytosis, endocytosis, simple diffusion, facilitated diffusion (brief outline of GLUT-1, 2, 3, 4 &5), ion channels, active transport (primary active transport- P-type [Na+K +ATPase], V-type, F-type pumps), secondary active transport (symport, uniport and antiport).	
		Practical	**30**
	22	Urine Analysis Qualitative tests of urine: Detection of abnormal constituents Proteins (Coagulation test, sulfosalicylic acid test, test for Bence-Jones proteins) Sugars (Benedicts test) Hemoglobin (o-toluidine test) Ketone bodies (Rothera's test, Gerhardt's test) Bile pigments (Fouchet's test, Gmelin's test) Bile salts (Hay's sulphur test). *Lab record should be maintained	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the structure and function of epithelial and connective tissues of the body	R, U	1, 4
CO-2	Describe structure and function of muscle and nervous system	R, U	1, 4
CO-3	Restate the structure of eye and mechanism of vision	R, U	1, 4
CO-4	Illustrate the structural and functional aspects of renal system	R, U	1, 2, 4
CO-5	Explain the structure of biological membranes and the mechanism of transport of molecules across membrane	R, U	1, 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

CO-1	Discuss the structure and function of epithelial and connective tissues of the body	1, 4	R, U	F, C	L,T	
CO-2	Describe structure and function of muscle and nervous system	1, 4	R, U	F, C	L,T	
CO-3	Restate the structure of eye and mechanism of vision	1, 4	R, U	F, C	L,T	
CO-4	Illustrate the structural and functional aspects of renal system	1, 2, 4	R, U	F, C	L,T	P
CO-5	Explain the structure of biological membranes and the mechanism of transport of molecules across membrane	1, 4	R, U	F, C	L,T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	-	3	-	-	2	2		2		
CO 2	2	-	-	3	-	-	2	2		2		
CO 3	2	-	-	3	-	-	2	2		2		
CO 4	2	2	-	3	-	-	2	2		2		3

CO 5	2	-	-	3	-	-	2	2		2		

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Rodwell, Victor W., David Allen Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil. Harpers illustrated biochemistry. McGraw-Hill Medical Publishing Division, 2015.
2. Devlin, Thomas M. Textbook of biochemistry: with clinical correlations. John Wiley & Sons, 2011.
3. Hall, John E. Guyton and Hall textbook of medical physiology. Elsevier Health Sciences, 2010.
4. Ganong, W. H. Review of Medical Physiology. Appleton and Lange 1999.
5. White, A., P. Handler, and E. L. Smith. Principles of Biochemistry. New York, McGraw-Hill 1117 (1954).

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK4DSCBCH203				
Course Title	**Plant Biochemistry**				
Type of Course	**DSC21**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NA				
Course Summary	The purpose of this course is to give students a brief awareness on the biochemical mechanisms occurring in plants, important secondary metabolites, hormones and phenomena such as photomorphogenesis and senescence.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Photosynthesis**		**10**
	1	Introduction, light and dark phase, structure of chloroplast, excitation of molecules by absorption of light, structure and properties of chlorophyll	
	2	Photochemical reaction system, photosynthetic electron transport chain	
	3	Cyclic and noncyclic photophosphorylation - Calvin cycle, regulation, Hatch-Slack pathway (C4 pathway)	
	4	Photorespiration, comparison of mitochondrial and photosynthetic electron transport chain.	
II	**Secondary metabolites**		**12**
	5	Phenols - Functions, Shikimate Arogenate Pathway, Phenyl Alanine/ Hydroxycinnamate pathway, Phenyl propanoids pathway,	
	6	Hydroxycinnamate conjugates, Hydroxycoumarins, hydroxy benzoates	
	7	Flavonoids, Lignins, Lignans, Neolignans, Tannins and Quinones.	
	8	Isoprenoids - Nomenclature, Classification and Occurrence, General pathway for Terpenoid biosynthesis and functions.	
	9	Alkaloids - Nicotine, Caffiene and Cocaine. Toxic secondary metabolites, secondary metabolites of medicinal importance	
III	**Plant Hormones**		**9**
	10	Structure and function of plant hormones such as Ethylene, Cytokinins, Auxins, Indole Acetic Acid,	
	11	Absicic acid, Florigin and Gibberlins.	
	12	Photochemical and hormone control in plants	
IV	**Photomorphogenesis and Senescence**		**9**
	13	Phytochromes - Structure, properties, function	

	14	Mechanism of action of phytochromes	
	15	Calcium and Calmodulin mediated Pfr responses	
	16	Senescence: Various levels of senescence, Factors affecting senescence	
	17	Mechanism of different biochemical changes during senescence	
	18	Senescence related to stress, Regulation of Senescence	
V	**Biochemical basis of Plant diseases**		**5**
	19	Host pathogen interaction, Mechanism of pathogenesis	
	20	Enzymes, Toxins, Mechanism of Plant resistance	
	21	Phytoallexins, Elicitors, Pathogen related proteins	
		Practical	**30**
	22	• Extraction Methods- Choice of solvents based on polarity • Extraction Procedure- Cold and Hot solvent extraction • Qualitative analysis of secondary metabolites • Estimation of phenols, Estimation of Tannins, Estimation of alkaloids, Estimation of saponins • Separation techniques: Paper chromatography, • Thin Layer Chromatography, • Column Chromatography, • Spectroscopic analysis of extract fractions for phytochemicals	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Define plant processes like photosynthesis	U	1
CO-2	Discuss the importance of photorespiration and electron transport chain in plants	An	1,2
CO-3	Explain the value of secondary metabolites produced in plants in pharmaceutical, food, agricultural industries and ecology	U	2
CO-4	Discuss the role of plant hormones and how these regulate plant functions	Ap	2
CO-5	Describe the process of photomorphogenesis and aging in plants	U	1
CO-6	Discuss host-pathogen interaction, plant resistance and disease development in plants	An	3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Plant Biochemistry

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

1	1	1,	U	F, C	LT	
2	2	1,2	An	F, C	LT	
3	3	2	U	F, C	LT	
4	4	2	Ap	F, C	LT	
5	5	1	U	F, C	LT	
6	6	3	An	F, C, P	LT	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-		2				
CO 2	2	3	-	-	-	-		2				3
CO 3	-	2			-	-						3
CO 4	-	2			-	-						3
CO 5	-	2			-	-						3
CO 6	-		2		-	-	2	2		2		

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal	Assignment	Project	End Semester

	Exam		Evaluation	Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

References

1. Dey, Prakash M., and Jeffrey B. Harborne, eds. Plant biochemistry. Academic Press, 1997.
2. Bonner, James, and Joseph E. Varner, eds. Plant biochemistry. Elsevier, 2012.
3. Salisbury, Frank B., and Cleon W. Ross. "Plant physiology. 4th." Edn. Belmont, CA. Wadsworth (1992).
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3. https://books.google.co.in/books?id=AVTtCAAAQBAJ&printsec=frontcover&dq=plant+hormones&hl=en&sa=X&ved=2ahUKEwivvqKs457rAhUbb30KHQ4aBREQ6AEwAnoECAQQAg#v=onepage&q=plant%20hormones&f=false

University of Kerala

Discipline	Biochemistry
Course Code	UK4DSCBCH204
Course Title	Techniques in Biochemistry
Type of Course	**DSC 24**
Semester	**IV**
Academic Level	300 - 399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites					
Course Summary	The course provides a thorough understanding of different techniques used in the biochemical field including types of microscopy, staining techniques, colorimetry, spectrophotometry, centrifugation method, different types of chromatographic and electrophoretic techniques. The course also provides an overview on different spectroscopic and histopathologic techniques.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Microscopy & Photometry**		**9**
	1	Principle, instrumentation and applications of Simple microscope	
	2	Principle, instrumentation and applications of compound microscope	
	3	Basic staining techniques (Gram staining)	
	4	Colorimeter and spectrophotometer	
II	**Methods in Homogenization & Centrifugation**		**9**
	5	Methods of tissue homogenization, Subcellular fractionation	
	6	Principle, instrumentation, and applications of different types of centrifugations (Differential and density gradient),	
	7	Ultracentrifugation.	
	8	Different types of rotors.	
III	**Chromatography & Electrophoresis**		**9**
	9	Principle, procedure, and applications of Paper chromatography, TLC	
	10	Ion exchange, Molecular sieve chromatography	
	11	HPLC	
	12	Agarose gel electrophoresis, SDS PAGE	
IV	**Spectroscopy**		**9**
	18	Flame Photometry, Fluorimeter	
	19	ESR and NMR spectroscopy	
	20	GC MS and HPLC MS	
V	**Basics of Histopathology**		**9**
	23	Basic knowledge on histopathology	
	24	Different steps such as fixation, tissue processing, cutting, staining and analysis	
	25	Immunohistochemistry	
		Practicals ● Solvent preparation for chromatography ● Paper chromatography and TLC ● Development of chromatogram ● Mechanical homogenization by mortar and pestle ● Serum separation by centrifugation ● Demonstration of electrophoresis	30hrs

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4. Biologist's Guide to Principles and Techniques of Practical Biochemistry by BryanL.Williams, Keith Wilson Hodder Education, ISBN 071312461X (0-7131-2461-X).
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8. Research Methodology for Biological Sciences (2006) by Gurumani N Publisher: MJP Publishers ISBN: 8180940160 ISBN-13: 9788180940163, 978-8180940163.
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10. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology. 2010.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basic principle, instrumentation and applications of different microscopic techniques and photometry.	R, U	1,2
CO-2	Explain the different methods of homogenization, subcellular fractionation, and centrifugation.	R, U	1,2
CO-3	Gain knowledge on different types of chromatographic, electrophoretic and spectroscopic techniques.	R, U	1,2,3
CO-4	Understand the basic concept of histopathology	R,U	1
CO-5	Gain confidence to do various chromatographic and centrifugation techniques	R, U, Ap	1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the basic principle, instrumentation and applications of different microscopic techniques and photometry.	1,2	R, U	F, C,P	L/T	P

CO-2	Explain the different methods of homogenization, subcellular fractionation, and centrifugation.	1,2	R, U	F, C,P	L/T	P
CO-3	Gain knowledge on different types of chromatographic, electrophoretic and spectroscopic techniques.	1,2,3	R, U	F, C,P	L/T	P
CO-4	Understand the basic concept of histopathology	1	R,U	F, C	L/T	
CO-5	Gain confidence to do various chromatographic and centrifugation techniques	1,2,3	R, U, Ap	F, C,P	L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	3	3			-	-	2					
CO 2	2	2			-	-	2					
CO 3	2	2	3		-	-	2					
CO 4	2				-	-	1					
CO 5	2	3			-	-	2					

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**BIOCHEMISTRY**				
Course Code	UK4DSEBCH200				
Course Title	**Lifestyle Diseases and Dietary Management**				
Type of Course	**DSE3** (Elective)				
Semester	III				
Academic Level	200 -299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	2 hours	4 hours
Pre-requisites	NIL				
Course Summary	The course is designed to provide a comprehensive approach to different lifestyle diseases, associated symptoms and risk factors. The course focuses on the importance of lifestyle modifications through diet for the management of lifestyle diseases.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Lifestyle Diseases**		**9**
	1	Definition and types of lifestyle diseases	
	2	Importance of lifestyle factors in disease development and prevention -role of diet and exercise.	
	3	Significance of balanced diet and BMI	
II	**Hypertension and Cardiovascular Diseases**		**9**
	4	Characteristic features and causes of hypertension. Definition of coronary heart disease, angina, myocardial infarction, ischemic disorders and atherosclerosis.	
	5	Symptoms and Risk factors of hypertension and CVDs	
	6	Dietary management-Low fat diet, high fiber diet, low carbohydrate diet, low sodium and improved intake of calcium, magnesium and potassium, Mediterranean diet and DASH diet.	
III	**Diabetes Mellitus**		**9**
	7	Basic information about Type-I diabetes, Type-II diabetes, and Gestational Diabetes.	
	8	Symptoms and Risk factors of Diabetes	

	9	Dietary Management-constant carbohydrate meal plan, counting carbohydrate meal plan, exchange meal plan, balanced diet, consistent mealtime, fiber rich diet, low GI food, moderate protein diet and low intake of sodium.	
IV	**Obesity**		**9**
	10	Types of obesity based on BMI. Subcutaneous obesity and abdominal obesity. Factors causing obesity- physiological, social, environmental, and psychological factors Childhood obesity and consequences. Basic concepts in weight management-role of exercise and diet plans.	
	11	Risk factors of Obesity	
	12	Dietary management- Balanced diet, low-calorie diets and reduced–portion size diets.	
V	**Liver Diseases**		**9**
	13	Basic information about the liver diseases due to unhealthy lifestyle- NAFLD, alcoholic liver disease, liver cirrhosis and fatty liver.	
	14	Symptoms and Risk factors	
	15	Dietary management- weight management through healthy diet and exercise, fiber rich diet, avoiding alcohol and processed foods.	

Practical (30 hours)

Planning and preparation of diet charts for the following diseases:

- Hypertension and cardiovascular diseases
- Diabetes mellitus
- Obesity
- Liver diseases

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Define and explain the different types of lifestyle diseases and understand the importance of a balanced diet.	R, U	1
CO-2	Outline and interpret the causes and risk factors of major lifestyle diseases.	R, U	1
CO-3	Relate and interpret the symptoms associated with different lifestyle diseases.	R, U	1
CO-4	Discuss and identify the type of diet to be followed in	R, U	1,3

	different lifestyle diseases.		
CO-5	Plan diets for the management of lifestyle diseases.	R, U, Ap	1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-

Create Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
CO-1	Define and explain the different types of lifestyle diseases and understand the importance of a balanced diet.	1	R, U	F, C	LT	
CO-2	Outline and interpret the causes and risk factors of major lifestyle diseases.	1	R, U	F, C	LT	
CO-3	Relate and interpret the symptoms associated with different lifestyle diseases.	1	R, U	F, C	LT	
CO-4	Discuss and identify the type of diet to be followed in different lifestyle diseases.	1,3	R, U	F, C	LT	
CO-5	Plan diets for the management of lifestyle diseases.	1,3	R, U, Ap	F, C,	LT	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-			2				
CO 2	1	-	-	-	-			2				
CO 3	1	-	-	-	-			2				
CO 4	1	-	2	-	-		2	2		2		
CO 5	1	-	2	-	-		2	2		2		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

CO 5	✓	✓		✓

References

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4. Food and Lifestyle in Health and Disease by Bruno Pham-Huy, Chuong and Pham Huy. CRC Press
5. Guide to Prevention of Lifestyle Diseases. R. Kumar, M. Kumar, Deep & Deep Publications, ISBN-13: 978-8176295185.
6. Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK4DSEBCH201				
Course Title	**INDUSTRIAL ENZYMES**				
Type of Course	**DSE4**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NIL				
Course Summary	The course provides a comprehensive understanding of industrial enzymology, history of enzyme development, as well as large-scale enzyme production techniques. Students gain insights into enzyme applications across various industries, including bakery and beverage production, dairy, fruit, vegetable, and meat processing, as well as paper, textiles, leather, medicine, research, pharmaceuticals, and cosmetics. By the end of the course, students are equipped with the knowledge and skills to analyze enzyme roles, optimize production processes, and contribute to innovation and sustainability in diverse industrial sectors				

Detailed Syllabus:

Module	Unit	Content		Hrs
I	**Introduction to industrial enzymology**			**9**
	1	Enzyme Structure**,** function and specificity		

	2	History of industrial enzyme development		
	3	Large Scale production of enzymes on an industrial Scale		
II	**Bakery & Beverage Industry**			**9**

	5	utilization of enzymes in the bakery sector, specifically in the creation of sweeteners and dough enhancements.		
	6	Process involved in beer and wine production**.**		
	7	Analyze the pivotal role of enzymes in various aspects of fruit juice extraction, wine production, brewing, and their impact on product flavor profiles and shelf stability.		
III	**Dairy, fruit & Vegetable and Meat processing industry**			**9**
	8	Enzymatic processes involved in cheese making and the production of other dairy products, emphasizing their impact on flavor development and texture enhancement.		
	9	Roles of pectinase, cellulase, amylase, and protease in fruit and vegetable processing, elucidating their contributions to product quality and shelf stability.		
	10	utilization of enzymes in meat processing, focusing on their effects on tenderness, flavor, and preservation methods.		
IV	**Paper, textiles and Leather industry**			**9**
	11	Enzymes used in paper pulp production, including the roles of cellulase, hemicellulase, and laccase in enhancing paper quality and sustainability.		
	12	Diverse enzymatic applications in the textile industry, focusing on their roles in desizing, stone washing, and bleaching processes to improve fabric quality		
	13	enhance the quality, efficiency, and sustainability of leather production, highlighting their contributions to process optimization and waste reduction.		
V	**Medicine, Research, Pharmaceutical and Cosmetic industry**			**9**
	14	Enzymes used in diagnosis and Prognosis of disease- Glucose oxidase, Cholesteryl esterase and oxidase, Peroxidase, Uricase, creatinase		

	15	Commonly used enzymes in life Science Research - molecular biology and Genetics, Proteomics and Protein Engineering**.**		
	16 **17**	Enzymes in drug manufacturing, formulation, and quality control Role of protease, lipase Cellulase, Hyaluroniclase, Amylase, Pectinase and collagenase in Cosmetic Industry		
		PRACTICALS (30 hrs) 1. Isolation & assay of amylase from horse gram seed Analysis of enzyme kinetics-effect of temperature, P^H, concentration of enzyme & concentration of substrate 2. Industrial visit		

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	The course provides a comprehensive understanding of historical evolution and impact across industries and insights into large-scale enzyme production.	R, U	1, 2, 3, 4
CO-2	Analyze emerging trends and innovations in enzyme technology within the bakery and beverage industry.	U, An	1, 3
CO-3	Evaluate the significance of enzyme applications in dairy, fruit and vegetable, meat processing, paper textile and Leather industries	R, U, Ap	1, 3, 4
CO-4	Gain insight into major diagnostic, research, Pharmaceutical, and Cosmetic applications of enzymes	R, U, Ap	1, 3, 4

3. **R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**
Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	The course provides a comprehensive understanding of historical evolution and impact across industries and insights into large-scale enzyme production.	1, 2, 3, 4	R, U	F, C	LT	
CO-2	Analyze emerging trends and innovations in enzyme technology within the bakery and beverage industry.	1, 3	U, An	F, C	LT	
CO-3	Evaluate the significance of enzyme applications in dairy, fruit and vegetable, meat processing, paper textile and Leather industries	1, 3, 4	R, U, Ap	F, C	LT	

CO-4	Gain insight into major diagnostic, research, Pharmaceutical, and Cosmetic applications of enzymes	1, 3, 4	R, U, Ap	F, C	LT	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	2	2	2	-	-	2	2		2		2
CO 2	2		3	-	-	-	2	2		2		
CO 3	1		2	2	-	-	2	2		2		
CO 4	2	-	2	3	-	-	2	2		2		

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments

- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	Biochemistry				
Course Code	UK4SECBCH200				
Course Title	**Enzyme Isolation and Analysis**				
Type of Course	**SEC-1**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	1. 2.				
Course Summary	The course provides a comprehensive overview of enzyme purification techniques, including isolation methods, separation techniques, purity detection, and industrial applications. Students will gain both theoretical knowledge and practical skills necessary for working with enzymes in various fields.				

Detailed Syllabus: Enzyme Isolation and Analysis

Module	Unit	Content	Hrs
I	**Introduction to Enzyme Purification**		**4**
	1	Objectives of enzyme purification	
	2	**Basic steps involved in the purification of enzymes**- Selection of source of enzyme, homogenization, methods of separation, determination of purity	
II	**Isolation of Enzymes from Different Sources-Basic Approach**		**12**
	5	Isolation of enzymes from microorganisms	
	6	Isolation of enzymes from plant sources	
	7	Isolation of enzymes from animal sources	
	8	Homogenization	
III	**Methods of Separation of Enzymes-Basic Principle**		**12**
	9	Dialysis & Ultrafiltration	
	10	Centrifugation	
	11	Gel filtration	

	12	Ion exchange Chromatography	
	13	Electrophoresis	
	14	Isoelectric focusing	
IV	**Detection of Purity of Enzymes**		**10**
	18	Determination of specific activity	
	19	Analytical methods to check the purity of enzymes- Ultracentrifugation, SDS PAGE and Isoelectric focussing (Basic approach)	
V	**Industrial Application of Enzymes**		**7**

	23	Enzymes in food industries	
	24	Role of enzymes in biofuel production	
	25	Role of enzymes in the paper industry	
	26	Role of enzymes in the detergent industry	

Practical (30 hours)

- Isolation of Urease
- Isolation of Amylase
- Determination of specific activity

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitiv e Level	PSO addresse d
CO-1	Understand the importance of enzyme purification	R, U	1, 2, 3
CO-2	Outline the basic steps involved in the isolation and purification of enzymes	R, U	1, 2, 3
C0-3	Acquire knowledge about the industrial applications of enzymes	R,U	1, 3, 4
C0-4	Gain practical knowledge on the isolation of enzymes	R, U,Ap	1, 2, 3, 4
CO-5	Attain knowledge about detection of purity of enzymes	R, U	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the importance of enzyme purification	1, 2, 3	R, U, Ap	F, C,	LT	
CO-2	Outline the basic steps involved in the isolation and purification of enzymes	1, 2, 3	R, U, Ap	F, C	LT	
C0-3	Acquire knowledge about the industrial applications of enzymes	1, 3, 4	U, R, An	F, C	LT	
C0-4	Gain practical knowledge on the isolation of enzymes	1, 2, 3, 4	An, Ap	F, C	LT	
CO-5	Attain knowledge about detection of purity of enzymes	1,2	R, U	F, C, P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	2	2		-	-	2	2		2		2
CO 2	1	2	2		-	-	2	2		2		2
CO 3	1		2	2	-	-	2	2		2		
CO 4	1	2	2	2	-	-	2	2		2		2

CO 5	1	1	-	-	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓

CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

Reference

- Fundamentals of Enzymology,3rdediton by Nicholas C Price & Lewis Stevens
- A Handbook of Enzyme Biotechnology by Wiseman
- Enzymes by Trevor Palmer, Philip Bonner
- Enzyme Technology by Ashok Pandey, Colin Webb, Carlos Ricardo Soccol, Christian Larroche

University of Kerala

Discipline	**BIOCHEMISTRY**				
Course Code	UK4SECBCH201				
Course Title	**DIAGNOSTIC BIOCHEMISTRY**				
Type of Course	SEC2				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Nil				

Course Summary	The course is intended to impart basic knowledge of clinical disorders, demonstrating the application of biochemical parameters and laboratory methods in, diagnosing diseases.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**An introduction to Clinical Biochemistry**		**4**
	1	Scope of clinical biochemistry in Diagnosis	
	2	Collection and preservation of biological fluids and clinical samples	
	3	Quality control and safety measures in clinical laboratory	
II	**Organ function tests**		**12**
	4	Liver function tests: - Serum Bilirubin: Total Bilirubin – Direct & Indirect, VD Bergh reaction, Liver enzymes: AST, ALT, ALP & GGT	
	5	Renal Function tests: tests of glomerular functions, , Clearance tests (creatinine and inulin clearance), Plasma creatinine, urea, β2-microglobulin	
	6	Thyroid function tests: TSH, T3, T4	
III	**Molecular diagnostics**		**12**
	7	Basics of Molecular diagnostics and its advantages over serological testing	
	8	Molecular Techniques for diagnosis – PCR , FISH	
	9	Immunodiagnostics: ELISA, Western blotting; immunocytochemistry	
IV	**Metabolic disorders**		**10**
	11	Carbohydrate metabolism-Hyperglycaemia, galactosemia, Lactose intolerance.	
	12	Nucleic acid metabolism-Hypo and hyper uricemia, gout.	
	13	Lipid Metabolism –Atherosclerosis, fatty liver	
V	**Instrumentation in Clinical Biochemistry laboratory**		**7**
	14	Semi auto and fully auto analyser (wet & dry chemistry)	
	15	ELISA, Nephelometry methods	
VI	**Practicals**		**15 hrs**
	16	Estimation of Blood glucose, Triglycerides and total cholesterol	
	17	Hematology: ESR, PCV & Blood grouping, Lab Visit	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understanding the basic set up and quality control in a clinical biochemistry lab	U	1
CO-2	Develop ability to handle biological fluids and clinical	U,E	1

	samples		
CO-3	Attain the proficiency of performing organ function tests	E, An,Ap	2
CO-4	Understanding of various metabolic disorders associated with carbohydrates, lipids and nucleic acid metabolism	A,An,U	1,4
CO-5	Acquire ability to handle basic biochemistry laboratory instruments	Ap, C	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1		1	U	F, C	L, T	
2		1	U,E	F, C	L, T	
3		2	E, An,Ap	F, C	L, T	
4		1,4	A,An,U	F, C	L, T	
5		2	Ap, C	F, C,P	L, T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	2	-		2	2		2		
CO 2	1							2				
CO 3	-	3										3
CO 4	-2	-		3			2	2		2		
CO	-	3	-		-							3

5												

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

Books for Reference:

1. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics; Elsevier
2. Clinical Biochemistry: An illustrated color text 3rd Ed. by Allan Gaw, Micheal Murphy, Robert Cowan, Denis O Reilly, Micheal Stewart and James Shepherd. Churchill Livingtons.
3. Laboratory Quality Control and Patient Safety By Jeremie M. Gras · 2017
4. Clinical Chemistry – principles, procedures and correlations, Bishop, Lipppincott,

5. Clinical biochemistry – Metabolic and clinical aspects, Pearson Professional Ltd
6. Practical clinical biochemistry, volume I and II, 5th Edition – Varley*et.al.*, CBS Publishers
7. Basic Concepts in Clinical Biochemistry: A Practical Guide By Vijay Kumar, Kiran Dip Gill · 2018

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK4VACBCH200				
Course Title	**Play of Hormones**				
Type of Course	VAC 1				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites	NA				
Course Summary	The course is intended to impart basic knowledge of the endocrine changes in a life time and its impact on the personal life				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to hormones**	9
	1	Classification, site of synthesis and function.	
	2	Disorders caused by hormone imbalance	
	3	Hormones on teenage emotions and mental health.	
II		**Role of hormones in male and female reproductive system**	9
	4	Role of hormones during menstrual cycle	
	5	Hormonal imbalance in male and female; symptoms (psychological and reproductive).	
	6	Semenarche, Menarche, Perimenopause, menopause (definition), symptoms, hormonal status and their impact.	
III		**Hormones during pregnancy and lactation**	9
	7	Endocrine fluctuations during pregnancy	
	8	Endocrine fluctuations during lactation	
	9	Postpartum depression	

IV	**Stress and hormones**		9
	10	Role of hormones in stress.	
	11	An overview of stress hormones- Epinephrine, norepinephrine and cortisol	
	12	Hormonal anxiety	
V	**Management of hormonal imbalance**		9
	13	Happy hormones. Physical activity and hormones.	
	14	Sleep cycle and hormones, obesity parameters, waist circumference is one of potentially modifiable risk factor for low testosterone and symptomatic androgen deficiency.	
	15	Awareness to society	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain a thorough grasp of how hormones regulate homeostasis by understanding their physiology and biochemistry.	U, An	1
CO-2	Analyse the role of hormones in human reproductive system	U, An, E	3
CO-3	Understand hormonal changes during pregnancy and lactation	U, An, E	1
CO-4	Apply understanding of hormonal action in stress condition	Ap, E, An	3
CO-5	Inculcate an awareness to society on how to manage imbalances associated with hormone release	C, Ap, U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Play of Hormones

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	U, An	F.C	LT	
2	2	3	U, An, E	F.C	LT	
3	3	1	U, An, E	F.C	LT	
4	4	3	Ap, E, An	F.C	LT	
5	5	1	C, Ap, U	F.C	LT	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3				-			2				
CO 2			2				2	2		2		
CO 3			2				2	2		2		
CO 4			3				2	2		2		
CO 5	1				-			2				

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

CO 5	✓	✓		✓

References

1. Text Book of Biochemistry, 5th edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi, ISBN81-8448-124-1, 9788184481242.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK3VACBCH201				
Course Title	**Science Journalism**				
Type of Course	VAC2				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites	NIL				
Course Summary	The course covers the history and current state of science communication, from its origins to modern challenges. It explores how Western science came to India and the growth of scientific institutions there. Students learn about different media used for science communication and how science intersects with politics and society. Overall, the course emphasizes the importance of clear and effective communication about science in today's world.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Evolution of Science Communication**		**12**
	1	Science communication at the end of the Enlightenment and the importance of notions of the public in the origin of modern science - development of new audiences for science in the Nineteenth century and the emergence of new science communication media (e.g. mechanics' institutes, science journalism, public museums and zoos)	5
	2	advent of the figure of the scientist as public expert and the debate about 'Two Cultures' –	4
	3	difference between science journalism and science communication	3
II	**Introduction of Western Science in India**		**10**
	4	Introduction of Western science in India through missionaries, travelers, army and civilian army of the East India Company–	3
	5	science in the 18th and 19th century –emergence of Indian pioneer scientists – science teaching-– developments during post-Independence period – emerging areas of science and technology – convergence in study of science	7
III	**Science Institutions in India**		**8**
	6	Institutions of science in India - the role of the Asiatic Society – Bose Institute	6

		– Indian Institute of Science - Council of Scientific and Industrial Research (CSIR) – Indian Space Research Organization (ISRO) – Indian Science Congress organizations for popularization of science – NCSTC and Vigyan Prasar – noted science societies at state level – Science and Technology Academies –	
	7	Awards for science communication and popularization.	2
IV	**New Media and Science Journalism**		**8**
	8	The boom in new media during the twentieth century and their impact on science journalism -–	2
	9	Role of a science page editor – popular science magazines in the west	2
	10	Science magazines in India – the ideal science reporter - scope of science journalism on radio & television in developing countries –	2
	11	Science serials on radio and television – Bharat ki Chaap on Doordarshan – Science serials on All India Radio - tech news - understanding present market trends.	2
V	**Science Journalism in Contemporary Context**		**7**
	12	Science as an essential element in political, corporate and community news	2
	13	Major issues in science journalism – environmental pollution – genetically modified crops – research for disease prevention and eradication – nuclear power – disaster mitigation – scientific knowledge for effective governance – the North-South divide in science research and scientific development.	5

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will recall the key historical developments in science communication from the Enlightenment to the present day	R,U	1
CO-2	Students will understand how Western science was introduced in India and its impact on the country's scientific landscape.	U	1
C0-3	Students will analyze the roles and contributions of key scientific institutions in India, such as the Asiatic Society and ISRO.	An	4

CO-4	Students will apply their understanding of science journalism practices to evaluate the role of new media in science communication.	U	2
CO-5	Students will critically analyze the intersection of science with political, corporate, and community news to assess the major issues in contemporary science journalism	E	4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	1	1	R,U	F, C	LT	
2.	2	1	U	F, C	LT	
3.	3	4	An	F, C	LT	
4.	4	2	U	F, C	LT	
5.	5	4	E	F, C	LT	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	-	-	-	-	-	-	2	-	-	-	-
CO2	1	-	-	-	-	-	-	2	-	-	-	-
CO3	-	-	-	2	-	-	-	2	-	-	-	-
CO4		2	-	-	-	-	-	2		2	-	-
CO5	-	-	-	3	3	-	-	2	-	-	-	1

Correlation Levels:

Leve	Correlation

l	
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam-Multiple choice/case studies
- Programming Assignments
- Final Exam -Multiple choice/case studies

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO5	✓	✓		

References

1. National Institute on Drug Abuse (NIDA)
2. Substance Abuse and Mental Health Services Administration (SAMHSA)
3. Centers for Disease Control and Prevention (CDC)

4. World Health Organization (WHO)

5.Extent, Pattern and Trend of Drug Use in India, Ministry of Social Justice and

Empowerment, Government of India, 2004.

6.. The Narcotic Drugs and Psychotropic Substances Act, 1985, (New Delhi: Universal,

2012)

Journal Articles:

1.McLellan AT, Lewis DC, O'Brien CP, Kleber HD. "Drug dependence, a chronic medical illness: implications for treatment, insurance, and outcomes evaluation." JAMA. 2000.

2. Volkow ND, Koob GF, McLellan AT. "Neurobiologic Advances from the Brain Disease Model of Addiction." N Engl J Med. 2016.

3.Gilman JM, Ramchandani VA, Crouss T, Hommer DW. "Subjective and neural responses to intravenous alcohol in young adults with light and heavy drinking patterns." Neuropsychopharmacology. 2012.

4.Volkow ND, Baler RD, Compton WM, Weiss SR. "Adverse health effects of marijuana use." N Engl J Med. 2014.

5.Degenhardt L, Hall W. "Extent of illicit drug use and dependence, and their contribution to the global burden of disease." Lancet. 2012

Discipline	BIOCHEMISTRY				
Course Code	**UK4VACBCH203**				
Course Title	**ECOLOGY AND ENVIRONMENTAL STUDIES**				
Type of Course	VAC3				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutoria l per week	Practical per week	Total Hours/W eek
	3	3 hours	-		3
Pre-requisites					
Course Summary	This course explores the intricate relationships between organisms and their environment, the principles of ecology, and the biochemical processes shaping environmental dynamics. It covers a broad spectrum of topics aimed at fostering an understanding of ecological systems, environmental issues, and sustainable practices.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	Ecology		**7**

		Definition, Scope and importance of environmental studies, Need for public awareness. Natural Resources: Renewable resources and non renewable sources	
		Fundamentals of Ecology: Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposes.	
		Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids.	

		Introduction types, characteristic features- (a) Forest ecosystem, (b) grassland ecosystem, (c) desert ecosystem and (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	
II	Environmental pollution		**12**
		Definition • Causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards .	
		Solid waste management: Causes, effects and control measures of urban and industrial wastes. •	
		Role of an individual in prevention of pollution.	
		Disaster management: floods earthquake, cyclone and landslides	
III	Biodiversity Conservation		**12**
		Introduction- Definition: genetic, species and ecosystem diversity. • Biogeographical classification of India.	
		Value of biodiversity: India is a mega-diversity nation. • Hot-spots of biodiversity.	
		Threats to biodiversity: habitat less, poaching of wildlife, man wildlife conflicts.	
		Endangered and endemic species of India. • Conservation of biodiversity; In-situ and ex-situ conservation of biodiversity	
IV	Social and Health Perspectives		**12**
		Water conservation, rain water harvesting, watershed management	

		Resettlement and rehabilitation of people, its problems and concerns.	
		Population explosion –Family welfare Programme	
		Environment and human health. • Human Rights. • Value education. Women and child welfare.	
V	Global environmental issues and solutions		**12**
		Global Warming, Ozone Depletion, Acid Rains	

		Hazardous Waste Management and International Regulations Sustainable Development Principles	
		Bioremediation Techniques Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material.	
		Phytoremediation. Chemical toxicology: Biochemical effects of heavy metals (Pb, As, Hg, Cd), pesticides, insecticides, herbicides, weedicides, larvicides.	
		ACTIVITIES Field work (5 hrs),Any one or two • Environmental Asset Documentation and Site Visits: Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain. • Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. • Study of common plants, Insects, Birds and Ecosystems • Analysis of Polluted Sites and Solid Waste Management Practices	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitiv e Level	PSO addressed
CO-1	Understand the fundamentals of ecology.	U	1, 3
CO-2	Apply the methods for waste management & prevention of environmental pollution	U, A	1, 2, 3, 4
C0-3	Understand & recognize biodiversity conservation.	U	1, 3
CO-4	Understand & apply various social & health perspectives	U, A	3, 4

CO-5	Identify global environmental issues & apply solutions for the safety	U, A	1, 2, 3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Ecology and Environmental studies

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
CO-1	Understand the fundamentals of ecology.	1, 3	U	F, C	LT	
CO-2	Apply the methods for waste management & prevention of environmental pollution	1, 2, 3, 4	U, A	C, P	LT	
C0-3	Understand & recognize biodiversity conservation.	1, 3	U	F, C, M	LT	
CO-4	Understand & apply various	3, 4	U, A	C, P	LT	
	social & health perspectives					
CO-5	Identify global environmental issues & apply solutions for the safety	1, 2, 3	U, A	C, P, M	LT	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	2	-	-	-		2				3
CO 2	2	3	2	2	-	-	2	2		2		3
CO 3	2	-	1	-	-	-	2	2		2		
CO 4	-	-	2	3	-	-	2	2		2		
CO 5	2	1	3	-	-	-	2	2		2		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam-Multiple choice questions

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assign ment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSCBCH300				
Course Title	**Bioenergetics and Carbohydrate Metabolism**				
Type of Course	**DSC23**				
Semester	V				
Academic Level	300 -399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NA				
Course Summary	The course provides an overview of bioenergetics and energy production by explaining the general principles of cellular energy metabolism and schematizing the oxidative pathways of carbohydrates.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Bioenergetics**	**7**
	1	Concept of free energy- standard free energy change and actual free energy change. ΔG and spontaneity of reactions.	
	2	Energy rich compounds- Classification -high and low energy compounds	
	3	ATP-Structure of ATP, reason for negative value of ΔG of hydrolysis of ATP, ATP/ADP cycle, coupling of exergonic and endergonic reactions,	
	4	Biological oxidation-reduction reactions- enzymes and co-enzymes involved (brief outline), redox potential (Eo), relation between standard redox potential and free energy change (Equation only).	
II		**Metabolism of Monosaccharides**	**12**
	5	Glycolysis (aerobic and anaerobic): Site, reactions (structure not required), energetics, regulation and significance. Fate of pyruvate	
	6	Metabolism of Galactose and Fructose: Site, reactions (structure not required), energetics, regulation and significance	
	7	Pyruvate dehydrogenase complex: Formation of acetyl CoA: Site, reactions (structure not required), energetics, regulation and significance	

	8	TCA cycle: Site, reactions (structure not required), energetics, regulation and significance, amphibolic nature, anaplerotic reactions. Substrate level phosphorylation.	
	9	Glyoxylate cycle: Site, reactions (structure not required), energetics, regulation and significance	
	10	HMP Shunt (Oxidative and non-oxidative pathway): Site, reactions (structure not required), energetics, regulation and significance	
III	**Metabolism Of Di- and Polysaccharides**		**8**
	10	Action of disaccharidases: Maltase, Sucrase, Lactase	
	11	Glycogenesis: Structure of Glycogen, Site, reactions (structure not required), energetics and regulation of glycogenesis	
	12	Glycogenolysis: Structure of Glycogen, Site, reactions (structure not required), energetics and regulation of glycogenolysis	
	13	Cori's cycle: Significance	
IV	**Electron Transport Chain**		**9**
	14	Structure of mitochondria	
	15	Components and sequence of electron carriers (Complex I, II, III, IV),	
	16	Events during electron transport (brief outline),	
	17	Q-cycle (brief concept only): Significance	
	18	Cytochrome oxidase mechanism (brief concept only): Significance	
V	**Oxidative Phosphorylation**		**9**
	19	ATP synthesis: substrate level and oxidative phosphorylation. P/O ratio (definition)	
	20	Complex V: structure of ATP synthase (brief outline)	
	21	Chemiosmotic hypothesis of mitochondrial oxidative phosphorylation (basic concept)	
	22	Boyer's binding change mechanism (brief outline)	
	23	ATP-ADP translocase	
	24	Inhibitors and uncouplers	
	25	Transport of reducing potentials into mitochondria: malate-aspartate shuttle, glycerol-3-phosphate shuttle	
	26	Net ATP yield from complete oxidation of glucose	
		Practical	**30hrs**
		● Preparing graphs in estimations ● Application of Beer-Lambert's law in quantitative analysis ● Estimation of glucose by Nelson Somogyi method ● Estimation of ketose by Roe-Papadopoulos method ● Estimation of pentose by Orcinol method ● Estimation of reducing sugar by Anthrone method ● Estimation of reducing sugar by O-toluidine method ● Estimation of reducing sugar Phenol-sulphuric acid ***Lab records to be maintained**	

References:

1. Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-

2009-4.
2. Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.
3. Textbook of Biochemistry with Clinical Correlations – Edited by Thomas M Devlin, Wiley-Liss Publications, ISBN 10 0-471-67808-2.
4. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Classify energy rich compounds and explain concept of free energy	R, U	1
CO-2	Illustrate the regulatory mechanism of aerobic and anaerobic metabolic pathways of monosaccharides	R, U, Ap	1
CO-3	Predict the regulatory mechanism involved in glycogen metabolism	R, U, Ap	1,3
CO-4	Summarize the events occurring during electron transport in mitochondria	R, U	1
CO-5	Calculate the net ATP yield in the degradation of carbohydrates	R, U, Ap	1, 3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Bioenergetics and Carbohydrate Metabolism

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Classify energy rich compounds and explain concept of free energy	1	R, U	F, C	L/T	

CO-2	Illustrate the regulatory mechanism of aerobic and anaerobic metabolic pathways of monosaccharides	1	R, U, Ap	F, C	L/T	P
CO-3	Predict the regulatory mechanism involved in glycogen metabolism	1, 3	R, U, Ap	F, C	L/T	P
CO-4	Summarize the events occurring during electron transport in mitochondria	1, 3	R, U, Ap	R, U, Ap	L/T	
CO-5	Calculate the net ATP yield in the degradation of carbohydrates	1,3	R, U, Ap	R, U, Ap	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	-	-	-	-	1					
CO 2	2		-	-	-	-	1					
CO 3	2	-	3	-	-	-	3					
CO 4	3	-	-	-	-	-	1					
CO 5	-	-	2	-	-	-	2					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	Biochemistry
Course Code	UK5DSCBCH301
Course Title	**Lipid, Nucleic acid, Amino acid Metabolism**

Type of Course	**DSC24**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	The course provides an overview of bioenergetics and energy production in metabolism of lipids, nucleic acid and amino acids.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Lipid Metabolism**		**12**
	1	Sources of body fat, hydrolysis of triacylglycerol and transport of fatty acids to mitochondria. Role of carnitine.	
	2	β-oxidation of saturated fatty acid, monounsaturated fatty acids and odd chain fatty acids. Calculation of energetics of oxidation of stearic and palmitic acid.	
	3	α-and ω-oxidation of fatty acids (basics only)	
	4	Sources of acetyl CoA, metabolism of ketone bodies, and ketonuria	
	5	Biosynthesis of saturated fatty acid	
	6	Biosynthesis of triglycerides, phospholipids (Lecithin and Cephalin), glycolipids (glucocerebroside), and sphingolipids (sphingomyelin)	
	7	Biosynthesis of cholesterol, regulation of cholesterol metabolism, and degradation of cholesterol to bile acids	
	8	Biosynthesis of steroid hormones (glucocorticoids-cortisol, mineralocorticoids-aldosterone, sex hormones-testosterone, estrone and estradiol)	
	9	Disorders of lipid metabolism- Zellweger syndrome, Refsum's disease, and Sudden infant death syndrome (SIDS).	
II	**Nucleic acid Metabolism**		**8**
	10	Sources of atoms of purines and pyrimidines	
	11	Salvage and de novo pathways of purine and pyrimidine with regulation	
	12	Formation of adenylate (AMP), guanylate (GMP), uridylate (UMP), CTP, deoxyribonucleotides, thymidylate (TMP) and nucleotide di- and triphosphates (Brief outline only)	
	13	Excretory products of purine and pyrimidine degradation. Gout. Disorders of purine or pyrimidine metabolism: Lesch-Nyhan syndrome, SCID	
III	**Nitrogen Metabolism**		**8**
	14	Nitrogen cycle	
	15	Biological nitrogen fixation: symbiotic nitrogen fixation- leguminous plants (rhizobium as example) leghaemoglobin, nitrogenase complex	
	16	Non-symbiotic nitrogen fixation one example (outline only)	

	17	Conversion of nitrate to ammonia by plants- nitrate reductase and nitrite reductase.	
IV	**Amino acid Metabolism**		**10**
	18	Nitrogen balance (positive, negative), general reactions of amino acid metabolism- transamination, oxidative deamination, trans deamination, and decarboxylation.	
	19	Nitrogen excretion. Urea cycle and its regulation	
	20	Glucogenic and ketogenic amino acids. Metabolism of glucogenic amino acid (isoleucine, valine) & ketogenic amino acid (leucine & lysine).	
	21	Brief outline of formation of Epinephrine, Norepinephrine & melanin from Tyrosine.	
	22	Metabolism of essential amino acid (His, Lys), non-essential amino acid (Arg, Gly).	
	23	Disorders of amino acid metabolism (Alkaptonuria, phenylketonuria, maple syrup urine disease, Hartnup disease, tyrosinosis, albinism).	
V	**Heme Metabolism**		6
	24	Heme synthesis and degradation**,**	
	25	Abnormal hemoglobin, disorders of heme metabolism (porphyria - erythropoietic and hepatic, Criggler Najjar syndrome).	
	26	Iron metabolism, iron absorption and transport, anemia.	
	27	**Practical** • Quantitative analysis of protein by Biuret method • Quantitative analysis of protein by Folin-Lowry Method • Quantitative analysis of Amino acids by Ninhydrin method • Quantitative analysis of Tyrosine by Folin and Denis method • Quantitative analysis of Cholesterol by Zak's Method • Quantitative analysis of DNA by Diphenyl Amine Method • Quantitative analysis of RNA by Orcinol Method.	30

References

1. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974
2. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
3. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757
4. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365.
5. Biochemistry (2008) by Rastogi Publisher: McGraw Hill ISBN: 0070527954 ISBN-13: 9780070527959, 978-0070527959.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe pathways and energetics involved in the metabolism of Lipids, Nucleic acid and Amino acids.	R, U	1
CO-2	Explain the role of enzymes involved under physiological conditions.	R, U	1
CO-3	Explain the metabolic regulatory mechanisms of above-mentioned biomolecules.	R, U	3
CO-4	Understanding the energetics and the mechanism of transport of these biomolecules in the body.	R, U	1
CO-5	Qualitatively analyse these biomolecules in a given test sample	R, U, Ap	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Lipid, Nucleic acid, Amino acid Metabolism
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe pathways and energetics involved in the metabolism of Lipids, Nucleic acid and Amino acids.	1	R, U	F, C	L	
CO-2	Explain the role of enzymes involved under physiological conditions.	1	R, U	F, C	L	
CO-3	Explain the metabolic regulatory mechanisms of above-mentioned biomolecules.	3	R, U	F, C	L	
CO-4	Understanding the energetics and the mechanism of transport of these biomolecules in the body.	R, U	R, U	F, C	L	

CO-5	Qualitatively analyse these biomolecules in a given test sample	2	R, U, Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	1	-	-	-	1					
CO 2	2	-	1	-	-	-	1					
CO 3	2	-	1	-	-	-	1					
CO 4	2	-	1	-	-	-	1					
CO 5	-	3	-	-	-	-	1					

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSCBCH302				
Course Title	**Human Physiology and Immunology**				
Type of Course	**DSC25**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	The course provides a comprehensive study of systems in our body which includes the physiology of blood, physiology of respiration, digestive system, specialized tissues, immune system function and associated disorders.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Blood Physiology**	**10**
	1	Basic idea of circulatory system, general functions of blood.	
	2	Blood components: Blood, plasma and serum. Formed elements: count, structure, function and clinical significance of (i) RBC (ii) WBC and (iii) platelets.	
	3	Haemoglobin – structure and functions. Plasma Proteins-types & functions.	
	4	Abnormal Haemoglobin: Thalassemia and hemoglobinopathies. (Outline only).	
	5	Blood forming organs, hemopoiesis: erythropoiesis, leukopoiesis and thrombopoiesis.	
	6	Hemostasis: Blood coagulation- Intrinsic and Extrinsic pathways, anticoagulants	

	7	Bleeding time and coagulation time	
	8	Basis of blood group classification (ABO, Rh).	
	9	Hemocompatibility and transfusion (basic idea only). Erythroblastosis fetalis.	

II		**Respiratory Physiology**	**8**
	10	Basic structure of lungs	
	11	Exchange of gases in alveoli and tissues, transport of oxygen in blood	
	12	O_2 dissociation curve - Effect of PO_2, PCO_2, H^+ concentration	
	13	Bohr effect, temperature and 2,3 BPG. Transport of CO_2 in blood	
	14	Chloride shift	
	15	Carbonic anhydrase reaction	
	16	Acid base balance: Respiratory regulation	
	17	Acid base disturbances- (respiratory acidosis and alkalosis, metabolic acidosis and alkalosis)	
	18	Compensation mechanism (basic idea only)	
III		**Digestion And Absorption**	**4**
	19	Gastrointestinal organs and functions	
	20	Digestion and absorption of carbohydrates	
	21	Digestion and absorption of proteins	
	22	Digestion and absorption of lipids	
	23	Lactose intolerance, Hartnup disease	
IV		**Specialized Tissues**	**8**
	24	Muscle: Structure of muscle, muscle proteins, energy sources for muscle contraction and sliding filament theory. Biochemical events during muscle contraction. Rigor mortis.	
	25	Neuron: Structure of neuron, glial cells, graded potential and action potential, ionic basis of action potential, threshold and all or none response, refractory period, excitatory and inhibitory chemical synapses, neurotransmitters and neuromodulators.	
	26	Bone: Composition, role of Ca, P and Vitamin D in bone remodelling.	
V		**Immunology And Immunological Disorders**	**15**
	27	Immunity- Basic concepts	
	28	Types of immunity-innate and acquired immunity.	
	29	Components of innate immunity - anatomic barriers, physiological barriers, phagocytic/endocytic barriers, inflammatory barriers.	
	30	Cells and organs of immune system	
	31	Acquired immunity- humoral and cell mediated immunity, characteristic attributes of acquired immunity.	
	32	Antigens, antigenicity, immunogenicity.	
	33	Factors influencing immunogenicity (basic concepts only).	
	34	Definition of epitope and adjuvant	
	35	Antibody production- Clonal selection theory.	
	36	Structure of immunoglobulin, classification of immunoglobulins.	
	37	Immune response: primary and secondary immune response. (basic idea only).	
	38	Disease related to immune function (elementary ideas only)	
	39	Hypersensitivity (brief outline only)	
	40	Autoimmune disorders (Hashimoto's Thyroiditis, Insulin Dependent Diabetes Mellitus, Myasthenia Gravis, Rheumatoid Arthritis) (brief outline only)	
	41	Immunodeficiency disorders (X linked agammaglobulinemia, Digeorge syndrome, SCID and AIDS) (Brief outline only)	
	42	Vaccination and immunization (Brief outline only).	
		Practical	**30**

		• Introducing students to equipments/tools used in clinical biochemistry lab • Different methods of blood collection- capillary and venous • Separation of serum, plasma and blood cells. • Determination of ESR by Westergren's methods • Determination of PCV by Westergrens and Wintrobe's method • Determination of RBC and TC/DC count using hemocytometer • Determination of Blood Grouping by agglutination method • Determination of Hemoglobin by Sahli's method. *Visit to a clinical laboratory to experience the advanced methods in haematology. *Visit to a research laboratory to learn how immunological techniques like ELISA, Western blotting etc were performed to determine immunological disorders	

References

1. Textbook of Medical Physiology, by Arthur C Guyton, John E Hall Prism Saunders 9th Edition ISBN: 81-7286-034-X.
2. Arthur Vander, James Sherman, and Dorothy Luciano Vander et al. Human Physiology: The Mechanism of Body Function, Eighth Edition , The McGraw-Hill Companies.
3. Granner, Robert K. Murray Darryl K., and Peter A. Mayes Victor W. Rodwell. Harper's Illustrated Biochemistry (Harper's Biochemistry).McGraw-Hill Medical, 2006.
4. Human Physiology an integrated approach by Dee Ungulaub Silverthorn
5. Principles of Anatomy and Physiology by Gerard J. Tortora and Bryan Derrickson, 13 th Edition
6. Kuby Immunology by Thomas J. Kindt (2006). W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903.
7. Delves, Peter J., Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt.Roitt's essential immunology. Vol. 20. John Wiley & Sons, 2011.
8. Barrett, K. E., Barman, S. M., Boitano, S., & Brooks, H. L. (2019). Ganong's Review of Medical Physiology.
9. Gupta, R. C., & Bhargava, S. (Eds.). (2022). Practical Biochemistry. CBS Publishers and Distributors. New Delhi.
10. Sherwood, L. (2015). Brooks/Cole Human Physiology: From Cell to System.
11. Widmaier, E. P., Raff, H., & Strang, K. T. (2019). Vander's Human Physiology – The Mechanism of Body Function. McGraw Hill. New York.
12. Martini, F. H., & Nath, J. L. (2009). Fundamentals of Anatomy and Physiology (8th ed.). Pearson Publications.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Describe hemostasis and predict hemocompatibility in transfusion	R, U, Ap	1,3
CO-2	Demonstrate the compensatory mechanism involved in acid-base disturbances	R, U, Ap	1
CO-3	Restate the digestion and absorption of biomolecules	R, U	1
CO-4	Discuss the biochemical events occurring in specialised tissues	R, U	3
CO-5	Explain immunological processes and related disorders	R, U	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Human Physiology and Immunology

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe hemostasis and predict hemocompatibility in transfusion	1,3	U, An	F, C	L/T	
CO-2	Demonstrate the compensatory mechanism involved in acid-base disturbances	1	R, U	P		P
CO-3	Restate the digestion and absorption of biomolecules	1	R, U	F, C	L/T	
CO-4	Discuss the biochemical events occurring in specialised tissues	3	R, U	F, C	L/T	
CO-5	Explain immunological processes and related disorders	1,2	R,U	F, C	L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	3	-	-	-	3					
CO 2	3	-	-	-	-	-	2					
CO 3	2	-	-	-	-	-	1					
CO 4	-	-	2	-	-	-	1					
CO 5	1	3	-	-	-	-	2					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSCBCH303				
Course Title	**MOLECULAR BIOLOGY**				
Type of Course	**DSC26**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	1 hour	5
Pre-requisites	Completed 200-299 level courses				
Course Summary	Molecular biology is the study of biological processes at the molecular level, focusing on the structure, function, and interactions of molecules such as DNA, RNA, and proteins. It encompasses topics such as gene expression, regulation, and the molecular mechanisms underlying cellular functions and genetic inheritance.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Genome Organisation and DNA replication**	**11**
	1	Concept of gene as unit of inheritance	
	2	Chromosome structure in prokaryotes and viruses	
	3	Chromosome structure in eukaryotes, DNA packaging in eukaryotic chromosomes, Chromatin, centromere, and telomere. Giant chromosomes, Repeated DNA sequences	
	4	Central Dogma	
	5	DNA replication in prokaryotes and eukaryotes,	
	6	Inhibitors of replication (any 3 examples).	
II		**Gene Expression**	**11**
	7	Transcription in prokaryotes and eukaryotes, enzymes involved in transcription, Post transcriptional modification (brief outline only).	
	8	Inhibitors of transcription (any 3 examples).	
	9	Genetic codon (characteristics of codon), Wobble hypothesis (brief concept).	
	10	Translation in prokaryotes and eukaryotes	

	11	Inhibitors of translation (any 3 examples)	
III	**Regulation of Gene Expression**		**11**
	12	Regulation of gene expression in prokaryotes: Jacob and Monod's operon concept, structural gene, regulator gene. Inducible operon (lac operon as	
		an example) and repressible operon (tryptophan operon as an example, attenuation).	
	13	Regulation of gene expression in eukaryotes-Alternate splicing, Cytoplasmic control of mRNA stability, Induction of transcription by environmental and biological factors, Transcription factors, Chromatin remodelling, Gene silencing, DNA methylation and imprinting (Brief outline only)	
IV	**Mutation and Repair**		**12**
	14	Mutation in Prokaryotes: Various types of mutation- spontaneous and induced mutation, point mutation- substitution (transition, transversion), insertion, deletion, missense, nonsense, frame-shift mutation, mutagens-different types. Ames test.	
	15	Chromosome variation- aneuploidy, polyploidy, duplication, deletion, inversion and translocation (Brief outline).	
	16	Repair in prokaryotes - direct, excision, mismatch, recombination and SOS.	
V	**Practical**		**30**
	17	Isolation of DNA and RNA	
	18	Estimation of DNA by Diphenylamine method	
	19	Estimation of RNA by Orcinol method	
	20	Institute visit	

References

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). Molecular Biology of the Cell (7th ed.). W. W. Norton & Company.
2. Lewin, B. (2017). Genes XI (11th ed.). Jones & Bartlett Learning.
3. Cox, M. M., Doudna, J. A., & O'Donnell, M. (2015). Molecular Biology: Principles and Practice (1st ed.). W. H. Freeman.
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Martin, K. C. (2020). Molecular Cell Biology (9th ed.). W. H. Freeman.
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7. Hartl, D. L., & Caveney, R. J. (2017). Lewin's Essential GENES (3rd ed.). Jones & Bartlett Learning.
8. Twyman, R. M. (2013). Advanced Molecular Biology: A Concise Reference. Garland Science.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the concept of genome organization and DNA replication in prokaryotes and eukaryotes	R, U	1, 4

CO-2	Explain the events occurring during gene expression in prokaryotes and eukaryotes	R, U	1 , 4
CO-3	Restate the processes involved in regulation of gene expression in prokaryotes and eukaryotes	R, U	1 , 4
CO-4	Illustrate the different types of mutation and repair system	R, U	1 , 4
CO-5	Employ methods to isolate and quantitate genetic material in organisms	R, U, Ap	1, 2, 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Molecular Biology

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe the concept of genome organisation and DNA replication in prokaryotes and eukaryotes	1,4	R, U	F, C	L/T	
CO-2	Explain the events occurring during gene expression in prokaryotes and eukaryotes	1,4	R, U	F, C	L/T	
CO-3	Restate the processes involved in regulation of gene expression in prokaryotes and eukaryotes	1,4	R, U	F, C	L/T	
CO-4	Illustrate the different types of mutation and repair system	1,4	R, U	F, C	L/T	
CO-5	Employ methods to isolate and quantitate genetic material in organisms	1,2,4	R, U, Ap	F, C, P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-						
CO 2	3	-	-	-						
CO 3	3	-	1	-						
CO 4	3	-	1	-						
CO 5	-	3	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓

CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSCBCH304				
Course Title	ENVIRONMENTAL BIOCHEMISTRY				
Type of Course	**DSC27**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Nil				
Course Summary	Environmental biochemistry studies the biochemical processes and interactions between living organisms and their environment, including the impact of pollutants, toxins, and natural compounds on biological systems. It encompasses topics such as biodegradation, bioaccumulation, and the biochemical mechanisms of detoxification and adaptation in response to environmental changes.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Environmental pollution**		**12**
	1	Environmental pollution- types- air, water, soil, marine and noise pollution.	
	2	Air Pollutants – Carbon monoxide, Oxides of Nitrogen, sulphur dioxide, hydrocarbons and photochemical smog, Green house gases, suspended particulate matter.	

	3	Water Pollutants- Organic pollutants - pesticides, insecticides, detergents, oil spills, toxic organic chemicals, Inorganic pollutants - heavy metals – Hg, Pb, As, Cd. Thermal pollution of water	
	4	Soil pollutants-organic pollutants-pesticides, natural pollutants-acid rain, anthropogenic pollutants-industrial wastes, inorganic pollutants-heavy metals	
	5	Marine pollutants-marine debris, plastics including microplastics, ocean acidification, nutrients, toxins and underwater noise.	
	6	Noise pollution-sources-domestic, industrial, automobiles, aircraft, social events	
II	**Analysis of pollution using physicochemical parameters**		**12**
	7	Air pollution analysis parameters-Air Quality Index (AQI), Carbon monoxide (CO), Nitrogen monoxide (NO), Nitrogen dioxide (NO_2), Ozone (O_3), Sulphur dioxide (SO_2), Ammonia (NH_3), particulate matter.	
	8	Water Analysis -Physical parameters- pH, temperature, color, odour, turbidity, total dissolved solids. Chemical parameters- total hardness chloride, nitrate, fluoride. Dissolved oxygen, BOD, pesticide residue, trace/ toxic metals, microbiological.	
	9	Soil analysis- Physical parameters- soil texture, water holding capacity, bulk density, particle density. Chemical parameters- pH, Organic matter content, available Phosphorous, Potassium and nitrogen	
III	**Environmental health impacts**		**6**
	10	Health impacts of environmental pollution – pulmonary, cardiovascular, endocrine, reproductive, neurological and other diseases	
IV	**Heavy metal and Pesticide toxicity**		**15**
	11	Heavy metals-Lead, mercury, arsenic and cadmium toxicity, mechanism of heavy metal toxicity-neurotoxicity, cardiovascular toxicity, nephrotoxicity, hepatotoxicity, skin toxicity, immunological toxicity, reproductive and developmental toxicity, genotoxicity and carcinogenesis	
	12	Pesticides -Classification of Pesticides- based on chemical nature and by site of action. Pesticide formulation. Pesticide labels and labelling, Material Safety Data Sheet (MSDS), determination of the signal word-based on toxicity category (category I, II, III and IV), importance of reading and understanding pesticide labels.	
	14	Tests on pesticides for determining human health risk- types of toxicity-(acute - LD50 or LC50), chronic, teratogenicity, gene mutation, chromosome aberration, neurotoxicity, immunotoxicity).	
V	**Environmental protection and sustainable development**		**15**
	15	Environment protection acts, environment protection policies and management	
	16	Bioremediation Technologies- *in situ*, *ex situ*, bioreactor, natural attenuation, and phytoremediation. Bioindicators and biosensors for the detection of environmental pollution, Biomaterial as substituents for non-biodegradable materials- Bioplastics.	

References:

1. Dykeman, J. (2017). Environmental Biochemistry. CRC Press.

2. Schwarzenbach, R. P., Egli, T., Hofstetter, T. B., von Gunten, U., & Wehrli, B. (2006). Global change and water quality. Science, 313(5790), 1072–1077.
3. Hocking, M. B. (2006). Handbook of Chemical Technology and Pollution Control (3rd ed.). Academic Press.
4. Brack, W., Hollender, J., & Schulze, T. (Eds.). (2018). The Handbook of Environmental Chemistry: Synthetic Organic Chemicals in the Environment (Vol. 10). Springer.
5. Carson, R. (2002). Silent Spring. Houghton Mifflin Harcourt. (Original work published 1962).
6. Snoeyenbos-West, O. L. O., & West, S. A. (2019). Environmental Biochemistry: Methods and Applications. Wiley.
7. Townsend, C. R., Harper, J. L., & Begon, M. (2000). Essentials of Ecology. Blackwell Science.
8. Hoag, G. E. (2006). Bioremediation: An Overview. Encyclopedia of Environmental Microbiology, 2, 497–513.
9. Mitra, S., & Lippincott, R. L. (2022). Environmental Biochemistry and Health. In Encyclopedia of Environmental Health (2nd ed., Vol. 2, pp. 185-193). Elsevier.
10. Tchounwou, P. B., & Kossmann, T. (2007). Biochemical and Physiological Toxicology. In Encyclopedia of Environmental Health (Vol. 2, pp. 185–195). Elsevier

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO Addressed
CO-1	Students will understand the complex biochemical interactions between living organisms and their environment, including the effects of pollutants, toxins, and other environmental stressors on biological systems	U	**1**
CO-2	Students will learn how to analyze processes such as biodegradation and bioaccumulation and their implications for environmental and human health.	U,An	1,3
CO-3	Students will explore the biochemical mechanisms organisms use to detoxify harmful substances and adapt to changing environmental conditions.	R, U	1
CO-4	Students will gain skills in assessing the environmental impact of various substances on ecosystems and human health, including the use of biochemical assays and analytical techniques.	R, U	1,2
CO-5	Students will learn how to apply their knowledge of environmental biochemistry to develop sustainable solutions for environmental problems, including strategies for pollution control and remediation	R,U,Ap	1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Environmental Biochemistry

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Students will understand the complex biochemical interactions between living organisms and their environment, including the effects of pollutants, toxins, and other environmental stressors on biological systems	**1**	U	F, C	L/T	
CO-2	Students will learn how to analyze processes such as biodegradation and bioaccumulation and their implications for environmental and human health.	1,3	U, An	P	L/T	
CO-3	Students will explore the biochemical mechanisms organisms use to detoxify harmful substances and adapt to changing environmental conditions.	1	R, U		L/T	
CO-4	Students will gain skills in assessing the environmental impact of various substances on ecosystems and human health, including the use of biochemical assays and analytical techniques.	1,2	R, U		L/T	
CO-5	Students will learn how to apply their knowledge of environmental biochemistry to develop sustainable solutions for environmental problems, including strategies for pollution control and remediation	1,3	R, U, Ap		L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-	2					

CO 2	3	-	2	-	-	-	2					
CO 3	3	-	-	-	-	-	3					
CO 4	3	2	-	-	-	-	2					
CO 5	3	-	3	-	-	-	3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSCBCH305				
Course Title	**CANCER BIOLOGY**				
Type of Course	DSC28				
Semester	V				
Academic Level					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4		-	4
Pre-requisites					
Course Summary	The course provides an understanding of the principles of cancer biology, molecular mechanisms underlying the initiation and progression of malignant tumors, diagnosis and therapeutic interventions in the management of disease.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Epidemiology**	**10**
	1	Definition of Cancer, Differences between normal cells and cancerous cells	
	2	Types of tumors, Types of cancer, Properties of malignant cells	
	3	Carcinogens- Physical, Chemical & Biological	
	4	Lifestyle risk factors- Smoking, Alcoholism, Obesity, Workplace & Environmental factors	
II		**Molecular Oncology**	**14**
	5	Oncogenes, Tumor suppressor genes, Mutation and tumor initiation, Cell proliferation, Tumor progression, Clonal selection and malignancy, Metastasis.	
	6	Tumor Markers: Hormones- HCG, calcitonin; Oncofetal antigens- AFP, CEA; Lineage Specific Proteins- PSA, M-Protein; DNA Markers- EGFR mutations, KRAS mutations, BRAF V600E mutation; Mucin & Other Glycoproteins- CA125, CA19-9, CA15-3; Enzymes- LDH, ALP	
III		**Oncovirology**	**12**
	10	Oncoviruses and immune system, Oncoviral antigens	

	11	Oncoviral integration – EBV as model, Oncoviruses- HPV, HBV, HCV, Human Polyomaviruses, KSHV	
	12	Viral Oncogenic mechanism – Inhibition of Apoptosis, reprogramming host metabolism, modulation of cellular microenvironment, attenuation of host immune control, transcriptional reprogramming, epigenomic reprogramming	
	13	Vaccination strategies in oncovirology	
IV	**Cancer Diagnosis**		**12**
	14	Principle of diagnostic procedures: Complete blood count, Cytogenetic analysis, Immunophenotyping, Tumor biopsy, Bone marrow aspiration,	
	15	Principle of Endoscopic examination and Pap Smear test. Imaging Tests: CT scan, MRI scan, Mammography, PET-CT, MUGA scans & Ultrasound scan,	
	16	Staging tests – Bone scans & X-ray, Cancer stages – TNM classification	
V	**Principles of Cancer management**		**12**
	17	Surgery – Resection, Excision and Reconstruction	
	18	Radiation therapy – Physical and biological basis of radiation therapy, Principle of hyperthermia, photodynamic therapy	
	19	Chemotherapeutic agents- folate antagonists, purine & pyrimidine antimetabolites, alkylating agents, antitumor compounds, anthracyclines, DNA intercalators, microtubule targeted anticancer drugs, vinca alkaloids, taxanes, epothilones, asparaginase & DNA topoisomerases;	
	20	Biotherapeutics, Endocrine therapy, Bone marrow transplantation	
	21	Targeted therapy, Precision medicine and Palliative care	

References

1. Weinberg, R. A., & Weinberg, R. A. (2006). *The biology of cancer*. WW Norton & Company.
2. Hesketh, R. (2023). *Introduction to cancer biology*. Cambridge University Press.
3. Pecorino, L. (2021). *Molecular biology of cancer: mechanisms, targets, and therapeutics*. Oxford university press.
4. Pezzella, F., Tavassoli, M., & Kerr, D. J. (Eds.). (2019). *Oxford textbook of cancer biology*. Oxford University Press.
5. Yaro, A. (2021). *Oncoviruses: Cellular and Molecular Virology*. AuthorHouse.
6. DeVita, V. T., Lawrence, T. S., & Rosenberg, S. A. (2012). *Cancer: principles & practice of oncology: primer of the molecular biology of cancer*. Lippincott Williams & Wilkins.
7. Stein, G. S., & Luebbers, K. P. (Eds.). (2019). *Cancer: Prevention, early detection, treatment and recovery*. John Wiley & Sons.
8. De, S. K. (2022). *Fundamentals of cancer detection, treatment, and prevention*. John Wiley & Sons.
9. Velcheti, V., & Punekar, S. R. (2021). *Handbook of Cancer Treatment-Related Symptoms and Toxicities*. Elsevier Health Sciences.
10. Jain, B. P., & Pandey, S. (Eds.). (2022). *Understanding Cancer: From Basics to Therapeutics*. Academic Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the molecular basis of malignant transformations	R, U,	1
CO-2	Viral infections and oncogenesis -types and prevention	R, U, Ap	1

CO-3	Advanced techniques in cancer diagnosis	R, U,Ap	1
CO-4	Summarize the events in cancer therapeutics	R, U	1,4
CO-5	Anticancerous drug development strategies	R, U, Ap	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Cancer Biology

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
				F, C		
				P		

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-						
CO 2	1	2	-	-	-	-						
CO 3	-	-	2	-	-	-						
CO 4	-	-	2	3	-	-						
CO 5	-	1	-	-	-	-						
CO 6	-	-	-	3	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSEBCH300				
Course Title	**Inborn Errors of Metabolism**				
Type of Course	DSE5				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	UK5DSCBCH300, UKDSCBCH301				
Course Summary	Inborn errors of metabolism are genetic disorders caused by mutations that affect the function of enzymes and metabolic pathways, leading to the accumulation of toxic substances or the deficiency of essential compounds. This course covers the biochemical basis, diagnosis, clinical manifestations, and treatment options for various inherited metabolic disorders, such as phenylketonuria and cystic fibrosis.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Inherited metabolic disorders of carbohydrate metabolism**	**13**

	1	Disorders of fructose, galactose and lactose metabolism - Fructosuria, Hereditary fructose intolerance, fructose 1,6-bisphosphatase deficiency, Galctosemia, Galctokinase deficiency, UDP-galactose 4-epimerase deficiency and lactose intolerance.	
	2	Disorders of glycolysis and Krebs cycle- Deficiency of Hexokinase, Phosphofructokinase, Triose phosphate isomerase, Aldolase, Pyruvate kinase, αKG-dehydrogenase, Succinate dehydrogenase and Fumerase.	
	3	Disorders of pyruvate metabolism - Pyruvate dehydrogenase deficiency, Pyruvate carboxylase deficiency	
	4	Glycogen storage diseases (Von Gierke Disease, Pompe Disease, Cori Disease, Anderson disease McArdle Disease, Hers disease and Lafora disease	
	5	Disorders of gluconeogenesis- PEP carboxykinase deficiency, Glucose-6-phosphatase deficiency	
	6	Disorders of HMP shunt pathway-Glucose 6-phosphate dehydrogenase deficiency, Ribose-5-phosphate isomerase deficiency, Wernicke-Korsakoff Syndrome	
II	**Inherited metabolic disorders of mitochondria**		**5**
	7	MM (Mitochondrial myopathies), MEALS (Mitochondrial encephalopathy	
	8	lactic acidosis and stroke-like episodes) syndrome, LHON (Leber hereditary optic neuropathy)	
	9	Leigh syndrome, Kearns-Sayre syndrome, MERRF (Myoclonic epilepsy and ragged-red fiber disease)	
III	**Inborn Errors of Lipid Metabolism**		**9**
	10	Inherited disorders fatty acid oxidation and accumulation of polyenoic fatty acids-Deficiency of Carnitine Palmitoyl transferase	
	11	Deficiency of Medium Chain Acyl-CoA Dehydrogenase (Reye-like syndrome or sudden infant death syndrome), Refsum disease, SIDS, Zellweger syndrome.	
	12	Lipid storage diseases-Tay-Sachs disease, Fabry disease, Gaucher disease, Krabbe disease, Farber disease.	
	13	Metachromatic leukodystrophy, Niemann-Pick disease	
IV	**Inborn errors of Amino acids, Urea cycle and Heme metabolism**		**15**
	14	Phenylketonuria, Tyrosinemia type I and II, Alkaptonuria	
	15	Homocysteinemia, Homocystinuria, Cystinuria, Histidinemia, Hyperlysinemia, Maple Syrup Urine disease	
	16	Isovaleric acidemia, Hyperprolinemia type I and II, Hyperornithinemia-hyperammonemia-homocitrullinuria (HHH) syndrome	
	17	Hypermethioninemia, Methylmalonic aciduria, Propionic acidemia, Glutaric aciduria, Albinism	
	18	Deficiencies of Urea cycle enzymes - Carbamoyl Phosphate Synthetase, Ornithine Transcarbamoylase, Argininosuccinate Synthetase, Argininosuccinate Lyase, Arginase	
	19	Acute Intermittent Porphyria, Crigler-Najjar syndrome	
V	**Inborn errors of Nucleic acid and Metal metabolism**		**3**
	20	Gout, Lesch-Nyhan syndrome, Arts syndrome, MNGIE (Mitochondrial neuro gastrointestinal encephalopathy syndrome)	
	21	Orotic aciduria type I and II, Hereditary Xanthinuria,	

	22	Hypouricemia**,** SCID**;** Wilson disease, hemochromatosis	
	23	**Practical** • Estimation of bilirubin • Estimation of Glucose 6-phosphate dehydrogenase • Estimation of Arginase • Urine analysis for abnormal constituents • Visit to hospitals for monitoring diseases related to inborn errors of metabolism	**30**

References:

1. Textbook of biochemistry with clinical correlations. Devlin, T. M. (Ed.). (2010). John Wiley & Sons. ISBN 0-471-41136-1.
2. Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124- 1:9788184481242.
3. Biochemistry by U. Styanarayana and U. Chakrapani, 5th edition, Elsevier publication, ISBN: 9788131248850.
4. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
5. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance. Publisher: McGraw-hill Book Company – Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757.
6. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
7. Biochemistry (2008) by Rastogi Publisher: McGraw Hill ISBN: 0070527954 ISBN-13: 9780070527959, 978-0070527959.

Suggested Readings:

- Candlish, J. K., & Crook, M. (1993). Notes on clinical biochemistry. World Scientific Publishing Company.
- Kumar, V., & Gill, K. D. (2018). Basic concepts in clinical biochemistry: a practical guide. Springer Singapore.
- Marshall, W. J., & Bangert, S. K. (Eds.). (2008). Clinical biochemistry: metabolic and clinical aspects. Elsevier Health Sciences.
- Marks, D. B., Marks, A. D., & Smith, C. M. (1996). Basic medical biochemistry: a clinical approach.
- Smith, C. (1987). Mark's Basic Medical Biochemistry.
- Tietz, N. W., Burtis, C. A., & Ashwood, E. R. (1994). Tietz textbook of clinical chemistry. W. B. Saunders Co., Philadelphia.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand various metabolic disorders and inborn errors of metabolism	U	1
CO-2	Analyse possible metabolic pathways and remember factors that lead to disorders in metabolism	R, An	1
CO-3	Evaluate various factors that lead to inborn errors	E	1,3
CO-4	Understand and evaluate various methods for the identification of inborn errors in metabolism	U, E	1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Inborn Errors of Metabolism

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand various metabolic disorders and inborn errors of metabolism	1	U	F, C	L/T	
CO-2	Analyse possible metabolic pathways and remember factors that lead to disorders in metabolism	1	R, An	F, C	L/T	
CO-3	Evaluate various factors that lead to inborn errors	1,3	E	F, C	L/T	
CO-4	Understand and evaluate various methods for the identification of inborn errors in metabolism	1,2,3	U, E	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6

CO 1	2	-	-	-	-	-	1					
CO 2	1	-	-	-	-	-	1					
CO 3	2	-	1	-	-	-	1					
CO 4	2	1	1	-	-	-	2					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSEBCH301				
Course Title	FOOD AND DAIRY SCIENCE				
Type of Course	DSE6				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NA				
Course Summary	Food and dairy science is the study of the chemistry, microbiology, processing, and safety of food and dairy products. The course encompasses topics such as food preservation techniques, quality control, nutritional analysis, and the development of new food products, with a focus on ensuring food safety and optimizing nutritional content.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Food**	**11**
	1	Outline of chemical composition of: cereals, pulses, tubers, milk, egg, fish, meat, fruits, alcoholic beverages, soft drinks, coffee, tea, jaggery, honey and spices.	
	2	Brief mention about the different antinutritional factors in food- phytic acid, lectins, tannins, saponins, amylase inhibitors and protease inhibitors.	
	3	Food borne-diseases: Lathyrism, Favism, Ergotism and Epidemic dropsy.	
	4	Analysis of moisture content-evaporation method, distillation method (Dean and Stark method), chemical reaction method (Karl-Fischer titration and gas production method), physical method (basics of	

		Hydrometry) and spectroscopic method (basic principle of microwave and IR only). Determination of total solid ash, total carbohydrates and fat.	
II	**Food Preservation and Adulteration**		**11**
	1	Preservation of foods: Low temperature (chilling and freezing), high temperature (boiling, pasteurization, autoclaving)	
	2	canning-steps involved in canning), dehydration, high osmotic pressure, chemical preservatives, cold sterilization and anaerobic conditions.	
	3	Food additives: Permitted colors, permitted food preservatives, emulsifying agents, flavoring agents, artificial sweeteners (saccharine)	
	4	Food adulteration: FSSA definition of an adulterant. Common adulterants in milk, coffee powder, mustard seeds, curry powders, butter, honey, rice, wheat, black pepper and vegetable oils. Health hazards due to adulteration	
	5	Elementary study on qualitative detection of adulteration in milk, edible oils and detection of saccharine.	
III	**Dairy Technology**		**12**
	1	Processing , storage, packing, distribution &transportation of dairy products. Enzymes in Dairy industry.	
	2	Heat treatment of milk- sterilization and pasteurization (LTH and HTST).	
	3	Tests to assess quality of milk-reductase test and resazurin test.	
	4	Outline study on the production of cheese, bread and fermented milk products (curd, kefir and yogurt).	
	4	Detection of Adulterants in Milk- detection of cane sugar, starch, cellulose, added urea, formalin, gelatin, ammonium compounds, sulphates, anionic detergents, skimmed milk powder, sodiumpowder, sodium compounds, sulphates, anionic detergents, skimmed milk powder, sodium chloride and neutralizers.Isolation of protein from milk.	
IV	**Food Safety and Quality Management**		**11**
	1	Food safety: definition and basic concepts of toxicity and hazard (physical, chemical and biological) in food.	

	2	Food quality and safety management systems: Good Manufacturing Practices (GMP), Good Handling Practices (GHP), Hazard Analysis Critical Control Points (HACCP).	
	3	Product certification/grading – BIS and AGMARK (basic approach only).	
		Food standards: Codex Alimentarius, ISO and Codex India. Brief study of the following: FSSAI, PFA 1954, FSSA 2006, FPO and essential commodity Act.	
V	**V: Food Analysis (practical)**		**30**
	23	Qualitative Testing of adulterants like metanil yellow (in turmeric & jaggery), rhodamine-B (in chilly powder), chicory (in coffee), sodium bicarbonate (in flour & jaggery), lead chromate (in pulses), vanaspati, coal tar dye &starch (in ghee), added sugar (in honey) prohibited colors, argemone oil & cotton seed oil (in edible oil).	15
	24	Quantitative Estimation of cholesterol in egg. Estimation of fructose in honey. Estimation of pentose in grapes. Estimation of sucrose in jaggery. Estimation of ascorbic acid in orange juice. Isolation and estimation of starch from potato	15

References

1. Fellows, P. J. (2016). Food Processing Technology: Principles and Practice (4th ed.). Woodhead Publishing.
2. Fox, P. F., McSweeney, P. L. H., Cogan, T. M., & Guinee, T. P. (2017). Cheese: Chemistry, Physics and Microbiology (4th ed.). Academic Press.
3. Chandan, R. C., & Kilara, A. (2013). Manufacturing Yogurt and Fermented Milks (2nd ed.). Wiley-Blackwell.
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5. Ohlsson, T., & Bengtsson, N. (2012). Minimal Processing Technologies in the Food Industry (2nd ed.). Woodhead Publishing.
6. Hill, A. R. (1996). Chemistry of the Natural Cheese Rind and Processed Cheese. In J. R. Whitaker, A. G. J. Voragen, & D. W. Wong (Eds.), Handbook of Food Chemistry (pp. 751–782). Marcel Dekker.
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Wiley & Sons.
8. Clark, S., Costello, M., Drake, M., & Bodyfelt, F. (2009). The Sensory Evaluation of Dairy Products (2nd ed.). Springer.
9. Belitz, H. D., Grosch, W., & Schieberle, P. (2009). Food Chemistry (4th ed.). Springer.
10. Robinson, R. K., & Batt, C. A. (2010). Encyclopedia of Food Microbiology (2nd ed.). Academic Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Describe the chemical composition of different types of food.Estimate the quantity of specific biomolecule in the given food sample	U, An	1
CO-2	Explain methods used to detect various components in foods.	R, U	1
CO-3	Explain the various food preservation techniques employed.	U	1
CO-4	Identify the common adulterants in food, Detect the presence of adulterants in different food sample	R, An	2
CO-5	Gain knowledge about the methods used in the production of dairy products	U	1
CO-6	Explain the importance of food safety & management system	U	1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Food and Diary Science

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe the chemical composition of different types of food.Estimate the quantity of specific biomolecule in the given food sample	1	U,An	F, C	L/T	
CO-2	Explain methods used to detect various components in foods.	1	R, U	P		P
CO-3	Explain the various food preservation techniques employed.	1	U	F, C	L/T	
CO-4	Identify the common adulterants in food, Detect the presence of adulterants in different food sample	2	R, An	F, C	L/T	
CO-5	Gain knowledge about the methods used in the production of dairy products	1	U	F, C	L/T	
CO-6	Explain the importance of food safety &	1,3	U	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-	1					
CO 2	1	-	-	-	-	-	1					
CO 3	1	-	-	-	-	-	2					
CO 4	-	3	-	-	-	-	1					
CO 5	1	-	-	-	-	-	2					
CO 6	2	-	3	-	-	-	3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

University of Kerala

Discipline	Biochemistry				
Course Code	UK5DSEBCH302				
Course Title	**Intermediary Metabolism and Bioenergetics**				
Type of Course	**DSE24**				
Semester	5				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	The course provides an overview of bioenergetics and energy production in metabolism of carbohydrate, lipids, nucleic acid and amino acids.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Carbohydrate metabolism**		**10**
	1	Reactions and energetics of glycolysis (aerobic and anaerobic), (structure not required)	
	2	Oxidative decarboxylation- TCA cycle (structure not required),	
	3	Anaplerotic reaction	
	4	Gluconeogenesis, (structure not required)	
	5	HMP shunt. (structure not required)	
	6	Galactosemia, Fructosuria, Essential pentosuria.	
	7	Glycogen Metabolism and regulation, cori cycle(structure not required)	
	8	brief study of the Glycogen storage diseases	
II	**Lipid Metabolism**		
	9	Fatty acid biosynthesis- saturated. (structure not required)	9
	10	Biosynthesis of triacylgycerol and phospholipid (structure not required)	
	11	Biosynthesis of Cholesterol (structure not required)	
	12	Fatty acid oxidation- beta oxidation, alpha and omega oxidation. (structure not required)	
	13	Ketone bodies: formation, utilization and excretion(structure not required)	
III	**Amino acid metabolism**		**8**

	14	Amino acid pool, glucogenic and ketogenic amino acids	
	15	Biosynthesis and degradation of tyrosine and phenylalanine	
	16	Transamination, deamination and decarboxylation,.	
	17	Urea cycle (structure not required) and regulation. Alkaptonuria, phenylketonuria	
IV			7
	18	**Nucleic acid metabolism** Sources of atoms of purines and pyrimidines,.	
	19	Biosynthesis and Degradation of purines and pyrimidines (structure not required)	
	20	de novo and salvage pathways with regulation, (structure not required)	
	21	Gout, Lesch Nyhan syndrome	
V		**Bioenergetics**	11
	22	Laws of thermodynamics-Role of high energy phosphates in energy transfer, concept of free energy. Biological oxidation, redox potential, coupled reactions.	
	23	Enzymes involved in oxidation and reduction-oxidases, dehydrogenases, hydroperoxides, oxygenases.	
	24	*Outline study of Electron Transport Chain.* Inhibitors of electron transport chain.	
	25	*Oxidative phosphorylation*:-Hypothesis – brief study	
	26	Chemiosmotic theory, P/O ratio, Inhibitors and Uncouplers	
	27	Malate aspartate and Glycerol-3-phosphate shuttle	

Practical (30 hours)

- Quantitative analysis of glucose by Nelson Somogyi method
- Quantitative analysis of ketose by Roe-Papadopoulos method
- Quantitative analysis of pentose by Orcinol method
- Quantitative analysis of protein by Biuret method
- Quantitative analysis of protein by Folin-Lowry Method
- Quantitative analysis of Amino acids by Ninhydrin method
- Quantitative analysis of Cholesterol by Zak's Method
- Quantitative analysis of DNA by Diphenyl Amine Method
- Quantitative analysis of RNA by Orcinol Method.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe pathways and energetics involved in the metabolism of Charbohydrates, Lipids, Nucleic acid and Amino acids.	R, U	1
CO-2	Explain the role of enzymes involved under physiological conditions.	R, U	1,3
CO-3	Explain the metabolic regulatory mechanisms of biomolecule synthesis	R, U	1,3
CO-4	Understanding the energetics and the mechanism of transport of these biomolecules in the body.	R, U	1
CO-5	Qualitatively analyse these biomolecules in a given test sample	R, U, Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Intermediary Metabolism and Bioenergetics
Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Describe pathways and energetics involved in the metabolism of Charbohydrates, Lipids, Nucleic acid and Amino acids.	1	R, U	F, C	L/T	
CO-2	Explain the role of enzymes involved under physiological conditions.	1,3	R, U	F, C	L/T	
CO-3	Explain the metabolic regulatory mechanisms of biomolecule synthesis	1,3	R, U	F, C	L/T	
CO-4	Understanding the energetics and the mechanism of transport of these biomolecules in the body.	1	R, U	F, C	L/T	
CO-5	Qualitatively analyse these biomolecules in a given test sample	1,2	R, U, Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-	1					
CO 2	2	-	1	-	-	-	1					
CO 3	2	-	1	-	-	-	1					
CO 4	3	-	-	-	-	-	1					
CO 5	1	3	-	-	-	-	1					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.

2. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2022). Biochemistry (9th ed.). W. H. Freeman.
3. Devlin, T. M. (2010). Textbook of Biochemistry with Clinical Correlations (7th ed.). Wiley-Liss.
4. Rodwell, V. W., Bender, D. A., Botham, K. M., & Kennelly, P. J. (2022). Harper's Illustrated Biochemistry (32nd ed.). McGraw-Hill.
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6. Nicholls, D. G., & Ferguson, S. J. (2013). Bioenergetics (4th ed.). Academic Press.
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10. Cortassa, S., Aon, D., & Westerhoff, P. J. (2002). Introduction to Metabolic and Cellular Engineering. CRC Press.

University of Kerala

Discipline	Biochemistry				
Course Code	UK5SECBCH300				
Course Title	**Basic Techniques in Biochemistry**				
Type of Course	**SEC3**				
Semester	**V**				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites					

Course Summary	The course provides a thorough understanding of different techniques used in the biochemical field including types of microscopy, staining techniques, colorimetry, spectrophotometry, centrifugation method, different types of chromatographic and electrophoretic techniques. The course also provides an overview on different spectroscopic and histopathologic techniques.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Microscopy & Photometry**		**6**
	1	Principle, instrumentation and applications of Simple microscope	
	2	Principle, instrumentation and applications of compound microscope	
	3	Basic staining techniques (Gram staining)	
	4	Colorimeter and spectrophotometer	
II	**Methods in Homogenization & Centrifugation**		**6**
	5	Methods of tissue homogenization, Subcellular fractionation	
	6	Principle, instrumentation, and applications of different types of centrifugations (Differential and density gradient),	
	7	Ultracentrifugation.	
	8	Different types of rotors.	
	Chromatography & Electrophoresis		**6**

	9	Principle, procedure, and applications of Paper chromatography, TLC	
	10	Ion exchange, Molecular sieve chromatography	
	11	HPLC	
	12	Agarose gel electrophoresis, SDS PAGE	
IV	**Spectroscopy**		**6**
	13	Flame Photometry, Fluorimeter	
	14	ESR and NMR spectroscopy	
	15	GC MS and HPLC MS	
V	**Basics of Histopathology**		**6**
	16	Basic knowledge on histopathology	
	17	Different steps such as fixation, tissue processing, cutting, staining and analysis	
	18	Immunohistochemistry	
	19	**Practical** ● Solvent preparation for chromatography ● Paper chromatography and TLC ● Development of chromatogram ● Mechanical homogenization by mortar and pestle ● Serum separation by centrifugation ● Demonstration of electrophoresis	**30**

References

1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology. 2010.
2. U Satyanarayana, Biochemistry, Books and Allied (p) Limited, 2014.
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8. Physical Biochemistry by David Freifelder Publisher: W.H.Freeman & Co Ltd (September 1976) ISBN-10: 0716705591 ISBN-13: 978-0716705598.
9. Research Methodology for Biological Sciences (2006) by Gurumani N Publisher: MJP Publishers ISBN: 8180940160 ISBN-13: 9788180940163, 978-8180940163.
10. Instrumental Methods of Chemical Analysis (2006) by M.S. Yadav Publisher: Campus Books International ISBN: 8187815620 ISBN-13: 9788187815624, 978-8187815624.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basic principle, instrumentation and applications of different microscopic techniques and photometry.	R, U	1
CO-2	Explain the different methods of homogenization, subcellular fractionation, and centrifugation.	R, U	1
CO-3	Gain knowledge on different types of chromatographic, electrophoretic and spectroscopic techniques.	R, U	1
CO-4	Understand the basic concept of histopathology	R,U	1
CO-5	Gain confidence to do various chromatographic and centrifugation techniques	R, U, Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Basic Techniques in Biochemistry

Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the basic principle, instrumentation and applications of different microscopic techniques and photometry.	1	R, U	F, C	L/T	
CO-2	Explain the different methods of homogenization, subcellular fractionation, and centrifugation.	1	R, U	F, C	L/T	
CO-3	Gain knowledge on different types of chromatographic, electrophoretic and spectroscopic techniques.	1	R, U	F, C	L/T	
CO-4	Understand the basic concept of histopathology	1	R,U	F, C	L/T	
CO-5	Gain confidence to do various chromatographic and centrifugation techniques	1,2	R, U, Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-	1					
CO 2	2	-	-	-	-	-	1					
CO 3	2	-	-	-	-	-	2					
CO 4	2	-	-	-	-	-	1					
CO 5	1	3	-	-	-	-	3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5SECBCH301				
Course Title	**QUALITY ASSESSMENT AND QUALITY CONTROL**				
Type of Course	SEC4				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	NIL				
Course Summary	To provide high-quality products and services, Organizations depend on effective quality management techniques. Two fundamental components of quality management are quality assurance (QA) and quality control (QC). This certificate course will give the students a foundational understanding of quality assurance and control, open up employment prospects, and improve their mobility across various sectors including clinical and pharmaceutical industry.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Basic concepts of QA and QC**	**8**
	1	Definition, Objectives of QA, difference between QA & QC, Quality testing, Functions of QA & QC	
	2	QA Processes, QC Procedures, Advantages and disadvantages of QA, Sources of quality variation (raw materials, processes, packaging, labelling, finished products, manual errors -personal, instrumental, and documentation).	
	3	Components of Quality control**:** Inspection, testing, statistical process control, documentation and records, documentation skills, corrective actions, training and education, Continuous Improvement.	
	4	Importance and benefits of Quality control, Quality Control methods. (X-Bar Chart, Taguchi Method, 100% Inspection Method). Basic tools of quality control	
II		**Quality Management system**	**8**
	5	Quality management systems in Food, pharmaceutical industries, health care and health care equipment.	
	6	Standards in Food Industry-GMP, GHP, HACCP, BIS, AGMAK, FSSAI, FSSA2006, Codex Alimentarius. Standards in Pharmaceutical Industry-ISO 9001, ISO 14001, ISOP 27701, ISO 45001, ISO22000, ISOGDPR.	

	7	Standards in Health Care- MDR, ISO13485, ISO 41001, ISO22301, ISO 37001, ISO27001, ISO9001, ISO14001.	
III	**Sample Preparation, Preservation, Storage**		**7**
	8	Basics of sample preparation, preservation and storage, handling of glassware, chemicals and biological samples	
	9	Good Storage Practices, Laboratory hazards and management (Chemical, biological, physical hazards),	
	10	Safety measures in handling and safety equipment. GLP	
IV	**Familiarizing Lab Equipment and Experimental Approaches**		**7**
	11	*Theoretical Aspects*: SOP of Electronic balance, pH meter, colorimeter, UV-Vis Spectrophotometer, microscope, micropipette-elementary level and hand on training.	
	12	*Practical Aspects*: Preparation of Solutions (Normal, Molar and percentage solution), preparation of buffers	
V	**Practical**		**30**
	13	**Institute visit**: Acquainting with cell culture lab, Animal house facilities	
	14	GLC, HPLC	
	15	**Industry visit**: QA QC lab of Industries	

References

1. Dave, B. P., & Mishra, D. D. (2006). Food Quality Assurance: Principles and Practice. S. Chand & Company Ltd. 4.
2. Ossewaarde, D. W. (2011). Food Safety and Quality Assurance.
3. Alli. (2003). Food quality assurance: Principles & practices. CRC Press.
4. Andre Gordon. (2020). Food Safety and Quality Systems in Developing Countries: Technical and Market Considerations (V5). Academic Press.
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6. Haider, I., & Asif, S. (2018). Quality control training manual: Comprehensive training guide for API, pharmaceutical & biotechnology laboratories. CRC Press.
7. Sarker, K. (2008). Quality systems & control for the pharmaceutical industry. Wiley

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Differentiate between quality assurance and quality control	U, R	4
CO-2	Develop familiarity with quality and its concept	R, U	4
CO-3	Familiarize sampling and analytical methodologies	R, U	4

	involved in quality assessment		
CO-4	Acquaint with minor and sophisticated instruments used in quality testing	R, U, Ap	4
CO-5	Understand the working of QA & QC labs in industries	R, U	2, 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: QAQC

Credits: 2:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,4	U, R	F, C	L, T	
2	2	1,4	R, U	F, C	L, T	
3	3	1,4	R, U	F, C	L, T	
4	4	1,4	R, U, Ap	F, C	L, T	
5	5	1, 4	R, U	F, C, P	L, T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	1	-	-	1	-		-	-	
CO 2	-	1	-	-	1	-	1	-	-	
CO 3	-	1	-	-	1	-	-	-	-	1
CO 4	-	1	-	-	1	-	-	-	-	1
CO 5	-	1	-	1	1	1		-	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK6DSCBCH300				
Course Title	**CLASSICAL AND MOLECULAR GENETICS**				
Type of Course	**DSC29**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	The objective of the course is to make students aware of the Mendelian genetics and the deviations from Mendelian principles. It deals with genome organization, replication, transcription, translation and mutations. It also deals with genome sequencing technologies and applications.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**GENETICS**	**15**
	1	Model genetic organisms (brief outline with examples).	

	2	Basic principles of heredity- Mendel's laws, monohybrid, dihybrid and test cross (pea plant).	
	3	Extensions of Mendelian principles: Gene interaction- Allelic gene interaction (complete dominance, co-dominance and incomplete dominance- brief outline with example) and non-allelic gene interaction (epistasis- duplicate recessive, recessive, dominant, dominant inhibitory and duplicate dominant epistasis-brief outline with example).	
	4	Penetrance, expressivity, genetic anticipation and genomic imprinting (definition with examples).	
	5	Sex linked characteristics (eye colour of drosophila): Brief outline of Morgan's studies.	
	6	Maternal inheritance (kappa particles in paramecium, male sterility in maize) and maternal effect (shell coiling in snails).	
	7	Pedigree analysis and applications - autosomal dominance, autosomal recessive, X-linked recessive (brief outline).	
	8	Bacterial and Viral Genetic Systems- Transformation, transduction and conjugation. Transposons and multiple drug resistance (brief outline).	
II	**GENOME ORGANISATION AND REPLICATION**		**6**
	9	Genome organization (prokaryotes and eukaryotes), chromatin, centromere, and telomere. Central Dogma.	
	10	DNA replication in prokaryotes, enzymes involved in replication, replication inhibitors (any 3 examples).	
III	**MUTATION AND REPAIR**		**5**
	11	Mutation in Prokaryotes: Various types of mutation- spontaneous and induced mutation, point mutation- substitution (transition, transversion), insertion, deletion, missense, nonsense, frame-shift mutation, mutagens- different types. Ames test.	
	12	Chromosome variation- aneuploidy, polyploidy, duplication, deletion, inversion and translocation (Brief outline).	
	13	Repair in prokaryotes - direct, excision, mismatch, recombination and SOS.	
IV	**GENE EXPRESSION**		**10**
	14	Transcription in prokaryotes, enzymes involved in transcription, transcription inhibitors (any 3 examples). Post transcriptional modification	
	15	Eukaryotic transcription and post transcriptional modification (brief outline only).	
	16	Genetic codon (characteristics of codon), Wobble hypothesis (brief concept).	
	17	Translation in prokaryotes, translation inhibitors (any 3 examples). Post translational modification	
V	**REGULATION OF GENE EXPRESSION**		**9**
	18	Operon- Structural gene and regulator gene	
	19	Jacob and Monod's operon concept .	
	20	Inducible operon (lac operon as an example)	
	21	Repressible operon (tryptophan operon as an example), Attenuation	
		PRACTICAL Isolation of DNA Estimation of DNA by Diphenylamine method Estimation of RNA by Orcinol method Conducting pedigree analysis to determine genotypes, identify phenotypes, and predict the type of inheritance	**30**

References:

1. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2020). An Introduction to Genetic Analysis (12th ed.). W. H. Freeman.
2. Snustad, D. P., & Simmons, M. J. (2018). Principles of Genetics (7th ed.). Wiley.
3. Klug, W. S., & Cummings, M. R. (2016). Concepts of Genetics (12th ed.). Pearson.
4. Hartl, D. L., & Ruvolo, M. (2018). Genetics: Analysis and Principles (6th ed.). McGraw-Hill Education.
5. Griffiths, A. J. F., Gelbart, W. M., Miller, J. H., & Lewontin, R. C. (2002). Modern Genetic Analysis (3rd ed.). W. H. Freeman.
6. Brown, T. A. (2017). Genomes (4th ed.). Garland Science.
7. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Pearson.
8. Brooker, R. J. (2014). Genetics: Analysis and Principles (5th ed.). McGraw-Hill Education.
9. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Martin, K. C. (2020). Molecular Cell Biology (9th ed.). W. H. Freeman.
10. Stansfield, W. D., & Hatfield, T. (2012). Schaum's Outline of Theory and Problems of Genetics (5th ed.). McGraw-Hill Education.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Illustrate the type of inheritance of a trait in organisms	An	1,2,3
CO-2	Summarise the process of replication in prokaryotes	U	1
CO-3	Explain the various kinds of mutation, chromosomal aberrations and repair systems	U	1,2
CO-4	Discuss the mechanisms of gene expression	U	1
CO-5	Compare different regulatory mechanisms in prokaryotes	U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Classic and Molecular Genetics

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Illustrate the type of inheritance of a trait in organisms	1,2,3	An	F, C	L/T	
CO-2	Summarise the process of replication in prokaryotes	1	U	F, C	L/T	

CO-3	Explain the various kinds of mutation, chromosomal aberrations and repair systems	1,2	U	F, C	L/T	
CO-4	Discuss the mechanisms of gene expression	1	U	F, C	L/T	
CO-5	Compare different regulatory mechanisms in prokaryotes	1	U	F, C	L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	3	2	2	-	-	-	3					
CO 2	3	-	-	-	-	-	1					
CO 3	2	1	-	-	-	-	2					
CO 4	3	-	-	-	-	-	1					
CO 5	2	-	-	-	-	-	1					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓

CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK6DSCBCH301				
Course Title	**CLINICAL BIOCHEMISTRY & MOLECULAR DIAGNOSTICS**				
Type of Course	**DSC30**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NIL				
Course Summary	The course will give the students the fundamental idea and comprehensive nature of clinical disorders, applying biochemistry fundamentals in diagnosis, interpreting and management of various clinical conditions				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**An introduction to Clinical Biochemistry**		**9**
	1	Scope of clinical biochemistry in Diagnosis	
	2	Collection and preservation of biological fluids and clinical samples	
	3	Clinical importance of biomolecules: Carbohydrates; hyper and hypoglycemia. Lipids: Lipid profile and atherosclerosis. Proteins: hypoalbuminemia, Bence jones proteins, Proteins in CSF	
	4	Quality control and safety measures in clinical laboratory	
II	**Cell biology and genetics in diagnostics**		**9**
	5	Chromosomal aberrations and Cytogenetic analysis	
	6	Disease identification and Genetic tests for following disorders- Thalassemia, Sickle Cell anemia, Alzheimer's	
	7	Molecular basis of cancer, oncogenes, tumor suppressor genes. Gene therapy and other molecular based therapeutic approaches.	
III	**Molecular diagnostics**		**9**

	8	Basics of Molecular diagnostics and its advantages over serological testing	
	9	Molecular Techniques for diagnosis – PCR and its modifications, FISH, Genotyping, Microarrays and mass spectrometry	
	10	Immunodiagnostics: Antibody Structure and Function antibody classes, isotypes, and characteristics, Production of Monoclonal antibodies, Immunoassay Systems; ELISA (direct and indirect, sandwich, competitive assays) Western blotting; immunocytochemistry	
	11	Ethical considerations in molecular diagnosis	
IV	**Organ function tests and therapeutic drug monitoring**		**9**
	12	Functions of liver, Liver function tests and clinical significance	
	13	Structure of nephron, urine formation and renal function tests	
	14	Thyroid hormones, Thyroid function tests, clinical implications of TFT, Pancreatic function tests and cardiac function tests	
	15	Therapeutic drug monitoring: Definition, applications and Monitoring methods	
V	**Diagnostic enzymology**		**9**
	16	Fundamentals of enzymology: Activation energy, holoenzyme, apoenzyme, prosthetic group, active site, Enzyme units- IU, Katal, specific activity and turnover number	
	17	Enzymes in health and diseases: Distribution and application of clinically important enzymes, Enzymes as diagnostic markers	
	18	Isoenzymes and its clinical importance. Enzymes as reagents, analytical agents and therapeutic agents	
	Practical		**30**
	19	Estimation of glucose, Total proteins, Lipid profile	
	20	Kidney function test and Liver function test	
	21	Blood estimations: ESR, Hb, PCV, Blood grouping, Differential count of WBC Awareness of Genetic tests	

References

1. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (Eds.). (2020). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics (7th ed.). Elsevier.
2. Armstrong, D. T. (Ed.). (2021). Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory (3rd ed.). Academic Press.
3. Kumar, P., & Clark, M. (2021). Clinical Medicine (10th ed.). Elsevier.
4. Lippincott Williams & Wilkins. (2021). Clinical Chemistry: Principles, Techniques, and Correlations (9th ed.). Lippincott Williams & Wilkins.
5. Larson, J. A., & Ashwood, E. R. (Eds.). (2014). Fundamentals of Molecular Pathology. Springer.
6. Gaw, A., Murphy, M. J., Cowan, R. A., & O'Reilly, D. S. (2018). Clinical Biochemistry: An Illustrated Colour Text (5th ed.). Elsevier.
7. Harr, R. R. (2018). Medical Laboratory Science: Clinical Chemistry (7th ed.). F. A. Davis Company.
8. Nieman, D. C., & DeRuisseau, K. C. (2020). Clinical Exercise Physiology (4th ed.). Human Kinetics.
9. Lopez-Garrido, J. A. (Ed.). (2021). Molecular Diagnostics: New Insights into Principles and Practices. Springer.
10. Kumar, P., & Mittal, B. (2022). Advance1s in Molecular Diagnostics and Personalized Medicine. Springer.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understanding the basic of a clinical biochemistry lab	U, E	1
CO-2	Apply molecular biology in diagnosis and interpretation of various diseases	Ap, E	2
CO-3	Attain comprehensive knowledge on performing organ function tests and therapeutic drug monitoring	R, U	1,2,3
CO-4	Acquire proficiency in laboratory testing of various blood parameters	Ap, E	2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Clinical Biochemistry and Molecular Diagnostics

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understanding the basic of a clinical biochemistry lab	1	U,E	F, C	L/T	
CO-2	Apply molecular biology in diagnosis and interpretation of various diseases	2	Ap, E	P		P
CO-3	Attain comprehensive knowledge on performing organ function tests and therapeutic drug monitoring	1,2,3	R,U	F, C	L/T	
CO-4	Acquire proficiency in laboratory testing of various blood parameters	2,4	Ap, E	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-	1					
CO 2	-	3	-	-	-	-	2					

CO 3	2	2	2	-	-	-	2					
CO 4	-	2	-	2	-	-	3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY
Course Code	UK6DSCBCH302
Course Title	**Endocrinology**
Type of Course	DSC31
Semester	VI
Academic Level	300-399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4			4
Pre-requisites	NIL				
Course Summary	The course equips students with a comprehensive understanding of endocrinology, covering fundamental concepts, mechanisms of hormone action, functions of hormones, and the pathophysiology of various endocrine disorders.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Endocrinology and mechanism of action of hormones**		**14**
	1	Hormones–definition. Chemical signalling–endocrine, paracrine and autocrine mechanisms	
	2	Chemical diversity of hormones, Transport of hormones in the circulation and half–lives. Regulation of hormones and feedback mechanisms	
	3	Hormone receptors–extracellular and intracellular. Mechanism of action of hormones–group I (Sterol derived hormones and Iodothyronine) and group II (Peptide hormones)	

	4	Receptor–hormone binding. G–protein coupled receptors, second messengers–cAMP, cGMP, IP_3, DAG and Ca^{2+}. Effector systems–Adenylate cyclase, Guanylate cyclase, Phosphodiesterases and Phospholipase C. Protein kinases (PKA, PKB, PKC and PKG). Signalling by NO	
II	**Hypothalamo–pituitary System, Hormones Regulating Metabolism and Calcium Homeostasis**		**14**
	5	Hypothalamo–pituitary regulatory system : anatomy and secretions (in brief)	
	6	Physiological and biochemical actions of hypothalamic hormones, anterior pituitary hormones and associated disorders (Gigantism, Acromegaly and Dwarfism); Posterior pituitary hormones–physiology and biochemical roles of Oxytocin and Vasopressin, Diabetes insipidus	
	7	Structure and functions of thyroid gland. Thyroid hormones: biosynthesis and biological functions. Physiological and biochemical actions of thyroxine. Hyper–and hypothyroidism: Goitre, Graves' disease, Cretinism and Myxoedema	
	8	Structure and functions of parathyroid gland, Biological functions of Parathyroid hormone (PTH). Regulation of calcium homeostasis by PTH, Vitamin D and calcitonin. Hyper–and hypoparathyroidism	
III	**Hormones of the Adrenals**		**10**
	9	Structure and anatomy of adrenal cortex and medulla. Mineralocorticoids, Glucocorticoids and Sex corticoids	
	10	Regulation of synthesis and biochemical functions of adrenal steroids, the Renin–Angiotensin system. Physiology and biochemical actions of Aldosterone and Cortisol	
	11	Adrenal medullary Hormones : Epinephrine and Norepinephrine. The Fight or Flight response	
	12	Pathophysiology and clinical features of Addison's disease, Conn's syndrome, Cushing's syndrome	

IV	**Pancreatic, GI Tract and Adipose Hormones**		**12**
	13	Endocrine regions and hormones of the pancreas : Structure, synthesis, regulation, physiology and biochemical actions of insulin, glucagon and somatostatin	
	14	Pathophysiology – Type I and type II Diabetes mellitus	
	15	Cells involved in the release of gastrointestinal hormones, Gastrin family of hormones (Gastrin, CCK and caerulein). The secretin family of hormones, Incretins and Ghrelin	
	16	Adipocyte hormones: Adiponectin and leptin; Appetite and satiety control	
V	**Reproductive Hormones**		**10**
	17	Hormones secreted by gonads	
	18	Cell types of the testis. Spermatogenesis and control of testicular function, Biological actions of androgens	
	19	Cell types of the ovaries, Hormones : Oestrogens and progesterone. The ovarian cycle, Interplay of hormones during ovarian and uterine phases of menstrual cycle, Placental hormones	
	20	Role of hormones during parturition and lactation. Hormone based contraception and hormone therapy	

References

1. Introduction to Endocrinology by Chandra S.Negi
2. Essentials of Physiology for Dental Students by K Sembulingam, Prema Sembulingam
3. Tortora's Principles of Anatomy and Physiology by Gerard J. Tortora, Bryan H. Derrickson
4. Clinical endocrinology by Dana Stoian
5. Harrison's Endocrinology by J. Larry Jameson
6. Williams Textbook of Endocrinology by Wilson, Jean D., Larsen, P. Reed, Kronenberg, Henry, Foster, Daniel W.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics of Endocrinology	R	1
CO-2	Outline the mechanism of action of different classes of hormones	U, R	1
CO-3	Explain the functions of hormones	U, R	1
CO-4	Discuss the Pathophysiology and clinical features of endocrine disorders	U, R	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Endocrinology

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	C O	PO/PS O	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the basics of Endocrinology	1	R	F,C		
CO-2	Outline the mechanism of action of different classes of hormones	1	U, R	F,C		
CO-3	Explain the functions of hormones	1	U, R	F,C		
CO-4	Discuss the Pathophysiology and clinical features of endocrine disorders	1,2	U, R	F,C		

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	-	-	-	-	-	1					

CO 2	3	-	-	-	-	-	1					
CO 3	3	-	-	-	-	-	1					
CO 4	2	3	-	-	-	-	1					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK6DSCBCH303				
Course Title	**CLINICAL BIOCHEMISTRY**				
Type of Course	**DSC32**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NIL				
Course Summary	The course is intended to impart basic knowledge of clinical disorders, demonstrating the application of biochemical parameters and laboratory methods in diagnosing diseases.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**An introduction to Clinical Biochemistry**		**9**
	1	Scope of clinical biochemistry in Diagnosis	
	2	Collection and preservation of biological fluids and clinical samples	
	3	Quality control and safety measures in clinical laboratory	
II	**Organ function tests**		**9**
	4	Liver function tests: - Serum Bilirubin: Total Bilirubin – Direct & Indirect, VD Bergh reaction, Liver enzymes: AST, ALT, ALP & GGT	
	5	Renal Function tests: tests of glomerular functions, measurement of GFR, Clearance tests (creatinine and inulin clearance), Plasma creatinine, urea, β2-microglobulin	
	6	Thyroid function tests: TSH, T3, T4	
III	**Molecular diagnostics**		**9**
	7	Basics of Molecular diagnostics and its advantages over serological testing	
	8	Molecular Techniques for diagnosis – PCR and its modifications, FISH	
	9	Immunodiagnostics: Antibody Structure and Function antibody classes, isotypes, and characteristics. ELISA, Western blotting; immunocytochemistry	

	10	Ethical considerations in molecular diagnosis	
IV	**Metabolic disorders**		**9**
	11	Carbohydrate metabolism-Hyperglycaemia, galactosemia, Lactose intolerance.	
	12	Nucleic acid metabolism-Hypo and hyper uricemia, gout.	
	13	Lipid Metabolism –Atherosclerosis, fatty liver, Taysach's and Niemann Pick diseases	
V	**Instrumentation in Clinical Biochemistry laboratory**		**9**
	14	Semi auto and fully auto analyser (wet & dry chemistry)	
	15	ELISA, ELFA, CLIA, ECLIA, HPLC (HbA1C) Nephelometry, Immunochromatography methods	
	Practical		**30**
	16	Estimation of AST, ALT, Total proteins, Lipid profile, Glucose, RFT	
	17	Blood estimations: ESR, Hb, PCV, Blood grouping, Differential count of WBC	

References

1. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (Eds.). (2020). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics (7th ed.). Elsevier.

2. Bruns, D. E., & Tietz, N. W. (2015). Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th ed.). Elsevier.

3. Rifai, N., Horvath, A. R., & Wittwer, C. T. (Eds.). (2018). Principles and Applications of Molecular Diagnostics (2nd ed.). Elsevier.

4. Marshall, W. J., Lapsley, M., Day, A. P., & Ayling, R. M. (2014). Clinical Biochemistry: Metabolic and Clinical Aspects (4th ed.). Elsevier.

5. Gaw, A., Murphy, M. J., Cowan, R. A., & O'Reilly, D. S. (2018). Clinical Biochemistry: An Illustrated Colour Text (5th ed.). Elsevier.

6. Harr, R. R. (2018). Medical Laboratory Science: Clinical Chemistry (7th ed.). F. A. Davis Company.

7. Katki, H. A. (2019). Essentials of Clinical Chemistry and Hematology in Laboratory Medicine. Springer.

8. Smith, A. F. (2021). Clinical Biochemistry: An Illustrated Manual. Wiley-Blackwell.

9. Crook, M. A. (2020). Clinical Biochemistry and Metabolic Medicine (9th ed.). CRC Press.

10. Vasudevan, D. M., & Sreekumari, S. (2018). Textbook of Biochemistry for Medical Students (8th ed.). Jaypee Brothers Medical Publishers.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO Addressed
CO-1	Understanding the basic set up and quality control in a clinical biochemistry lab	U	1
CO-2	Develop ability to handle biological fluids and clinical samples	U, E	1,2
CO-3	Attain the proficiency of performing organ function tests	E, An, Ap	1,2,3
CO-4	Understanding of various metabolic disorders associated with carbohydrates, lipids and nucleic acid metabolism	A, An, U	1,2,3
CO-5	Acquire ability to handle basic biochemistry laboratory instruments	Ap, C	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Clinical Biochemistry

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understanding the basic set up and quality control in a clinical biochemistry lab	1	U	F, C	L/T	
CO-2	Develop ability to handle biological fluids and clinical samples	1,2	U,E	P		P
CO-3	Attain the proficiency of performing organ function tests	1,2,3	E, An,Ap	P		P
CO-4	Understanding of various metabolic disorders associated with carbohydrates, lipids and nucleic acid metabolism	1,2,3	A,An,U	F, C	L/T	
CO-5	Acquire ability to handle basic biochemistry laboratory instruments	2	Ap, C	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	1					
CO 2	2	3	-	-	-	-	2					
CO 3	1	2	2	-	-	-	3					
CO 4	2	2	3	-	-	-	3					
CO 5	-	3	-	-	-	-	2					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

CO 5	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK6DSCBCH304				
Course Title	**Advanced biochemistry**				
Type of Course	DSC33				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per eek	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Basic knowledge in Biology				
Course Summary	The Course describes anatomy, physiological and biochemical functions of specialised tissues of the body and biological membranes.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Principles of Gene Cloning**		**12**
	1	Introduction, history, the advent and importance of gene cloning PCR, real time PCR.	
	2	Outline study of recombinant DNA technology.	
	3	DNA manipulating enzymes, palindromes.	
	4	Cloning vectors in prokaryotes and eukaryotes (pBR 322, pUC18, M13, Cosmids, Phagemids, yeast vectors, animal viral vectors, plant viral vectors, Ti plasmids).	
	5	Construction of genomic library and c-DNA library.	
II	**DNA technology**		**12**
	6	Isolation and purification of total cell DNA.	
	7	DNA sequencing methods (Maxam Gilbert sequencing, Sanger's method).	
	8	Principle and applications of In situ hybridization, DNA fingerprinting, DNA foot printing, RFLP, RAPD, AFLP, and STR analysis.	
	9	Outline study of Site- directed mutagenesis, DNA-protein interaction Assays.	
III	**Elements of Nanoscience**		**12**
	10	Basics and scale of nanotechnology, different classes of nanomaterials: Liposomes, quantum dots shell structures, metal oxides and semiconductors (Definition & Physico-chemical properties and application only).	
	11	Synthesis of nanomaterials- Physical & Chemical Methods.	
	12	Characterization of nanostructures: DLS, FTIR & X-ray diffraction (Basic idea).	

	13	Types of nanostructures: one dimensional, two dimensional and three-dimensional nano-structured materials.	
IV	**Nanobiotechnology**		**12**
	14	Nano biomaterials, Structural & functional principles of bio nanotechnology: Size, zeta potential, bioavailability, and excretion.	
	15	Protein and DNA based nanostructures (Definition and examples only),	
	16	Nano bio-analytics, nanotechnology in food, medicine and health science application.	
V	**Omics**		**12**
	17	Basic concepts and tools of proteomics.	
	18	Quantitative and targeted proteomics, proteogenomic, metabolomics, metabolomic data analysis, genomics.	
	19	Next generation sequencing (NGS) technology, gene expression and gene regulation networks.	
	20	Basic idea of molecular diagnostics.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Illustrate the principle and techniques involved in gene cloning	R, U	1, 3, 4
CO-2	Explain the principle and techniques of DNA isolation and characterisation	R, U	1, 3, 4
CO-3	Summarise the methods to synthesise and characterise various types of nanomaterials	R, U	1, 3, 4
CO-4	Describe the biological applications of nanotechnology	R, U	1, 3, 4
CO-5	Discuss the different branches of Omics and their biological application	R, U	1, 3, 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Advanced Biochemistry

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Illustrate the principle and techniques involved in gene cloning	1, 3, 4	R, U	F, C	L,T	

CO-2	Explain the principle and techniques of DNA isolation and characterisation	1, 3, 4	R, U	F, C	L,T	
CO-3	Summarise the methods to synthesise and characterise various types of nanomaterials	1, 3, 4	R, U	F, C	L,T	
CO-4	Describe the biological applications of nanotechnology	1, 3, 4	R, U	F, C	L,T	
CO-5	Discuss the different branches of Omics and their biological application	1, 3, 4	R, U	F, C	L,T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	1	1	-	-	1					
CO 2	1		1	1	-	-	1					
CO 3	1	-	1	1	-	-	1					
CO 4	1	-	1	1	-	-	1					
CO 5	1		1	1	-	-	1					

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, T. A. Brown, WileyBlackwel.
2. Principles of Gene Manipulation & Genomics – 7th Edition – Sandy B. Primrose, Richard Twyman–Blackwell 30
3. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
4. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
5. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
6. Processing & properties of structural nanomaterials- Leon L. Shaw, Nano chemistry: A
7. Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.
8. Bernhard O. Palsson, Sangeeta N. Bhatia, "Tissue Engineering" Pearson Publishers 2009.
9. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

University of Kerala

Discipline	BIOCHEMISTRY
Course Code	UK6DSCBCH305
Course Title	**GENERAL INFORMATICS AND BIOINFORMATICS**
Type of Course	**DSC34**

Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NIL				
Course Summary	General informatics and bioinformatics involve the application of computational tools and data analysis techniques to manage, analyze, and interpret large datasets, particularly in the context of biological research. This course covers topics such as algorithms, data storage, and visualization, as well as the use of bioinformatics tools in areas like genomics, proteomics, and drug discovery.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Bioinformatics**		**10**
	1	Fundamentals of computers-Generations of computers, types of computers, components of a computer, Software, Hardware, Data storage and memory, Basics of operating system, Computer network and internet, Introduction to programming. Computer security and privacy	
	2	Programming languages for Bioinformatics- Python, Perl and R	
	3	Scope of Bioinformatics- genomics, proteomics, computer-aided drug design, systems biology, Human genome project	
	4	Applications of Bioinformatics	
II	**Biological databases**		**8**
	5	Introduction to biological databases- classification based on the type of data stored- primary, secondary and composite databases	
	6	Classification based on composition of data types- sequence databases, metabolite databases, structure databases, chemical databases, bibliographic databases	
	7	Nucleic acid sequence databases (EMBL, GenBank, DDBJ)	
	8	Protein sequence databases (SwissProt, PIR, TrEMBL)	
	9	Genome databases (ArrayExpress, Ensembl)	
	10	Micro-array databases (ArrayTrack)	

	11	Metabolite databases (KEGG, EcoCyc,MetaCyc)	
	12	Structure databases (PDB, CATH, SCOP)	
	13	Chemical databases (ACToR)	
	14	Bibliographic databases (PubMed, Google Scholar)	
	15	Biomolecular and model organism databases (FlyBase, SGD, AGR)	
III	**Sequence alignment**		**8**
	16	Sequence alignment, Pairwise sequence alignment-Global and Local alignment	
	17	Multiple sequence alignment -Progressive and Iterative methods	
	18	Sequence analysis tools – BLAST, FASTA, CLUSTAL W	
IV	**Molecular Phylogenetics**		**6**
	19	Phylogenetic tree, representation of phylogenetic tree- dendrogram and cladogram. Methods of construction of phylogenetic tree – maximum parsimony, maximum likelihood and distance-based methods	
	20	Phylogenetic tree construction steps	
	21	Phylogenetic analysis using PHYLIP	
	22	Applications of phylogenetic tree	
V	**Structural Bioinformatics**		**13**

	23	Protein structure classification- protein structure databases-CATH and SCOP	
	24	Molecular modelling – homology modelling and *ab inito* modelling	
	25	Protein structure prediction -Overview of protein structure prediction methods	
	26	Molecular visualization software-PyMOL, VMD	
	27	Drug discovery pipeline-overview of drug discovery process, role of computational methods in drug discovery	
	28	Computer – Aided Drug Discovery and Designing (CADD)- principles of CADD in drug discovery	
	29	Molecular Docking-Introduction to molecular docking in drug design	
	30	Ethical issues in Bioinformatics-Ethics in genome projects, Ethical considerations in personalized medicine, responsible conduct of research in bioinformatics	
		Practical **Bioinformatics:** Internet basics, Introduction to NCBI Web sites, Introduction to D Sequence alignment, Phylogenetic analysis, Protein structure predi Computer-aided drug designing	**30**

References:

a. Alexis and Mathews Leon, Fundamentals of Information and Technology. Alexis Leon. Vikas Publishing. ISBN 08125907890.
b. Bioinformatics: A Beginner's Guide. By Jean-Michel Claverie and Cedric Notredame; Wiley Publishing, Inc.2003.
c. Bioinformatics: A Practical approach. K.Mani and N.Vijayaraj, Aparna Publication, 2004. 12
d. Introduction to Bioinformatics T.K. Atwood and D.J. Parry – Smith Publisher Pearson Education Pvt. Ltd ISBN 81-7808-507. 2002.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Students will learn to manage, organize, and analyze large datasets using computational tools and methods, including data preprocessing, cleaning, and transformation.	U	1
CO-2	Students will gain proficiency in bioinformatics software and databases, using them to perform tasks such as sequence alignment, gene expression analysis, and protein structure prediction.	U, Ap	2,3
CO-3	Students will develop skills in applying algorithms and computational methods to solve complex biological problems, such as identifying genetic variants or modeling biological systems.	Ap, An	2,3
CO-4	Students will learn how to present and interpret biological data effectively using data visualization techniques, enabling them to communicate findings clearly and persuasively.	Ap, E	2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: GENERAL INFORMATICS AND BIOINFORMATICS

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Students will learn to manage, organize, and analyze large datasets using computational tools and methods, including data preprocessing, cleaning, and transformation.	1	U	F, C	L/T	
PCO-2	Students will gain proficiency in bioinformatics software and databases, using them to perform tasks such as sequence alignment, gene expression analysis, and protein structure prediction.	2,3	U, Ap	P		P
CO-3	Students will develop skills in applying algorithms and computational methods to solve complex biological problems, such as identifying genetic variants or modeling biological systems.	2,3	Ap, An	P		P
CO-4	Students will learn how to present and interpret biological data effectively using data visualization techniques, enabling them	2,3,4	Ap,E	C,P	L/T	P

	to communicate findings clearly and persuasively.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	2	3	-	-	-	1	1	-	-	-	-
CO 3	-	3	2	-	-	-	1	2	-	-	-	-
CO 4	-	2	1	2	-	-	1	2	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK6DSEBCH300				
Course Title	**MICROBIAL BIOCHEMISTRY**				
Type of Course	**DSE7**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	NIL				
Course Summary	Microbial biochemistry is the study of the biochemical processes within microorganisms, including bacteria, archaea, fungi, and viruses, and their interactions with the environment. This course covers topics such as microbial metabolism, enzymatic pathways, gene regulation, and the role of microbes in biogeochemical cycles and biotechnological applications.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**INTRODUCTION TO MICROBIAL WORLD**		**9**
	1	Morphology and classification: History of microbiology. Principles of classification of microbes; A brief introduction to major groups of microorganisms - bacteria, viruses, fungi, protozoa, algae.	
	2	Ultrastructure of bacteria, Chemical composition of cell wall, Staining techniques-simple, differential, special staining techniques and negative staining.	
	3	Viruses: Morphology, classification, nomenclature and replication of viruses, DNA viruses and RNA viruses.	
	4	Bacteriophage - general characteristics, viral oncogenes and retroviruses, virus-host interaction, viral infections- Emerging infectious diseases.	
II	**MICROBIAL GENETICS AND METABOLISM**		**9**
	5	Microbial genetics: The inheritance of characteristics and variability, phenotypic and genotypic changes, mutations, plasmids, bacterial recombination, bacterial conjugation, transduction, and bacterial transformation.	
	6	Genetic engineering of microorganisms for biotechnology - recombinant microbes, recombinant plants, recombinant animals.	
	7	Microbial metabolism: Glycolysis, Tricarboxylic acid cycle, Pentose phosphate pathway, Entner-Doudoroff pathway.	
	8	Microbial electron transport chain, Fermentation	
III	**CLINICAL AND APPLIED MICROBIOLOGY**		**9**
	9	Clinical Microbiology: Biosafety, Identification of microorganisms from specimen - direct identification, culture-based methods, isolation of pure culture.	
	10	Biochemical tests used for the identification and differentiation of bacteria, microscopic and molecular methods, and Indirect identification of infectious agents.	
IV	**CONTROL OF MICROBES AND ANTIMICROBIAL THERAPY**		**9**
	11	Antimicrobial agents: Conditions influencing antimicrobial action, Physical agents – Temperature, Desiccation, Osmotic pressure, Radiation, Surface tension, Interfacial tension and Filtration.	
	12	Chemical agents: Characteristics of an ideal antimicrobial chemical agent, Mode of action and practical applications of Phenols, Alcohols, Halogens, Heavy metals, Dyes, Detergents, Quaternary ammonium compounds, Aldehydes and Gaseous agents. Evaluation of antimicrobial chemical agents.	
	13	Antimicrobial Drugs-Interaction between drugs and microbes, antimicrobial action of important antibiotics-Penicillin, Streptomycin, Tetracyclin, Chloramphenicol and Rifampicin, Antibiotic resistance.	
V	**APPLIED MICROBIOLOGY AND ANTIMICROBIAL THERAPY**		**9**
	14	Applied Microbiology and antimicrobial therapy: Microbiology of food-food spoilage, controlling food spoilage, types of food-borne diseases, microbiology of fermented food.	
	15	Applied environmental microbiology- water purification and sanitary analysis. Biodegradation, bioremediation, bioaugmentation.	
		Practical	**30**
	16	Sterilization techniques - Chemical agents for the control of microbial growth. Physical agents for the control of microbial	

		growth. Preparation of media: Liquid, solid, and semi solid media. (Deep, Slant and plate preparation).	
	17	Staining techniques: Simple, Differential and Special staining. Motility test: Hanging drop method. Pure culture techniques: Streak plate, Pour plate. Total viable count determination - streak plate, pour plate.	
	18	Biochemical tests for identification: IMViC reactions, Oxidase, catalase, Urease, Carbohydrate fermentation. Detection of enzyme activity- amylase, caseinase, and Phosphatase test for the quality of milk. Water analysis.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO Addressed
CO-1	List out components of blood and explain their function	R, U	1
CO-2	Identify disorders resulting from abnormality in blood count and structure of hemoglobin	U, An	1,2
CO-3	Describe the formation of blood cells, blood coagulation process, respiratory regulation of acid-base balance, muscle contraction, nerve impulse transmission, digestion and absorption of biomolecules	U	1
CO-4	Explain types of immunity, immune responses, antibody production	U	1
CO-5	Identify compatible blood groups	U, Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Namof the Course: Microbial Biochemistry

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	List out components of blood and explain their function	1	R, U	F, C	L/T	
CO-2	Identify disorders resulting from abnormality in blood count and structure of hemoglobin	1,2	U, An	F, C	L/T	
CO-3	Describe the formation of blood cells, blood	1	U	F, C	L/T	

	coagulation process, respiratory regulation of acid- base balance, muscle contraction, nerve impulse transmission, digestion and absorption of biomolecules					
CO-4	Explain types of immunity, immune responses, antibody production	1	U	F, C	L/T	
CO-5	Identify compatible blood groups	1,2	U, Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	-	-	-	-	1	-	-	-	-	-
CO 2	1	2	-	-	-	-	1	-	-	-	-	-
CO 3	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	-	-	-	-	-	1	-	-	-	-	-
CO 5	1	3	-	-	-	-	2	-	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

1. Pelczar, M. J., E. C. S. Chan, and N. R. Krieg. *Microbiology. Fifth edition, Tata Mcgraw-hill Publishing Company Ltd., New Delhi* (2009).

2. Willey, J., Sandman, K., D, Wood. *Prescott's Microbiology- 11th international ed.*: McGraw-Hill Higher Education, 2020.

3. Pommerville, Jeffrey. *Alcamo's fundamentals of microbiology: Body systems*. Jones & Bartlett Publishers, 2012.

4. Microbiology by Tortora, Funke and Case.

University of Kerala

Discipline	BIOCHEMISTRY
Course Code	UK6DSEBCH301
Course Title	**Molecular Immunology**
Type of Course	DSE8

Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3		2	5
Pre-requisites	NIL				
Course Summary	The course aims to provide a comprehensive understanding of immunology, from fundamental concepts to advanced topics relevant to clinical applications and therapeutic interventions				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Overview of the Immune System**		**9**
	1	Introduction and historical perspectives; Ontogeny of the immune system	
	2	Cells of immune system. Cells of the myeloid lineage- Neutrophils, Basophils, Mast cells, Eosinophils; Antigen presenting cells–Monocytes, Macrophages and Dendritic cells; Cells of the Lymphoid lineage–B and T cells; Cluster of Differentiation (CD) antigens, T–Lymphocyte subpopulations in humans	

	3	Primary and secondary lymphoid organs–Thymus, Bone marrow, Lymph node, Spleen and MALT–specific roles	
	4	Types of immunity. Innate immunity–anatomical and physiological barriers to infection, Phagocytosis and Inflammatory responses. Adaptive immunity–Specificity, Diversity, Memory, Self and nonself discrimination. Passive and active immunity. Role of lymphocytes in adaptive immunity–humoral and cell–mediated immunity. Interactions between innate and adaptive immunity	
	5	Role of complement proteins in innate and adaptive immunity	
II	**Antigens and Antibodies**		**9**
	6	Antigens, Immunogenicity and antigenicity, Factors affecting immunogenicity, Adjuvants, Epitopes, Haptens, Super antigens, Pattern–recognition receptors (PRR)	
	7	Antibodies–Structure, Complementarity determining regions (CDRs), Effector functions of antibodies–Opsonisation, Complement activation, Antibody dependent cell–mediated cytotoxicity	
	8	Antibody classes and biological activities. Genetic basis of antibody diversity (Outline only); Antigenic determinants–Isotype, Allotype, Idiotype and Immunoglobulin superfamily	
	9	Monoclonal antibodies–production and clinical uses, Hybridoma technology, Immunotoxins, Abzymes	
	10	Antigen–antibody interactions, Antibody–affinity and avidity. Precipitation, Immunoelectrophoresis and immunodiffusion. Agglutination, Radioimmunoassay (RIA), ELISA, Western blotting, Immunofluorescence	
III	**Biology of Lymphocytes and molecules of immune response**		**9**
	11	B cell maturation and selection, B cell activation, Theory of clonal selection, Formation of plasma and memory cells, Humoral response, T–dependent and T–independent responses	
	12	Structure and role of T cell receptor and co–receptor, T cell development, selection and differentiation; Cell mediated cytotoxic responses, Effector T cells and cytotoxic T cells	
	13	Natural killer cells, NKT cells and antibody dependent cellular cytotoxicity (ADCC)	

	14	MHC complex–organization and classes, pathways of antigen processing and presentation	
	15	Cytokines, Cytokine secretion by T_H^1 and T_H^2 subsets	
IV	**Immunopathologies**		**9**
	16	Hypersensitivity, Gell and Coombs classification–IgE mediated (Type I) hypersensitivity, Antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity	
	17	Immunological tolerance and autoimmunity, Mechanisms of autoimmunity, Organ specific autoimmune diseases–Hashimoto's thyroiditis, IDDM, Graves' disease, Myasthenia gravis; Systemic diseases–SLE, Rheumatoid arthritis, Multiple sclerosis	
	18	Therapy for immunological diseases–Immune complex disease, Immunosuppression and immunomodulation	
	19	Primary and secondary immunodeficiencies. Humoral, cellular, combined, complement related and phagocytic immunodeficiency diseases (In brief). Secondary Immunodeficiency diseases–AIDS, Immunoprophylaxis	
V	**Transplantation immunology and vaccines**		**9**
	20	Transplantation–immunologic basis of graft rejection, Clinical manifestations, Immunosuppressive therapy	
	21	Tumor antigens, Basics of cancer immunotherapy (In brief)	
	22	Vaccine development: Properties of different types of vaccines–Killed and live, Attenuated vaccines, Sub–unit and conjugate vaccines, Toxoids, m-RNA vaccines. Vaccines against AIDS, COVID and tropical infectious diseases – Leprosy, Malaria and TB. Viral vector vaccines, DNA vaccines	
	23	Immunization – Active and passive modes. Therapy for immunological diseases. Immuno therapy for cancer, Concept of "Herd Immunity" and its relation to vaccination	

	24	PRACTICAL Serum and plasma separation Blood smear identification of leucocytes by Giemsa stain Isolation of lymphocytes from blood. Assays based on agglutination reactions - Blood typing. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.	**30**

References

1. Mark Peakman, Basic and Clinical Immunology; Churchill Livingstone. 2nd Ed., 2009.

2. Talwar GP, Rao KVS and Chauhan VS, Recombinant and Synthetic Vaccines; Narosa, New Delhi. 1994.

3. Benjamini E, Coico R and Sunskise G,;Immunology – A short course, Wiley – Liss Publication, NY. Ed.4; 2000.

4. Kuby J, Immunology, WH Freeman and Co. NY. Ed.4; 1997.

5. Clark WR, The Experimental Foundations of Modern Immunology; John Wiley and Sons Inc. New York. 1991.

6. Leslie Hudson and Frank C. Hay., Practical Immunology. Wiley. Ed.3; 1989.

7. Noel R. Rose, Herman Friedman, John L. Fahey., Manual of Clinical Laboratory Immunology. ASM. Ed.3; 1986.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop a comprehensive understanding of the immune system,Understand types of immunity , Define antigens, immunogenicity, and antigenicity	U, R	1
CO-2	Describe the structure, functions, and effector mechanisms of antibodies, including antigen-antibody interactions	U	1

CO-3	Discuss hybridoma technology, Immunotoxins, Abzymes, Explain immunological techniques	U,R	1
CO-4	Understand hypersensitivity, autoimmune and immunodeficiency disorder	U	1,2
CO-5	Understand the concepts of vaccination and immunization	U	1,2,3
CO-6	Outline the basic concepts of transplantation immunology and cancer immunotherapy	U	1.

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Molecular Immunology

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	**C O**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
CO-1	Develop a comprehensive understanding of the immune system,Understand types of immunity , Define antigens, immunogenicity, and antigenicity	1	U,R	F,C	L/T	
CO-2	Describe the structure, functions, and effector mechanisms of antibodies, including antigen-antibody interactions	1	U	F,C	L/T	
CO-3	Discuss hybridoma technology, Immunotoxins, Abzymes, Explain immunological techniques	1	U,R	F,C	L/T	
CO-4	Understand hypersensitivity, autoimmune and immunodeficiency disorder	1,2	U	F,C	L/T	
CO-5	Understand the concepts of vaccination and immunization	1,2,3	U	F,C	L/T	
CO-6	Outline the basic concepts of transplantation immunology and cancer immunotherapy	1.	U	F,C	L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	-	-	-	-	-	1					
CO 2	2	-	-	-	-	-	1					
CO 3	2	-	-	-	-	-	2					
CO 4	2	2	-	-	-	-	1					
CO 5	1	3	3	-	-	-	3					
CO 6	2	-	-	-	-	-	1					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK5DSEBCH302				
Course Title	**Physiology, Nutrition & Endocrinology**				
Type of Course	**DSE 11**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Nil				
Course Summary	The course provides a comprehensive study of systems in our body which includes the physiology of blood, physiology of respiration, specialized tissues, digestive system ,endocrine system and associated disorders & basic understanding of nutrition.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Blood Physiology**	**10**
	1	Basic idea of circulatory system, general functions of blood.	
	2	Blood components: Blood, plasma and serum. Formed elements: function and clinical significance of (i) RBC (ii) WBC and (iii) platelets,plasma proteins - function	
	3	Haemoglobin – structure and functions. Plasma Proteins-types & functions.	
	4	Abnormal Haemoglobin: Thalassemia and hemoglobinopathies. (Outline only).	
	5	Blood forming organs, hemopoiesis: erythropoiesis, leukopoiesis and thrombopoiesis.	
	6	Hemostasis: Blood coagulation- Intrinsic and Extrinsic pathways	
II		**Respiratory & Renal Physiology**	**9**
	7	Basic structure of lungs	
	11	Exchange of gases in alveoli and tissues, transport of oxygen & carbon dioxide in blood	
	12	O_2 dissociation curve , Bohr effect, Chloride shift, Carbonic anhydrase reaction	
	13	Structure of nephron, mechanism of formation of urine	
	14	Acid base balance: Respiratory regulation, Acid base disturbances- (respiratory acidosis and alkalosis, metabolic acidosis and alkalosis), Compensation mechanism (basic idea only)	
III		**Specialized Tissues**	**8**
	15	Muscle: Structure of muscle, muscle proteins, energy sources for muscle contraction and sliding filament theory. Biochemical events during muscle contraction.	
	16	Neuron: Structure of neuron, glial cells Nerve impulse generation & propagation- resting membrane potential,action potential , threshold stimulus ,all or none law ,refractory period ,saltatory conduction, synapses- synaptic transmission, neurotransmitters.	
IV	**Nutrition, Digestion& Absorption**		**9**
	17	Calorific value of food, determination of calorific value –Bomb calorimeter, Basal metabolic rate, factors affecting BMR, Specific Dynamic Action of food (SDA). Nutritional significance of carbohydrates, proteins and fat. Essential fatty acids, essential amino acids, limiting amino acids and significance of dietary fibre. Balanced diet and Recommended Daily Allowance (RDA).	
	18	Vitamins-Fat and water soluble vitamins- Functions and deficiency diseases	
	19	Digestion and absorption of carbohydrates, proteins & lipids	
V		**Endocrinology**	**9**
	20	Hormones –Introduction ,classification	
	21	Functions of the following hormones-Thyroxin, GH, TSH, LH, FSH, ADH and oxytocin, cortisol, cortisone, corticosterone , aldosterone , epinephrine and nor-epinephrine , testosterone, estrone and estrasdiol (structures of hormones not expected)	
	22	Salient features of endocrine disorders- Addisons disease, cushings syndrome, diabetes mellitus, goitre, hypothyroidism and hyperthyroidism, hashimotos thyroiditis, diabetes insipidius, acromegaly.	
	23	**Practica** • Introducing students to equipments/tools used in clinical biochemistry lab	30 hrs

		• Different methods of blood collection- capillary and venous • Separation of serum, plasma and blood cells. • Determination of RBC and TC/DC count using hemocytometer • Determination of Hemoglobin by Sahli's method. • Determination of ESR • Preparation of dietary charts. • Case study based on deficiency of Vit A, D, B1 and C *Visit to a clinical laboratory to experience the advanced methods in haematology.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe hemostasis ,identify different types of blood cells & haematological disorders	R, U,Ap	1,2,4
CO-2	Demonstrate the gaseous exchange in lungs, mechanism of urine formation & compensatory mechanism involved in acid-base disturbances	R, U	1
CO-3	Understand the basic concepts of nutrition & restate the digestion and absorption of biomolecules	R, U	1,2
CO-4	Discuss the biochemical events occurring in specialised tissues	R, U	1
CO-5	Explain functions of hormones & disorders associated with it & develop skills in interpreting clinical signs and symptoms associated with endocrine disorders	R, U,Ap	1,2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Describe hemostasis ,identify different types of blood cells & haematological	1,2,4	R, U,Ap	F, C	L/T	P

	disorders					
2	Demonstrate the gaseous exchange in lungs,mechanism of urine formation & compensatory mechanism involved in acid-base disturbances	1	R, U	F,C	L/T	
3	Understand the basic concepts of nutrition & restate the digestion and absorption of biomolecules	1,2	R, U	F,C	L/T	P
4	Discuss the biochemical events occurring in specialised tissues	1	R, U	F,C	L/T	
5	Explain functions of hormones & disorders associated with it & develop skills in interpreting clinical signs and symptoms associated with endocrine disorders	1,2,4	R, U,Ap	F,C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	3	-	2	-	-						
CO 2	2	-	-	-	-	-						

CO 3	3	2	-	-	-	-						
CO 4	3	-	-	-	-	-						
CO 5	2	3	2	-	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓	✓	✓

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6. Textbook of Human Nutrition. Anjana Agarwal and Shobha A Udipi. Jaypee Brothers Medical Publishers (P) Ltd.
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University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK6SECBCH300				
Course Title	**Analytical Biochemistry**				
Type of Course	**SEC5**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	.NIL				

Course Summary	The course provides an overview of phytochemical analysis, health and environmental risks of pesticides, qualitative methods employed in the detection of adulterants in common food commodities, methods used for chemical and bacteriological analysis of water and methods employed in the detection of toxic metals in food and biological samples.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Phytochemical Analysis**		**9**
	1	Preparation of plant materials for extraction (Pre-washing, drying and grinding), methods of solvent extraction (sonication, soxhlet extraction, maceration using solvents in the increasing order of polarity) and freeze drying.	
	2	Plant metabolites-Distinction between primary and secondary metabolites, Major classes and importances of secondary metabolites- Alkaloids, terpenoids, flavonoids, phenolics, steroids, coumarins, quinines, glycosides, amines and non-protein amino acids, gums, and resins (structure not needed).	
	3	Phytochemical analysis of secondary metabolites- Alkaloid (Dragendorff's test, Wagner test), Anthraquinone (Borntrager's test), Cardiac glycosides (Kellar – Kiliani test), Flavonoid (Shinoda test), Phenol (Phenol test), Reducing sugar (Fehling test), Saponin (Foam test), Steroid (Zaks test), Tannin (Braymer's test), Terpenoid Salkowski test).	
	4	Isolation of bioactive compounds using separation techniques such as TLC, column chromatography, flash chromatography, Sephadex chromatography and HPLC	
II	**Pesticides: Health & Environmental Risks**		**10**
	5	Classification of Pesticides- based on chemical nature- (organochlorine, organophosphate, carbamates, pyrethrum, biopesticides), site of action (stomach toxicants, contact toxicants, fumigants, systemic toxicants, chemical repellents).	
	6	Environmental consequences of pesticide use and natural pesticides.	
	7	Pesticide labels and labelling, Material Safety Data Sheet (MSDS), determination of the signal word-based on toxicity category (category I, II, III and IV), importance of reading and understanding pesticide labels.	
	8	Tests on pesticides for determining human health risk- types of toxicity- (acute - LD50 or LC50), toxic effects on mammalian tissues- teratogenicity, gene mutation, chromosome aberration, neurotoxicity, immunotoxicity).	
	9	Pesticide residue in foods: Maximum residue level (MRL), Acceptable daily intake (ADI), analysis of pesticide residue in foods- Gas chromatography.	
III	**Food Adulteration and Detection**		**7**
	10	Definition of adulterants, Familiarisation of common adulterants	

	11	Basic concepts of toxicity and hazard (physical, chemical and biological) in food	
	12	Detection of adulterants in milk, edible oils, fats, cereal flour, sugar, pulses, cereals, green vegetables and honey, Spices and condiments (turmeric powder, chilli powder, coriander powder, black pepper powder, asafoetida)- qualitative aspects only	
IV	**Water Analysis**		**9**
	13	Physical parameters-temperature, pH, colour, odour, turbidity, total dissolved solids.	
	14	Chemical parameters- total hardness (titrimetric method), detection of chloride (Argentometric method), Nitrate (Phenoldisulphonic acid (PDA) method, fluoride (zirconium alizarin method).	
	15	Dissolved oxygen, BOD (Winkler method), COD (dichromate method), pesticide residue (gas chromatography).	
	16	Toxic metal detection- Cadmium, Lead, Mercury (Atomic Absorption Spectroscopy (AAS).	
	17	Bacteriological analysis- test for coliform bacteria-multiple tube dilution method (presumptive, confirmed and completed test).	
V	**Analysis of Toxic Metals in Food and Biological Samples**		**10**
	18	Toxicology of metals - analysis of metal elements in food using colorimetry- copper (carbamate method), lead and mercury - by dithizone method, arsenic (molybdenum blue method)	
	19	Outline study of action and detection of alcohol in beverage (colorimetric method using sodium dichromate)	
	20	Mechanism of toxic action of lead, mercury, arsenic, cyanide and carbon monoxide (outline only). Detection of copper, lead, mercury, arsenic, cyanide and carbon monoxide in biological samples.	

		Practical	**30**
	21	Qualitative analysis of phytochemicals in Plant extract.	
	22	Quantitative Analysis of Phytochemicals-Total Phenolic Content (Modified Folin-Ciocalteau method), Total Flavonoid Content (Zhishen et al method), Total Alkaloid Content (Sodium metaperiodate method)	
	23	Testing of adulterants like metanil yellow (in turmeric & jaggery), rhodamine-B (in chilli powder),chicory (in coffee), sodium bicarbonate (in flour & jaggery), lead chromate (in pulses), vanaspati, coal tar dye & starch (in ghee), added sugar (in honey) prohibited colors, argemone oil & cotton seed oil (in edible oil).	
	24	Paper Chromatography/Thin layer Chromatography	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Describe the methods used in phytochemical extraction and qualitatively analyze different phytochemicals present in an extract.	R, U, Ap	1, 2, 4
CO-2	Identify and explain the different types of pesticides, their toxicological impact, and tests to detect toxicity.	R, U	1, 2,
CO-3	Understand the type of adulterants mixed in common food products and describe and analyze the qualitative methods used in adulterant detection.	R, U, Ap	1, 3, 4
CO-4	Outline and describe the different methods used in the chemical and bacteriological analysis of water.	R, U	1, 2, 4
CO-5	Discuss the methods used in the analysis of toxic metals in food and biological samples and explain the mechanism of action of toxic elements in our body system.	R, U	1, 2. 3, 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Analytical Biochemistry

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
CO-1	Describe the	1, 2, 4	R, U, Ap	F, C, P	L	P

	methods used in phytochemical extraction and qualitatively analyze different phytochemicals present in an extract.					
CO-2	Identify and explain the different types of pesticides, their toxicological impact, and tests to detect toxicity.	1, 2,	R, U	F, C, P	L	P
CO-3	Understand the type of adulterants mixed in common food products and describe and analyze the qualitative methods used in adulterant detection.	1, 3, 4	R, U, Ap	F, C, P	L	P
CO-4	Outline and describe the different methods used in the chemical and bacteriological analysis of water.	1, 2, 4	R, U	P	L	P
CO-5	Discuss the methods used in the analysis of toxic metals in food and biological samples and explain the mechanism of action of toxic elements in our body system	1, 2. 3, 4	R, U	F, C, P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	2	-	1	-	-	1	-	-	-	-	-
CO 2	1	1	-	-	-	-	1	-	-	-	-	-
CO 3	2	-	3	2	-	-	1	-	-	-	-	-

CO 4	1	2	-	1	-	-	2	-	-	-	-	-
CO 5	2	3	2	3	-	-	3	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

1Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

References

- Laboratory Handbook on Biochemistry. S.Shanmugam, J.Satish Kumar,K. Panneerselvam Publisher: PHI Learning Private Limited New Delhi ISBN 976-81-2030-4103-
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- Food Science Chemistry and Experimental Foods. Dr. M.S. Swaminathan Publisher: The Bangalore Printing and Publishing Co. Ltd. ISBN-13 5551234022180.
- Microbiology by Lansing M. Prescott, John P. Harley and Donald A. Klien. 5th edition. Publisher: McGraw- Hill Higher Education. ISBN- 13: 978-0072320411.
- Parikh's Textbook of Medical Jurisprudence Forensic Medicine and Toxicology, 6th edition, Dr. C. K. Parikh. CBS Publishers & Distributors. ISBN-13: 978-8123906751.
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- TextBook of Microbiology. R. C. DUBEY AND D.K. Maheswary. Revised Edition .Publisher: S. Chand ISBN-10: 8121925592.
- Environmental Toxicology. Satake M. Publisher: Discovery Publishing Pvt. Ltd. ISBN: 8171413501.

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK7DSCBCH400				
Course Title	**CELL SIGNALLING**				
Type of Course	**DSC35**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Completed 300-399 level courses				
Course Summary	Cell signaling is the process by which cells communicate with each other through chemical signals, allowing them to coordinate and regulate essential functions such as growth, development, and responses to environmental cues.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Cell Signalling**		**10**
	1	Overview of Cell Signalling	
	2	Types of Cell Signalling: Autocrine, Paracrine, Endocrine, and Juxtacrine	
	3	Signal Transduction	
	4	Receptors and Ligands	
II	**INTRACELLULAR SIGNALLING**		**10**
	5	G-Protein Coupled Receptors (GPCRs)	
	6	Receptor Tyrosine Kinases (RTKs)	
	7	Ion Channel Receptors	
	8	Intracellular Receptors	
III	**SIGNALLING PATHWAYS**		**15**
	9	MAPK/ERK Pathway	
	10	PI3K/AKT Pathway	
	11	JAK-STAT Pathway	
	12	Wnt Signalling Pathway	
	13	NF-kB Pathway	
	14	TGF-beta pathway	
	15	Notch signaling pathway	

	16	Hedgehog signaling pathway	
	17	mTOR pathway	
IV	**CELLULAR RESPONSES TO SIGNALLING**		**10**
	18	Gene Expression	
	19	Cell Cycle Control	
	20	Apoptosis	
	21	Cell Migration and Adhesion	
V	**ADVANCED TOPICS IN CELL SIGNALLING**		**15**
	22	Signalling in Cancer	
	23	Signalling in Neurological Disorders	
	24	Therapeutic Targeting of Signalling Pathways	
	25	Recent Advances in Cell Signalling Research	

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1. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Martin, K. C. (2020). Molecular Cell Biology (9th ed.). W. H. Freeman.
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Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental concepts and principles of cell signaling, including signal transduction pathways and their regulation	U	1
CO-2	Identify and describe the various types of cell signaling molecules, receptors, and downstream effectors involved in signal transduction.	U,An	1
CO-3	Analyze the mechanisms of cell signaling across different cellular contexts and biological systems.	An	1,3

CO-4	Explain the role of cell signaling in physiological processes such as development, immune response, and homeostasis	An,E	1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Cell Signalling

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the fundamental concepts and principles of cell signaling, including signal transduction pathways and their regulation	1	U	F, C	L/T	
CO-2	Identify and describe the various types of cell signaling molecules, receptors, and downstream effectors involved in signal transduction.	1	U, An	F, C	L/T	
CO-3	Analyze the mechanisms of cell signaling across different cellular contexts and biological systems.	1,3	An	F, C	L/T	
CO-4	Explain the role of cell signaling in physiological processes such as development, immune response, and homeostasis	1,3	An, E	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6

CO 1	3	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	-	-	-	-	-	2	-	-	-	-	-
CO 3	2	-	2	-	-	-	1	-	-	-	-	-
CO 4	1	-	3	-	-	-	2	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	**BIOCHEMISTRY**				
Course Code	UK7DSCBCH401				
Course Title	**ADVANCED TECHNIQUES IN BIOCHEMISTRY**				
Type of Course	**DSE36**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Completed 300-399 level courses				
Course Summary	The course provides a comprehensive understanding of various advanced techniques used in the field of Biochemistry. Students will be able to gain knowledge on PCR, electrophoresis, spectroscopy, plant genetic engineering and genome mapping. The course also provides practical knowledge in chromatography, electrophoresis, and various sample analysis.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**PCR, Electrophoresis and Blotting.**		**9**
	1	DNA amplification by PCR - Conventional, Reverse-Transcriptase, Inverse, Quantitative Real-time, Nested and Multiplex PCR. Primer designing.	
	2	Electrophoresis: Basic principles, instrumentation and applications of electrophoresis. Factors affecting electrophoresis. Electrophoretic techniques –zone electrophoresis, 2-D gel electrophoresis and Pulse field, Factors affecting electrophoresis.	
	3	Blotting techniques (Southern, Northern and Western) Principle, methodology and applications.	
II	**Flow Cytometry, histopathology & Immunological techniques**		**9**

	4	Flow cytometry - fluidics, optics and electronics, data analysis and applications.	
	5	Hemagglutination inhibition assay, HLA typing, leukocyte migration inhibition assay, complement fixation, Immunofluorescence, Immunodiffusion, Immuno electrophoresis, Radioimmunoassay (RIA), ELISA (indirect, direct, sandwich, chemiluminescence, ELISPOT assay).	
III	**Spectroscopy**		**9**
	6	Principle, instrumentation, working and application of UV, Visible and IR spectroscopy, spectrofluorimetry, flame photometry, Atomic Absorption Spectrometry and luminometry.	
		Matrix-assisted laser desorption/ionization, Time- of Flight Mass spectroscopy (MALDI-TOF MS), X-ray crystallography.	
IV	**Plant Genetic engineering**		**9**
	7	Direct gene transformation methods: chemical treatment, electroporation, particle bombardment and microinjection. Indirect gene transfer methods: vector mediated, Ti and Ri plasmid as vectors.	
	8	Identification of transgenic plants: reporter genes, transient gene assays, molecular markers RFLP, AFLP and QLT.	
V	**Genome mapping**		**9**
	9	DNA sequencing, DNA profiling, Radiation hybrid mapping, Fluorescence *in situ* hybridization (FISH), Sequence tagged site mapping (STS), expressed sequence tag mapping (EST), chromosome jumping, chromosome walking.	
	10	CRISPR-Cas9, TALE nucleases and Zinc-finger nucleases	
		Practical • Separation of serum and plasma from blood by centrifugation method • Purification of protein by dialysis method • Quantitative estimation of biomolecules by colorimetric method. • Separation of biomolecules by TLC Separation of DNA by agarose gel electrophoresis. • Separation of protein by agarose SDS PAGE. • Immuno diffusion • Familiarisation of basic techniques of	**30**

		immunohistochemistry from an authorized histopathology laboratory.	

References

1. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.
2. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). Biochemistry (8th ed.). W. H. Freeman.
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9. Lutz, R. (Ed.). (2015). Flow Cytometry and Cell Sorting. Springer.
10. Roux, B. (Ed.). (2016). Membrane Protein Structure: Experimental Approaches. Springer

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain knowledge on techniques like PCR, electrophoresis and blotting	U	1
CO-2	Develop an understanding about the principle and application of flow cytometry, immunological techniques and spectroscopy.	R, U	1
CO-3	Understand the different processes used in plant genetic engineering and genome mapping.	U, R	1
CO-4	Summarize latest genome editing tools	U,	1

CO-5	Analyse and training on different techniques of biochemistry	An	3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Advance Techniques in Biochemistry

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO /PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Gain knowledge on techniques like PCR, electrophoresis and blotting	1	U	F, C	L/T	
CO-2	Develop an understanding about the principle and application of flow cytometry, immunological techniques and spectroscopy.	1	R, U	F, C	L/T	
CO-3	Understand the different processes used in plant genetic engineering and genome mapping.	1	U, R	F, C	L/T	
CO-4	Summarize latest genome editing tools	1	U,	F, C	L/T	
CO-5	Analyse and training on different techniques of biochemistry	1	An	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	-	-	-	-	-	1	-	-	-	-	-

CO 4	2	-	-	-	-	-	1	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / **High**

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK7DSCBCH402				
Course Title	**RESEARCH METHODOLOGY**				
Type of Course	**DSC37**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Completion of 300-399 level courses				
Course Summary	Research methodology involves the systematic process of planning, conducting, and analyzing scientific research, ensuring that the approach is valid, reliable, and ethical. This course covers topics such as research design, data collection and analysis, and interpretation, providing students with the tools and frameworks needed to carry out robust studies and critically evaluate existing research.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**INTRODUCTION TO RESEARCH METHODOLOGY**	**9**
	1	Goal and characteristics of Research	
	2	Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.	
	3	Research Design: Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.	
	4	Research Formulation – Defining and formulating the research problem, Selecting the problem, Importance of literature review, Literature review – Primary and secondary sources. Identifying gap areas from literature review - Development of working hypothesis	
II		**DATA HANDLING AND ANALYSIS**	**9**
	5	Significance of statistical methods in biological investigations	
	6	Probability theory (addition and multiplication theory). Probability distributions (binomial, Poisson and normal)	
	7	Stages of statistical investigation	

	8	Data collection: types of data collection (primary and secondary), methods of data collection- census and sampling, sampling techniques- random (simple, stratified, systematic) and non-random (purposive, quota, convenience)	
	9	Data presentation- tabular, diagrammatic (line, bar, pie diagram), graphical (line graph, histogram, frequency polygon, frequency curve, Ogive curve)	
	10	Data analysis- measures of central tendency (arithmetic mean), measure of dispersion (standard deviation), standard error. Correlation and regression	
	11	Testing of significance- student's t-test (paired and unpaired), chi- square test, ANOVA- One way and two-way.	
III	**ETHICS IN RESEARCH**		**9**
	12	Research involving animals: outline of the controversy. Ethical issues raised by animal research - pain, distress and suffering. Methods of euthanasia.	
	13	CPCSEA guidelines for ethical animal use and prevention of animal cruelty in research. Three Rs principle.	
	14	Bioethics involving research with humans: Research on human subjects and samples. Importance of informed consent.	
	15	Privacy, ethics and legal issues. Ethical issues involving human embryo and stem cell research.	
	16	Research output- Honesty and integrity of a good researcher.	
	17	Ethical issues- Plagiarism, fabrication and falsification.	
	18	Misrepresentation of information. Proper interpretation of results and proper scientific presentation.	
	19	Software to check plagiarism in publications.	
	20	Legal implications of plagiarism and research fabrication.	
IV	**SCIENTIFIC WRITING AND PRESENTATION**		**9**
	21	Characteristic logical format for writing thesis and papers - Essential features of abstract, Introduction, Review of literature, Materials and methods, results and discussion	
	22	Effective illustration, Tables and figures, reference style- Harvard and Vancouver system.	
	23	Citation and Acknowledgement, ISBN & ISSN. Peer review.	
	24	Impact factor and H- index of journals.	
	25	Presentation tools: oral and poster, Microsoft Power Point and PDF slides	
V	**INTELLECTUAL PROPERTY**		**9**
	26	IPR policy of Government of India	
	27	Indian & International Patent laws	
	28	Types of patents	
	29	Indian Patent Act 1970, Recent Amendments	
	30	Protection of New GMOs	
	31	Financial assistance for patenting-introduction to existing schemes. Procedure for patent application, international harmonization of patent laws	

	32	Patenting of life forms -plant, animals, microbes, gene, process and products	
		Practical • Perform literature review on a topic • Design a research experiment • Collect data based on the experiment • Present the data using various methods • Testing significance using Students t test, • ANOVA Study correlation and regression	**30**

References

1. Creswell, J. W., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). SAGE Publications.
2. Kothari, C. R. (2004). Research Methodology: Methods and Techniques (2nd ed.). New Age International.
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4. Bryman, A. (2016). Social Research Methods (5th ed.). Oxford University Press.
5. Yin, R. K. (2018). Case Study Research and Applications: Design and Methods (6th ed.). SAGE Publications.
6. Neuman, W. L. (2014). Social Research Methods: Qualitative and Quantitative Approaches (7th ed.). Pearson.
7. Punch, K. F. (2014). Introduction to Social Research: Quantitative and Qualitative Approaches (3rd ed.). SAGE Publications.
8. Bell, J., & Waters, S. (2018). Doing Your Research Project: A Guide for First-Time Researchers (7th ed.). Open University Press.
9. Silverman, D. (2019). Doing Qualitative Research (5th ed.). SAGE Publications.
10. Flick, U. (2018). An Introduction to Qualitative Research (6th ed.). SAGE Publications.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Illustrate a research design and research formulation	Ap	1
CO-2	Analyse the significance of a research finding	An	1,2

CO-3	Describe the ethics in research	U	1
CO-4	Demonstrate skills in scientific writing and presentation	Ap	1,2
CO-5	Explain the basics of intellectual property rights	U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Research Methodology

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Illustrate a research design and research formulation	1	Ap	F, C	L/T	
CO-2	Analyse the significance of a research finding	1,2	An	F, C	L/T	
CO-3	Describe the ethics in research	1	U	F, C	L/T	
CO-4	Demonstrate skills in scientific writing and presentation	1,2	Ap	F, C	L/T	
CO-5	Explain the basics of intellectual property rights	1	U	F, C	L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-	1	-	-	-	-	-
CO 2	1	3	-	-	-	-	2	-	-	-	-	-
CO 3	2	-	-	-	-	-	1	-	-	-	-	-

CO 4	1	3	-	-	-	-	2	-	-	-	-	-
CO 5	3	-	-	-	-	-	2	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	Biochemistry				
Course Code	UK7DSCBCH403				
Course Title	**Genetic engineering**				
Type of Course	**DSC38**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutoria l per week	Practical per week	Total Hours/W eek
	4	3 hours	-	2 hours	5
Pre-requisites	Completed 300-399 level courses				
Course Summary	Genetic engineering involves manipulating the DNA of organisms to introduce new traits or alter existing ones, often to improve agricultural crops, develop medical therapies, or advance biotechnology. This course covers the principles and techniques of genetic modification, including gene editing, cloning, and the ethical, legal, and societal implications of these technologies.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Genetic variation at the molecular level**		**9**
	1	Recombination, Jumping genes, Poly morphisms	
	2	Gene Mapping-Linkage and Physical mapping	
	3	Molecular Marker's for Gene Mapping- VNTR, STR, microsatellite, SNP. RFLP, RAPD, AFLP, SSR	
	4	Restriction Mapping, Fluorescence in situ hybridization (FISH), Sequence-Tagged Sites (STS) mapping	
II	**Gene Isolation and Manipulations**		**9**
	5	Restriction endonucleases, Types of restriction endonucleases, recognition sequences, cleavage patterns.	

	6	Isolation and Sequencing of DNA-chemical and enzymatic methods	
	7	Next Generation Sequencing, Illumina sequencing, Pyrosequencing, small oligonucleotide ligation and detection system (SOLiD) Sequencing.	
	8	Construction of genomic and cDNA library	
III	**Vectors**		**9**
	9	Properties of good vector, Cloning vectors and expression vectors: Plasmids, Bacteriophages, phagemids - pBR322, pUC8, pGEM3Z, M13 and Ti plasmid	
	10	Lambda vectors; Insertion and Replacement vectors	
	11	Cosmids: Artificial chromosome vectors (YACs; BACs) and Expression vectors	
IV	**Gene Cloning**		**9**
	12	Gene Cloning methods: Cohesive end cloning, blunt end cloning, cloning using adapters, linkers and homopolymer tailing.	
	13	Artificial gene transfer methods- Physical methods (Electroporation, Gene gun, Biolistic, Protoplast fusion, Microinjection)	
	14	Chemical Methods (Liposome mediated, Calcium phosphate mediated, PEG mediated gene transfer).	
	15	Selection of transformed cells and identification of recombinants: Blue-white screening, Identification of recombinant phages, colony and plaque hybridization probing.	
V	**Genome editing**		**9**
	17	Genome editing: An overview	
	18	Tools for genome editing Cre-Lox, CRISPR CAS, TALEN	
	19	Applications of rDNA technology, Genetic engineering in animals (Transgenic mice) and plants	
		Practical • Isolation of DNA from various sources • UV absorption spectrum of DNA and RNA • Estimation of DNA by Diphenylamine method • Isolation of plasmid DNA and Restriction digestion • PCR • Agarose gel electrophoresis Gene cloning • Virtual labs exercise on rDNA techniques.	

References:

1. Cell and molecular biology: concepts and experiments. Karp, G. (2009). John Wiley & Sons.
2. Genes IX. Benjamin Lewin (2008). **Jones** and Bartlett Publishers. ISBN:0763752223 ISBN-13: 9780763752224, 978-0763752224
3. Genetic Engineering: Principles and Applications. Berg, J., Tymoczko, J. S., & Stryer, L. (2008). New York, NY: W. H. Freeman.
4. Gene Cloning and DNA Analysis: An Introduction. Brown, T. A. (2016). Hoboken, NJ: Wiley-Blackwell.

5. Genomes 5. Brown, T. A. (2023). CRC Press.
6. Molecular Cloning: A Laboratory Manual (4th ed.). Green, M. R., & Sambrook, J. (2012). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
7. Principles and applications of recombinant DNA. Glick, B. R., & Pasternak, J. J. (1998). *ASM, Washington DC*.
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11. Principles of Gene Manipulation and Genomics. Primrose, S. B., & Twyman, R. (2006). Hoboken, NJ: John Wiley & Sons.
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Suggested Readings

- Becker, S., & Boch, J. (2021). TALE and TALEN genome editing technologies. *Gene and Genome Editing*, *2*, 100007.
- Chandrasekharan, M. C., et al. (2013). "TALENs: A Versatile Tool for Genome Engineering." Journal of Cellular Physiology, 228(11), 2053–2062.
- Hsu, P. D., Lander, E. S., & Zhang, F. (2014). Development and applications of CRISPR-Cas9 for genome engineering. *Cell*, *157*(6), 1262-1278.
- Doudna, J., & Sternberg, S. (2017). A crack in creation: The new power to control evolution. Random House.
- Church, G. M., & Regis, E. (2012). Regenesis: How Synthetic Biology Can Reinvent Nature and Ourselves. New York, NY: Basic Books.
- Jiang, F., & Doudna, J. A. (2017). CRISPR–Cas9 structures and mechanisms. *Annual review of biophysics*, *46*, 505-529.
- Doudna, J. A., & Sternberg, S. H. (2014). "CRISPR/Cas9: A Revolutionary Tool for Gene Editing." Nature Reviews Molecular Cell Biology, 15(7), 427–431.
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- Mukherjee, S. (2016). The Gene: An Intimate History. New York, NY: Scribner
- Mullis, K. B. (1985). "The Polymerase Chain Reaction: A New Method for Amplifying Nucleic Acids." Cold Spring Harbor Symposia on Quantitative Biology, 51(1), 263–273.
- Sanger, F., et al. (1977). "A New Method for DNA Sequencing: Primer Extension Reactions with dNTPs." Proceedings of the National Academy of Sciences, 74(12), 5463–5467.

- Watson, J. D. (2018). *Molecular Biology of the Gene.* New York, NY: Pearson.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand genome editing and its applications	U	1
CO-2	Remember and understand tools for genome editing	R, U	1
CO-3	Apply techniques of genome editing	A	1,2
CO-4	Analyse and evaluate the results on the use of genome editing tools like Cre-Lox, CRISPR-CAS, TALEN etc	An, E	1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Genetic Engineering

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand genome editing and its applications	1	U	F, C	L/T	
CO-2	Remember and understand tools for genome editing	1	R, U	F, C	L/T	
CO-3	Apply techniques of genome editing	1,2	A	P	L/T	
CO-4	Analyse and evaluate the results on the use of genome editing tools like Cre-Lox, CRISPR-CAS, TALEN etc	1,2,3	An, E	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive Mapping of

COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-	1					
CO 2	2	-	-	-	-	-	1					
CO 3	2	3	-	-	-	-	2					
CO 4	2	3	3	-	-	-	3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / **High**

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	**BIOCHEMISTRY**				
Course Code	UK7DSCBCH405				
Course Title	**NEUROBIOCHEMISTRY AND SENSORY PHYSIOLOGY**				
Type of Course	**DSC39**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	NIL				
Course Summary	Neurobiochemistry and sensory physiology explore the biochemical processes underlying nervous system function and the physiological mechanisms of sensory perception. This course covers the molecular and cellular basis of neural communication, neurotransmission, and the structure and function of sensory systems such as vision, hearing, taste, smell, and touch.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**NERVOUS SYSTEM**	**12**
	1	Nervous system: Basic structure of neuron. Behaviour-reflex arc-synapse. Organisation of vertebrate nervous system- Central nervous system (CNS) and Peripheral nervous system (PNS). Structure and location of classes of neurons	
	2	Peripheral nervous system (PNS)- Afferent division and efferent division- Autonomous nervous system (ANS)-sympathetic and parasympathetic nervous system-significance-autonomic nerve pathway. Role of adrenal medulla.	
	3	Classes of neurotransmitter receptors- cholinergic, adrenergic and	

		muscarinic receptors. Somatic nervous system. Somatic nervous system (SNS). Comparison between ANS and SNS	
	4	Central nervous system: Glial cells-components-functions. Features protecting CNS- blood brain barrier. Cerebrospinal fluid (CSF). Significance of oxygen and glucose. Major components of brain-functions.	
II		**GENERAL PRINCIPLES OF SENSATION**	**12**
	5	Basic senses of human body- Somesthetic sensation. Role of Somatosensory cortex, Sensory homunculus. Primary functions of sensors. Ion channels on sensory cells. Muller`s law of specific nerve energies, Weber-Fechner law	
	6	Classification of senses. Classification of receptors based on structure, location and kind of stimulus it perceives.	
	7	Sensory Processes-Transduction and Perception. Mechanism of transduction of stimuli from sensory receptors. Adaptation of receptors-phasic & tonic adaptations.	
III		**PHOTORECEPTION**	**12**
	5	Visual system: Structure of eye-layers, fluids. Visual cycle	
	6	Photoreceptor cells-Rods and Cones-functions. Retinal layers (brief outline). Photopigments in photoreceptors.	
	7	Photoreceptor activity in dark and light.	
	8	Phototransduction and initiation of action potential in vertebrate visual pathway.	
	9	Dark adaptation and light adaptation. Colour vision (brief overview)	
	10	Depth perception, visual input and non-sight activities	
IV		**MECHANO RECEPTION**	**12**
	13	Tactile sensation. Tactile receptors. Transduction in touch and pressure.	
	14	Pain and Nociceptor. Classes of pain. Types of stimulus exciting pain receptors. Pain Transduction in the pain pathway. Tissue ischemia as cause of pain. Pain suppression. Referred pain. (Brief outline only).	
	15	Proprioception: mechanoreception of motion and position.	
	16	Ears, hearing and mechanoreception of sound waves. Components of ear involved in hearing. Sound transduction.	
V		**CHEMO AND THERMORECEPTION**	**12**
	19	Taste: Gustation - definition. Chemoreceptors for taste-taste buds-location.	
	20	Categories of taste qualities-Tastants and receptor potential, Taste transduction	
		Smell-Olfaction -definition. Components of olfactory mucosa and their function	
	21	Olfactory receptors-Odorants-Olfactory pathway	
	22	Thermal sensation in human-thermal receptors-stimulation of thermal receptors-adaptation	

References

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7. Haines, D. E. (2019). Fundamental Neuroscience for Basic and Clinical Applications (5th ed.). Elsevier.
8. Gardner, E., Martin, J. H., & Jessell, T. M. (2016). Principles of Sensory Physiology (2nd ed.). McGraw-Hill Education.
9. Shepherd, G. M. (2016). The Synaptic Organization of the Brain (6th ed.). Oxford University Press.
10. Meredith, M. (2019). Sensory and Motor Systems in Neuroscience. Springer.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will gain a comprehensive understanding of how neurons communicate through synaptic transmission, neurotransmitter release, and receptor activation.	U	1
CO-2	Students will learn about the structure and function of different sensory systems, including vision, hearing, taste, smell, and touch, and how these systems process sensory information.	U	1
CO-3	Students will develop an integrated perspective on how biochemical processes within the nervous system underlie and influence sensory perception and overall physiological function.	U	1
CO-4	Students will learn how neurobiochemical pathways influence behavior and cognitive processes, gaining an understanding of how changes in neurotransmitter levels or receptor functions can affect mood, cognition, and sensory perception.	U, An	1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Neurobiochemistry and Sensory Physiology

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO	CO	PO/PS	Cognitive	Knowledge	Lecture	Practical

No.		O	Level	Category	(L)/Tutorial (T)	(P)
CO-1	Students will gain a comprehensive understanding of how neurons communicate through synaptic transmission, neurotransmitter release, and receptor activation.	1	U	F, C	L/T	
CO-2	Students will learn about the structure and function of different sensory systems, including vision, hearing, taste, smell, and touch, and how these systems process sensory information.	1	U	F, C	L/T	
CO-3	Students will develop an integrated perspective on how biochemical processes within the nervous system underlie and influence sensory perception and overall physiological function.	1	U	F, C	L/T	
CO-4	Students will learn how neurobiochemical pathways influence behavior and cognitive processes, gaining an understanding of how changes in neurotransmitter levels or receptor functions can affect mood, cognition, and sensory perception.	1,3	U, An	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive Mapping of

COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-	1					
CO 2	2	-	-	-	-	-	1					
CO 3	2	-	-	-	-	-	1					
CO 4	2	-	3	-	-	-	1					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / **High**

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	**BIOCHEMISTRY**
Course Code	UK7DSCBCH406
Course Title	**Omics**
Type of Course	**DSC40**
Semester	VII

Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours			4
Pre-requisites					
Course Summary	The course describes the recent advances in fields like Genomics, Transcriptomics, Proteomics, Metabolomics, Glycomics and Lipidomics. It also exploits the modern techniques to reveal the complex interactions in a cell due to the presence of biological macromolecules.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Genomics**		**15**
	1	Introduction to Genomics. Structural and functional Genomics; Structure, organization and composition of eukaryotic and prokaryotic Genomes; Evolution and structure of Mitochondrial and Chloroplast Genomes; C-value paradox	
	2	Split Genes-Introns and Exons; Significance of non–coding DNA; Repetative DNA, CpG islands	
	3	Comparative Genomics–Identification and classification using molecular markers–16S rRNA typing/sequencing	
	4	Single nucleotide polymorphism (SNP), STS; Conventional sequencing techniques–Maxam-Gilbert and Sanger sequencing (Outline only), Evolution of DNA sequencing methods	
	5	Shotgun Genome sequencing; Next Generation Sequencing (NGS) and applications**.** Human Genome Project; Recognition of coding and non-coding sequences and gene annotation	
	6	Recognition of coding and non-coding sequences and gene annotation; Genome editing, Applications of Genomics to medicine; RNA interference	
	7	Ethical and legal considerations in Genomics	
II	**Transcriptomics**		**12**
	8	Transcriptomics, Definition and aims–Transcriptional structure of the genes and transcriptional start site. Post-translational modifications; Type I, II and self-splicing; Types of transcripts (mRNA, tRNA, rRNA, scRNA, snRNA, siRNA, miRNA)	
	9	Steps for generating data on RNA transcripts-Isolation of RNA, EST, Serial and Cap analysis of gene expression (SAGE/CAGE), Microarrays	
	10	RNA-Seq; Sequencing technology platforms commonly used for RNA-Seq	
	11	Applications of transcriptomics-Diagnostics and disease profiling, Generation of human and pathogen transcriptomes for individualised treatment, Drug resistance, Gene function	

		annotation, Noncoding RNA	
	12	Fundamentals of transcriptome databases–Gene Expression Omnibus, Expression Atlas, Genevestigator, RefEx. Computational approach to predict the potential targets of miRNAs, RNA Darkmatter	
III	**Proteomics**		**15**
	13	Introduction to Proteomics. Functional Protein families, Evolution from Protein Chemistry to Proteomics	
	14	Gel based proteomics [PAGE, 2-D electrophoresis, Two-dimensional Fluorescence Difference Gel Electrophoresis (DIGE), Blue Native PAGE (BN-PAGE)], Gel casting, Staining and Image Analysis, Iso–electric focusing	
	15	Gel free proteomics methods [liquid chromatography, Isotope–Coded Protein Label (ICPL), Combined FRActional Diagonal Chromatography (COFRADIC)]	
	16	Quantitative Proteomics [Stable Isoptope Labeling by Aminoacids in Cell Culture (SILAC), Isotope Coded Affinity Tag (ICAT), Isobaric Tagging for Relative and Absolute Quantification (iTRAQ), Chromatin Immunoprecipitation (ChIP)],Protein Chips	
	17	Mass Spectrometry- Ionization sources (ESI and MALDI), MALDI-TOF	
	18	Structural proteomics and protein-protein interaction- Yeast–2–Hybrid, Co–immuno precipitation (CO-IP), Tandem affinity purification (TAP)	
	19	Protein modifications in Proteomics-Phosphoproteins and Glycoproteins; Proteomics applications, Challenges in Proteomics	
IV	**Metabolomics**		**9**
	20	Metabolome and Metabolomics; Basic concepts, Metabolic fingerprinting, Metabolic pathway analysis, Single Cell Metabolomics with MS	
	21	Metabolism-Centered Screening of Potential Drug Targets, Metabolomic strategies for the identification of new metabolic pathways, Metabolomics for improved drug targeting and chemical risk analysis	
	22	Metabolic Connectome, Role in the Prediction, Diagnosis, and Treatment of Complex Diseases	
	23	Tools of metabolomics– Capillary electrophoresis, Gas chromatography, Electrochemical detectors	
V	**Glycomics and Lipidomics**		**9**
	24	Fundamentals of Glycomics, Relationship of glycome to the Genome and Proteome. Tools for characterizing Glycome-MS, Lectin and Antibody Arrays, Imaging the Glycome by Metabolic and Covalent Labeling	
	25	Comparative Glycomics; Functional Glycomics using Glycan Microarrays; Informatics challenges of Glycomic data	
	26	Lipidomics–Definition, Processes of Lipidomic workflow	
	27	Separation based Lipidomics (LC-MS), Mass Spectrometry-	

		based Lipidomic Approaches-Shotgun lipidomics, Imaging based lipidomics, Lipid databases and identification tools	

References

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2. Campbell, A. M., & Heyer, L. J. (2006). Discovering genomics, proteomics, and bioinformatics. 2nd Edition. Pearson.
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5. Cold Spring Laboratory Press.Wilson and Walker's (2018), Principles and Techniques of Biochemistry and Molecular Biology, 8th Ed. Hofmann and Clokie
6. Fundamentals of Advanced Omics Technologies: From Genes to Metabolites 1st Edition - November 15, 2008, Editors: Carolina Simó, Alejandro Cifuentes, Virginia GarcíaCañas
7. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing
8. Metabolomics, by Ute Roessner, ISBN 978-953-51-0046-1, Hard cover, 364 pages, Publisher: InTech
9. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press
10. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press.
11. Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press.
12. Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley.
13. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
14. Handbook of Glycomics-Richard D. Cummings, J. Michael Pierce Academic Press
15. Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Create an awareness on genome sequence analysis and its importance in different biological processes	U	1
CO-2	Understand the concept of microarray data analysis and RNA-Seq for gene expression	U	1
CO-3	Focus on the advantages, limitations and challenges associated with analysis of the proteome by different techniques	U	1
CO-4	Know the metabolic connectome and its implications in disease Biology	U	1,2
CO-5	Understand the concept of functional Glycomics and method for studying Lipidomics	U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Omics
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Create an awareness on genome sequence analysis and its importance in different biological processes	1	U	F,C	L/T	
CO-2	Understand the concept of microarray data analysis and RNA-Seq for gene expression	1	U	F,C	L/T	
CO-3	Focus on the advantages, limitations and challenges associated with analysis of the proteome by different techniques	1	U	F,C	L/T	
CO-4	Know the metabolic connectome and its implications in disease Biology	1,2	U	F,C	L/T	
CO-5	Understand the concept of functional Glycomics and method for studying Lipidomics	1	U	F,C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	3	-	-	-	-	3	-	-	-	-	-
CO 5	2	-	-	-	-	-	1	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / **High**

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar

- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK7DSEBCH400				
Course Title	**TISSUE ENGINEERING AND 3D BIOPRINTING**				
Type of Course	**DSE9**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Nil				
Course Summary	Tissue engineering and 3D bioprinting involve the design and creation of biological tissues and organs using a combination of biomaterials, cells, and advanced fabrication technologies, enabling the development of innovative therapies for regenerative medicine and personalized healthcare.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of tissue engineering**	**12**
	1	Key milestone in Tissue Engineering, Stem Cell Tissue Engineering,	

	2	Principles of Tissue Regeneration and repair	
	3	Cell sourses and culture techniques	
	4	Mechanical Forces On Cells	
II	**Technologies for Tissue Engineering**		**12**
	5	Bioreactors, Biomimetic Materials- (Basics only)	
	6	Polymer Scaffold For Tissue Engineering	
	7	Nanocomposite Scaffolds Tissue Engineering	
	8	Regulatory Issues In Tissue Engineering	
III	**Applications of Tissue Engineering**		**12**
	9	Bone Tissue Engineering, Cartilage Tissue Engineering	
	10	Nerve Tissue Engineering, Human Skin Substitute	
	11	Cardiac Tissue and Vascular Graft Tissue Engineering	
	12	Heart Valve Tissue Engineering	
IV	**INTRODUCTION OF 3D BIOPRINTING**		**12**
	13	Overview of 3D printing technologies: stereolithography, extrusion based printing and inkjet printing	
	14	3D Manufacturing: Materials and Methods	
	15	Development of bioinks, Blueprints(Digital models of tissues and organs)	
	16	3D-Bioprinting Technologies, Tools and Bioprinters	
V	**APPLICATIONS OF 3D BIOPRINTING**		**12**
	17	Applications in prosthetics, implants	
	18	Applications in regenerative medicine	
	19	Ethical and regulatory issues	

References

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Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the principles and fundamentals of tissue engineering, including biomaterials, cell biology, and scaffold design.	U	1
CO-2	Describe various methods of scaffold fabrication and tissue engineering techniques, such as 3D bioprinting	U	1
CO-3	Discuss the ethical, regulatory, and societal issues associated with tissue engineering, including considerations of safety, consent, and access to healthcare.	An	1
CO-4	Describe the properties and characteristics of bioinks used in 3D bioprinting, including rheological behavior, biocompatibility, and cell support.	U,An	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course :Tissue Engineering and 3D Printing

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the principles and fundamentals of tissue engineering, including biomaterials, cell biology, and scaffold design.	1	U	F, C	L/T	
CO-2	Describe various methods of scaffold fabrication and tissue engineering techniques, such as 3D bioprinting	1	U	F, C	L/T	

CO-3	Discuss the ethical, regulatory, and societal issues associated with tissue engineering, including considerations of safety, consent, and access to healthcare.	1	U,An	F, C	L/T	
CO-4	Describe the properties and characteristics of bioinks used in 3D bioprinting, including rheological behavior, biocompatibility, and cell support.	1	U	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	-	-	-	-	-	1	-	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar

- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	Biochemistry				
Course Code	UK7DSEBCH401				
Course Title	**Plant Tissue culture**				
Type of Course	**DSE10**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	NIL				

Course Summary	The course on plant tissue culture offers a comprehensive understanding of theory and practical applications. It covers fundamental topics such as tissue culture history, cellular totipotency, and advanced concepts like dedifferentiation and organogenesis. Additionally, students engage in hands-on activities including the preparation and sterilization of media, as well as field visits or internships in tissue culture laboratories, providing valuable experiential learning opportunities.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Basic Aspects of Plant Tissue Culture**		**9**
	1	A brief history of plant tissue culture, Cellular totipotency	
	2	Concept of dedifferentiation, redifferentiation, and organogenesis	
II	**Tissue Culture Media**		**9**
	5	Selection of media	
	6	Media composition	
	7	Media preparation and sterilization	
III	**Micropropagation**		**9**
	8	Selection of suitable material	
	9	Stock plant selection	
	10	Size of explant	
	11	Avoidance of diseased tissue	
IV	**Brief outline of types of plant tissue culture**		**9**
	12	Meristem culture	
	13	Callus culture	
	14	Anther culture	
	15	Ovary culture	
	16	Ovule culture	
	17	Pollen culture	
V	**Applications of plant tissue culture (Brief outline)** Micropropagation, Clonal propagation Somatic hybridization Production of disease-free plants Production of secondary metabolites Crop improvement Production of synthetic seeds Conservation of endangered species Cryopreservation of germplasm		**9**
	Practical ● Preparation of MS medium and its sterilization ● Field visit/Internship in a Tissue culture lab		**15**

References

1. B. R. C. Murthy & V. S. T. Sai (2017). Botany-Plant tissue culture and its biotechnological applications, Venkateswara Publications, Guntur.
2. Pullaiah. T. and M.V.Subba Rao. 2009. Plant Tissue Culture. Scientific Publishers, New Delhi.
3. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
4. R Keshavachandran and K V Peter. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan.
5. S S Bhojwani, M K Razdan (1996). Plant tissue culture: Theory and Practice. Elsevier.
6. L Gamborg, G C Philips (Eds.) (2005). Plant cell, tissue, and organ culture: Fundamental methods. Narosa Publishing House
7. Kalian Kumar De (2003) An introduction to plant tissue culture, New Central Book Agency Pvt. Ltd.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO Addressed
CO-1	Understand the basic principles of plant tissue culture	U	1
CO-2	Recall different types of plant tissue culture techniques	R, U	1,2
CO-3	Understand the applications of plant tissue culture	U	1
CO-4	Gain practical knowledge of plant tissue culture	Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Plant Tissue Culture

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the basic principles of plant tissue culture	1	U	F, C	L/T	
CO-2	Recall different types of plant tissue culture	1,2	R, U	F, C	L/T	

	techniques					
CO-3	Understand the applications of plant tissue culture	1	U	F, C	L/T	
CO-4	Gain practical knowledge of plant tissue culture	1,2	Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive Mapping of

COs with PSOs and POs :

	PSO1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1					
CO 2	2	3	-	-	-	-	1					
CO 3	2	-	-	-	-	-	1					
CO 4	1	3	-	-	-	-	1					

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / **High**

Assessment Rubrics:

- Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations

CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK8DSCBCH400				
Course Title	Developmental Biology				
Type of Course	**DSC41**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Nil				
Course Summary	Developmental biology studies the process by which organisms grow and develop, from fertilization to the formation of tissues, organs, and body structures. This course explores the molecular, cellular, and genetic mechanisms that drive embryogenesis, morphogenesis, and postnatal growth, as well as how these processes can be altered in diseases or manipulated in regenerative medicine.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Concepts of Ontogeny**	**12**
	1	Potency, Commitment, Specification- Autonomous, conditional and syncytial, determination and differentiation, induction and competence.	

	2	Orchestration of embryonic development: Morphogenic gradients in cell specification, cell fate, fate map and cell lineages	
II	Germ Cell Development and Fertilization		**12**
	3	Spermatogenesis and Oogenesis, Germline formation, Specification of primordial germ cells, Migration, Proliferation and differentiation into mature gametes.	
	4	Acrosome reaction, Recognition of egg and sperm, Prevention of polyspermy	
	5	Fusion of genetic material, Cytoplasmic rearrangements, Epigenetic modifications, Activation of the zygote, Mitotic cell division, Cell differentiation.	
III	**Embryogenesis and Spatial Patterning**		**12**

	6	Process of transformation of the zygote into embryo (Cleavage, Blastula formation, Gastrulation)	
	7	Pattern formation in drosophila with a special focus on the genes involved (Maternal genes –bicoid and nanos and hunchback. Gap genes, pair rule genes, segmentation genes, homeotic genes).	
IV	**Molecular communications in embryogenesis**		**12**
	8	Paracrine factors in organ induction: Notch and RTK signalling, Fibroblast growth factor, Transforming growth factor-beta family-smad signalling	
	9	Hedgehog proteins, Wnt proteins- canonical and noncanonical signalling	
V	**Organogenesis**		**12**
	23	Brief description of limb development, lens induction in amphibians and neuronal differentiation in vertebrates	
	24	Regeneration in vertebrates	
	25	Sex determination: Chromosomal sex determination in drosophila, dosage compensation.	

References

1. Gilbert, S. F. (2016). Developmental Biology (11th ed.). Sinauer Associates.
2. Slack, J. M. W. (2013). Essential Developmental Biology (3rd ed.). Wiley-Blackwell.
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4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
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10. Peifer, M. (1995). Regulation of cell architecture in Drosophila: the roles of the cytoskeleton, cell adhesion, and signaling during morphogenesis. Current Opinion in Genetics & Development, 5(5), 556-561.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will gain a foundational understanding of the stages and processes of development, including cell differentiation, tissue formation, and morphogenesis.	U	1
CO-2	Students will understand the fundamental signaling pathways and molecular mechanisms that guide developmental processes, such as cell-to-cell communication and pattern formation.	U	1
CO-3	Students will become familiar with the genetic basis of development, including the role of regulatory genes, gene expression patterns, and genetic control of developmental pathways.	U	1
CO-4	Students will recognize the interdisciplinary nature of developmental biology, including its connections to genetics, molecular biology, and evolutionary biology, as well as its relevance to medical research and biotechnology.	U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Developmental Biology

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Students will gain a foundational understanding of the stages and processes of development, including cell differentiation, tissue formation, and morphogenesis.	1	U	F, C	L/T	
CO-2	Students will understand the fundamental signaling pathways and molecular mechanisms that guide developmental processes, such as cell-to-cell communication and pattern formation.	1	U	F, C	L/T	
CO-3	Students will become familiar with the genetic basis of development, including the role of regulatory genes, gene expression patterns, and genetic	1	U	F, C	L/T	

	control of developmental pathways.					
CO-4	Students will recognize the interdisciplinary nature of developmental biology, including its connections to genetics, molecular biology, and evolutionary biology, as well as its relevance to medical research and biotechnology.	1	U	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	-	-	-	-	-	1	-	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / **High**

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

University of Kerala

Discipline	BIOCHEMISTRY				
Course Code	UK8DSCBCH401				
Course Title	**Pharmacology**				
Type of Course	**DSC42**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5

Pre- requisites	NIL
Course Summary	This course gives the students basic understandings of various phases of pharmacology include pharmaceutics phase, pharmacokinetic phase, pharmacodynamic phase and pharmacogenetics. This course gives an idea of how to design a drug, drugs mode of action, absorption, distribution and elimination. Mechanisms of action of some important pharmaceuticals are also will be explained in this course.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Sources of drugs and dosage forms**		**6**
	1	Sources of drugs- plants, animals, minerals, synthetic and biosynthetic.	
	2	Dosage forms (definition), ideal dosage form, ED_{50}, LC_{50}, LD_{50}, different dosage forms	
	3	Tablets	
	4	Capsules	
	5	Liquid oral preparations	
	6	Topical preparations	
	7	Nasal preparations, ear preparations	
	8	Powders and granules	
	9	Sterile formulations	
	10	Immunological products	
II	**Drug delivery methods**		**6**
	11	Drug administration methods - systemic (enteral and parenteral) and local.	
	12	Novel drug delivery systems	
III	**Pharmacokinetics**		**8**
	13	Pharmacokinetics (definition), ADME	
	14	Drug absorption	
	15	Bioavailability- factors affecting bioavailability	
	16	Drug distribution- factors affecting drug distribution	

	17	Biotransformation of drugs - role of cytochrome P450 and enzymes in biotransformation, Phase I and Phase II reactions with example	
	18	Routes of drug elimination	
IV	**Pharmacodynamics-molecular mechanisms of drug action**		**10**
	19	Pharmacodynamics (definition)	
	20	Drug-receptor interaction (agonist, antagonist)	
	21	Major types of receptors and their mode of action (with examples)	
	22	General mode of action of drugs	
	23	Antibacterial drugs (Penicillin, Rifampicin and Streptomycin)	
	24	Antifungal drugs (Polyenes, Azoles, Echinocandins)	
	25	Antiparasitic drugs (Aminoquinolines, Benzimidazole)	
	26	Antiviral drugs (Maraviroc, Amantadine, Acyclovir, Raltegravir, Saquinavir, Zanamivir)	
	27	Antineoplastic drugs (5-fluorouracil, Cyclophosphamide, Vinca alkaloids)	
V	**Fundamentals of drug discovery, development and approval**		**15**
	28	Phases of drug development process- discovery and development, pre-clinical research, clinical research, regulatory authority review and post-market safety monitoring	
	29	Drug discovery and development – Target discovery, target validation, lead generation and optimization	
	30	Pre-clinical research – Pharmacokinetics, short -term toxicology, formulation, synthesis of drug	
	31	Clinical research - Phase I, Phase II and Phase III trials in humans for safety and effectiveness	
	32	Regulatory authority review -Review of application, approval and marketing	
	33	Post-market safety monitoring – Safety and monitoring of marketed drug (Phase IV)	
	34	**Practical** Isolation and characterization of bioactive compounds (from natural sources) Internships/ visit in drug manufacturing companies	30

References

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- Handbook Of Experimental Pharmacology by Kulkarni SK (2007) Publisher: Vallabh Publications / Prakashan ISBN: 8185731128, ISBN-13: 9788185731124, 978-8185731124
- Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy by David E Golan (2011) Publisher Lippincott Williams and Wilkins ISBN-10: 1608312704, ISBN-13 : 978- 1608312702

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addresse d
CO-1	understand the sources of drugs and different dosage forms	U	1
CO-2	gain knowledge of different drug delivery methods	R, U	1
CO-3	understand drug absorption, bioavailability, biotransformation and elimination of drugs	R, U	1
CO-4	learn the concepts of molecular mechanisms of drug action and general mode of action of drugs	R, U	1
CO-5	understand the different phases of drug discovery, development, approval by regulatory authority, safety and monitoring of marketed drug	R, U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Pharmacology

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PS O	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	understand the sources of drugs and different dosage forms	1	U	F, C	L/T	
CO-2	gain knowledge of different drug delivery methods	1	R, U	F, C	L/T	
CO-3	understand drug absorption, bioavailability, biotransformation and elimination of drugs	1	R, U	F, C	L/T	
CO-4	learn the concepts of molecular mechanisms of drug action and general mode of action of drugs	1	R, U	F, C	L/T	
CO-5	understand the different phases of drug discovery, development, approval by regulatory authority, safety and monitoring of marketed drug	1	R, U	F, C	L/T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive Mapping of

COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	-	-	-	-	-	1					
CO 2	2	-	-	-	-	-	1					
CO 3	2	-	-	-	-	-	1					
CO 4	3	-	-	-	-	-	1					
CO 5	3	-	-	-	-	-	1					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / **High**

Assessment Rubrics:

- Quiz / Assignment/Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

Discipline	BIOCHEMISTRY				
Course Code	UK8DSCBCH402				
Course Title	**Nanomaterials for Biomedical Applications**				
Type of Course	**DSC3**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Basic infrastructure for the synthesis of nanomaterials				
Course Summary	This course helps the student to become aware of synthesis, characterization and biomedical applications of materials at the nanolevel				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Nanomaterials**		**9**
	1	Introduction to Nanomaterials–History and scope of Nanoscience. Nanomaterials in nature	
	2	Classification of nanostructures–Carbon-based (Fullerenes, Graphene, Carbon black, Carbon nanotube, Carbon fibre); Organic (Cyclodextrin, Micelles, Liposomes, Dendrimers); Inorganic based nanomaterials (Metal and metal oxide nanomaterials)	
	3	Composite–based nanoparticles; Semiconductor based (Quantum dots, Quantum wires and Quantum wells); Core shell nanostructures	

	4	Classification based on pore dimensions–Micro porous, meso porous and macro porous nanomaterials; Classification based on number of dimensions-zero-, one-, two- and three-dimensional nanomaterials	
II	**Strategies for the Synthesis of Nanomaterials**		**9**
	5	Bottom–up approaches- Sol–gel method, Spinning method, Soft and Hard Templating Method, Pyrrolysis Method,	
		Chemical vapour deposition Method, Solvothermal and Hydrothermal Methods, Reverse Micelle Method, Green Synthesis of Nanoparticles	
	6	Top–down approaches Nanolithography, Mechanical Milling, Thermal Decomposition, Laser Ablation, Sputtering Method, The Arc Discharge Method	
	7	Consolidation of Nano powders–Isostatic pressing, Spark plasma sintering, Microwave assisted sintering	
III	**Characterization Tools for Nanomaterials**		**9**
	8	Introduction to the principles and applications of the techniques used for characterization of nanomaterials	
	9	Characterization of optical, electronic, and electrical properties UV–Vis spectroscopy, Photoluminescence, UV–Vis diffuse reflectance spectroscopy (DRS), Spectroscopic ellipsometry, Fourier Transform Infrared Spectroscopy (FTIR), Zeta-potential analysis, Cyclic voltammetry (CV), Raman spectroscopy	
	10	Structural and chemical characterization–X–ray diffraction analysis, Energy–dispersive X–ray spectroscopy (EDX), X-Ray photoelectron spectroscopy (XPS); Morphological and topographical characterization-Scanning Electron Microscopy (SEM), Energy Dispersive Analysis (EDS), Scanning Tunneling Microscopy (STM), Transmission Electron Microscopy (TEM), Atomic Force Microscope (AFM), Dynamic Light Scattering (DLS), Brunauer–Emmett–Teller (BET) method, Barrett–Joyner–Halenda (BJH) method	
	11	Characterization of thermal properties–Diferential Scanning Calorimetry (DSC), Diferential Thermal Analysis (DTA), Thermo Gravimetric Analysis (TGA). Characterization of mechanical and magnetic properties –Tensometry, Electron Spin Resonance Spectroscopy (ESR)	
IV	**Tools for Testing the Biocompatibility of Nanomaterials**		**9**
	12	*In vitro* and *in vivo* assessment of tissue compatibility	
	13	Cellular assays-Cytotoxicity, Adhesion, Migration, Proliferation, Differentiation, Sensitization assays, Irritation tests, Acute Systemic Toxicity and Implantation tests	
	14	Tests for Genotoxicity and Hemocompatibility	

	15	Microscopy–Fundamentals of Phase Contrast Microscope, Epifluorescence Microscope, Confocal Microscope and Total Internal Reflection Microscope	
V	**Nanomaterials for Biomedical Applications**		**9**
	16	Nanomedicine, Biomimetic nanomaterials, Nanomaterials in tissue engineering and regenerative medicine	
	17	Functionalization of nanomaterials for biological targeting	
	18	*In vitro* and *in vivo* diagnostic approaches, Nano sensors, Nano machines, Theranostic approaches	
	19	Drug delivery–passive and active methods, Cancer therapy, Plasmonic photothermal therapy, Photodynamic therapy	
	20	Nanomaterials for treating cardiovascular diseases, Nanomaterials in dental and orthopaedic applications	
	21	Nanomaterials as contrast agents, Optical imaging, MR imaging, CT imaging, PET and SPECT imaging	
	22	Ethical implications of Nanotechnology	
	23	**Practical** 1. Synthesis of Ag metal nanoparticles by chemical route 2. Green synthesis of chitosan nanoparticles 3. Synthesis of transition metal oxide nanoparticles by hydrothermal route 4. Analysis of nanoparticles by UV-Vis and FTIR spectroscopy 5. Analysis of the XRD spectrum of a standard sample	**30**

References

1. Nano- The Essentials, T. Pradeep, McGraw Hill Education (2007)
2. Introduction to Nanotechnology, Charles P Poole, Frank J, Wtey India Education (2012)
3. Nanostructures and Nanomaterials-Synthesis properties and Applications, G. Cao, Imperial College Press (2004)
4. Lasers and nonlinear optics B B Laud, New age international publishers (1985)
5. Nanoparticles and Nanostructured Films, Preparation, Characterization and Applications, Janos.H. Fendler, Wiley-VCH (1998)
6. Optical properties of semiconducting Nanocrystals, S.V. Gaponenko, Cambridge press (1997)
7. Nanomaterials for medical diagnosis and therapy, By Challa S. S. R. Kumar, Wiley-VCH, (2007)
8. Cabor Harsanyi, Sensors in biomedical applications. Fundamentals, Technology and Applications, CRC Press, New York (2000)
9. Fluorescence sensors and Biosensors, R. B. Thompson (Ed), CRC Press, New York, (2006)
10. Nanotechnology in Tissue Engineering and Regenerative Medicine, Popat K. (editor),

CRS Press (2011)
11. Nanotechnology: Principles and Practices, Sulabha K. Kulkarni 3rd Edition, Springer
12. Reis, Rui L. Encyclopedia of tissue engineering and regenerative medicine. Academic Press (2019)
13. Andrew D. Leavitt (auth.), Harold S. Bernstein (eds.), Tissue Engineering in Regenerative Medicine (2011) Humana Press, Springer New York Dordrecht Heidelberg London

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand nanomaterials and their classification	U	1
CO-2	Create an awareness on the various modes of synthesis of substances at the nanolevel	C	1,2
CO-3	To learn the characterization techniques employed for nanomaterials	U	1,2
CO-4	Discuss the role of nanomaterials in the biomedical field	U	1,2
CO-5	Display the various methods of preparation of nanoparticles and to characterize them	E	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Nanomaterials for Biomedical Applications

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand nanomaterials and their classification	1	U	F, C	L/T	
CO-2	Create an awareness on the various modes of synthesis of substances at the nanolevel	1,2	C	F, C	L/T	
CO-3	To learn the characterization techniques employed for nanomaterials	1,2	U	F, C	L/T	
CO-4	Discuss the role of nanomaterials in the biomedical field	1,2	U	F, C	L/T	
CO-5	Display the various methods of preparation of nanoparticles and to characterize them	1,2	E		L/T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

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CO 5	1	2	-	-	-	-	2	-	-	-	-	-

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CO 4	✓	✓		✓
CO 5	✓	✓		✓

Sl No	Name of Course	Online Link	Host of the course
1	Biochemistry	https://onlinecourses.nptel.ac.in/noc22_cy06/preview	Swayam
2	Biochemistry - IITM	https://onlinecourses.nptel.ac.in/noc24_bt12/preview	Swayam
3	Biochemistry & Molecular Biology	https://onlinecourses.swayam2.ac.in/cec19_bt02/preview	Swayam
4	Biochemistry of Biomolecules	https://onlinecourses.swayam2.ac.in/cec20_bt12/preview	Swayam
5	Experimental Biochemistry	https://onlinecourses.nptel.ac.in/noc22_cy32/preview	Swayam
6	Chemistry and Biochemistry-BioChemistry	https://archive.nptel.ac.in/courses/104/105/102105034/	NPTEL
7	Biotechnology	https://archive.nptel.ac.in/courses/102/103/102103097/	NPTEL
8	Chemistry and Biochemistry-Biological Inorganic Chemistry	https://archive.nptel.ac.in/courses/104/105/104105130/	NPTEL
9	Essential Biomolecules: Nucleic Acids and Peptides	https://archive.nptel.ac.in/courses/104/103/104103121/#	NPTEL
10	MOLECULAR BIOLOGY	https://onlinecourses.swayam2.ac.in/cec20_ma13/preview	Swayam
11	MOLECULAR BIOLOGY	https://onlinecourses.nptel.ac.in/noc24_bt07/preview	Swayam
12	Human Molecular Genetics	https://onlinecourses.nptel.ac.in/noc22_bt07/preview	Swayam
13	Introduction to Cell Biology	https://onlinecourses.nptel.ac.in/noc22_bt33/preview	Swayam
14	Basics of Biology	https://onlinecourses.nptel.ac.in/noc22_bt17/preview	Swayam
15	Enzymology	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview#:~:text=The%20course%20is%20designed%20to,of%20inhibitors	Swayam

		%20on%20enzyme%20activity	
16	Enzyme Sciences and Technology	https://onlinecourses.nptel.ac.in/noc23_bt05/preview	Swayam
17	Basic concepts in Enzymology	https://onlinecourses.swayam2.ac.in/cec22_bt16/preview	Swayam
18	Food and Nutrition	https://onlinecourses.swayam2.ac.in/cec19_ag02/preview	Swayam
19	Maternal Infant Young Child Nutrition	https://onlinecourses.nptel.ac.in/noc22_bt01/preview	Swayam
20	Sports and Performance Nutrition	https://onlinecourses.nptel.ac.in/noc24_hs82/preview	Swayam