ADAMAS UNIVERSITY

SCHOOL OF LIFE SCIENCE & BIOTECHNOLOGY

DEPARTMENT OF BIOLOGICAL SCIENCES

B.Sc. BIOCHEMISTRY (4 YEARS) PROGRAMME COURSE STRUCTURE & PROPOSED SYLLABUS
TOTAL CREDITS –167
2024-28

ADAMAS UNIVERSITY, KOLKATA, SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

VISION OF THE UNIVERSITY

To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building.

MISSION STATEMENTS OF THE UNIVERSITY

M.S 01: Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology

M.S 02: Foster outcomes based education system for continuous improvement in education, research and all allied activities

M.S 03: Instill the notion of lifelong learning through culture of research and innovation

M.S 04: Collaborate with industries, research centers and professional bodies to stay relevant and up to date.

M.S 05: Inculcate ethical principles and develop understanding of environmental and social realities.

CHANCELLOR / VICE CHANCELLOR

ADAMAS UNIVERSITY, KOLKATA, SCHOOL OF LIFE
SCIENCE AND BIOTECHNOLOGY

VISION OF THE SCHOOL

To achieve global standard and excellence in research on various inter-disciplinary and multi-disciplinary domains of biological sciences through biotechnological innovation along with producing global citizens as graduates by intensive teaching learning process who would be vanguard to sustainable societal development.

MISSION STATEMENTS OF THE SCHOOL

M.S 01: To disseminate knowledge of life science and biotechnology for scholarly progression, intellectual development and strive for innovation.

M.S 02: To enable latest skill sets in the domain of microbiology, biotechnology, biochemistry (biological sciences) with ability to evolve and engage in learn-unlearn and relearn, being a lifelong learner and use the knowledge to other multi-disciplinary programs.

M.S 03: To establish state of art infrastructure and research ambiance in attracting the best minds to serve under the single roof of school of life science and biotechnology in undertaking scientific investigation of social relevance.

M.S 04: To inculcate values, culture along with scientific knowledge to foster the spirit of self- reliance and entrepreneurship development.

DEAN / SCHOOL CONCERNED

ADAMAS UNIVERSITY, KOLKATA SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

VISION OF THE DEPARTMENT

To achieve **excellence in education and research in biochemistry** for **societal development** through **innovation** and producing **technologically sound graduates** as **global citizen** fostering **life-long learning.**

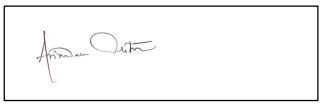
MISSION STATEMENTS OF THE DEPARTMENT

M.S01: Adopt and implement latest curriculum in biochemistry with futuristic approach and innovative pedagogy fostering knowledge, intellectual and skill development.

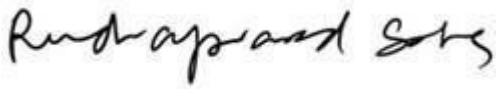
M.S02: To enable and enhance skill in biochemistry sets through rigorous training and research through multidisciplinary approach.

M.S03: To cater professional and societal need of cutting-edge research in biochemistry through collaboration and industry-academic partnership.

M.S04: To inculcate values, culture along with knowledge about biochemistry to foster the spirit of self-reliance and entrepreneurship development.



HOD



DEAN / SCHOOL CONCERNED

ADAMAS UNIVERSITY, KOLKATA SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Name of the Program: B.Sc. Biochemistry (Hons.)

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO 01 **:** Acquire basic theoretical and practical domain knowledge.

PEO 02 **:** Acquainted with tools and technology related to the field of

PEO 03 **:** Ability to do identify research gaps, comprehend fundamentals, and

PEO 04 **:** Develop as professional aspirants and sustainable

PEO 05 **:** Global outlook with imbibed human values.

HOD

DEAN / SCHOOL CONCERNED

ADAMAS UNIVERSITY, KOLKATA SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Name of the Programme: B.Sc. Biochemistry (Hons.)

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01/ PO 01: Fundamental Knowledge: Strong fundamental knowledge in basic and applied field of biochemistry.

GA 02/ PO 02: Critical Thinking: Ability to correlate between courses and develop critical/logical thinking.

GA 03/ PO 03: Skill: Develop skill set related to biochemistry and allied fields.

GA 04/ PO 04: Technical Knowledge: Familiarized with classical as well as modern tools and techniques in biochemistry.

GA 05/ PO 05: Logical Thinking: Ability to identify scientific research gaps and problems pertaining to biochemistry and allied fields.

GA 06/ PO 06: Problem identification ability: Explore the acquired knowledge and skills of biochemistry to identify approaches for suitable solution.

GA 07/ PO 07: Analytical Knowledge Ability to retrieve biological data for a meaningful solution.

GA 08/ PO 08: Career goals: Decide upon career path, force the challenges and develop professional aspirations.

GA 09/ PO 09: Teamwork: Uphold integrity and collaborative approach in workplace.

GA 10/ PO 10: Sustainable Development to environment: To accept and implement learning towards sustainable development.

GA 11/ PO 11: Development to society: Practice ethical philosophies and systems in creating and partnering a progressive society.

GA 12/ PO 12: Development to humanity: Develop as global citizen to contribute in the greater benefits of humanity.

HOD **DEAN / SCHOOL CONCERNED**

DEPARTMENT OF BIOCHEMISTRY

ADAMASUNIVERSITY
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

B.Sc. Biochemistry (Program Code: BIC3405)

(2024-28)

.

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY								
UNDERGRADUATE COURSE STRUCTURE								
B.Sc. BIOCHEMISTRY								
BATCH 2024-28								
SEMESTER I								
S.No	**Type of Course**	**Code**	**Title of the Course**	**Contact Hours Per Week**				**Remarks**
				L	**T**	**P**	**C**	
1	CC	BIC101	Molecules of life	2	1	1	4	CC-1
2	CC	BIC102	Enzymes	2	1	1	4	CC-2
3	MDC	BIT105	Renewable energy resources	2	0	1	3	MDC1
4	AEC	AEC101	Communicative English-I	2	1	0	3	AEC1
5	Minor	100-199	To be chosen from a pool of minors	2	1	1	4	Minor1
6	VAC	VAC101	Environmental Education-I	2	0	0	2	VAC1
Semester Credits							**20**	
SEMESTER II								
7	CC	BIC103	Cell Science	2	1	1	4	CC-3
8	CC	MIB104	Bacteriology and Virology	2	1	1	4	CC-4
9	MDC	MIB106	Microbes for sustainable development	2	0	1	3	MDC2
10	SEC	SEC144	Forensic Science	1	0	1	2	SEC-1
11	VAC	VAC105	Community engagement and Social responsibility	1	0	0	2	VAC2
12	AEC	AEC102	Communicative English-II	2	1	0	3	AEC2
13	Minor	100-199	To be chosen from a pool of minors	2	1	1	4	Minor2
Semester Credits							**22**	
SEMESTER III								
14	CC	BIC201	Metabolism: carbohydrate and lipid	2	1	1	4	CC-5
15	CC	BIC202	Basics of plant and animal sciences	2	1	1	4	CC-6
16	MDC	BIT206	Introduction to Biomaterials	2	0	1	3	MDC3
17	Minor	CHM204	Spectroscopic methods of analysis	3	1	0	4	Minor3
18	AEC	AEC106	Professional Communication Skills	2	0	0	2	AEC3
19	SEC	SEC145	Clinical Biochemistry	1	0	1	2	SEC-2
20	VAC	VAC102	Human Values and Ethics	2	0	0	2	VAC3
21	PDC	PDC201	Professional development course-1	0	0	1	1	

Semester Credits							**22**	
SEMESTER IV								
22	CC	BIC203	Advanced microbiology	2	1	1	4	CC-7
23	CC	BIC204	Metabolism of amino acids and Nucleic acids	2	1	1	4	CC-8
24	CC	MIB205	Molecular Biology	2	1	1	4	CC-9
25	SEC	SEC146	Molecular diagnostics	1	0	1	2	SEC-3
26	Minor	200-299	To be chosen from a pool of minors	2	1	1	4	Minor4
27	VAC		To be chosen from subjects offered from University	2	0	0	2	VAC4
28	PDC	PDC202	Professional development course-2	0	0	1	1	
Semester Credits							**21**	
SEMESTER V								
29	CC	MIB301	Immunology	2	1	1	4	CC-10
30	CC	BIC302	Human physiology	2	1	1	4	CC-11
31	CC	BIC303	RDT and genetic engineering	2	1	1	4	CC-12
32	Minor	300-399	To be chosen from a pool of minors	2	1	1	4	Minor5
33	SEC	SEC142	IPR and Biosafety	1	1	0	2	SEC-4
34	INT	BIC304	Internship	0	0	4	4	
35	PDC	PDC301	Professional development course-3	0	0	1	1	
Semester Credits							**23**	
SEMESTER VI								
36	CC	MIB305	Bioinformatics	2	1	1	4	CC-13
37	CC	BIC306	Bioenergetics	2	1	1	4	CC-14
38	CC	BIC307	Nutrition and toxicology	2	1	1	4	CC-15
39	Minor	300-399	To be chosen from a pool of minors	2	1	1	4	Minor6
40	SEC	SEC147	AI in Biology	1	0	1	2	SEC-5
41	Project	BIC308	Project work on Biochemistry	0	0	4	4	
42	PDC	PDC302	Professional development course-4	0	0	1	1	
Semester Credits							**23**	
Total Credits of the Program after 3rd Year							**131**	
			SEMESTER VII					

43	CC	BIC401	Plant Biochemistry	2	1	1	4	CC-16
44	CC	BIC402	Developmental Biology	2	1	1	4	CC-17
45	CC	BIC403	Genomics and Proteomics	2	1	1	4	CC-18
46	CC (For With research)	BIC404	Research Methodology for Biochemistry (should start working on dissertation topic)	3	1	0	4	CC-19 (Research)
47	CC (For Without research)	BIC405	Modern biochemical techniques and bioinstrumentation	3	1	0	4	CC-19(without Research)
48	Minor		To be chosen from a pool of minors	2	1	1	4	Minor7
49	PDC	PDC401	Professional development course-5	0	0	1	1	
Total Semester Credit							**21**	
			Semester VIII					
50	CC	MIB406	Biostatistics and biomathematics	2	1	1	4	CC-20
51	CC (For Without research)	BIC407	Cancer Biology	2	1	1	4	CC-21 (without Research)
52	CC (For Without Research)	MIB408	Biomedical Nanotechnology	2	1	1	4	CC-22 (without Research)
53	Minor (For Without Research)	400-499	To be chosen from a pool of minors				4	Minor8
54	Minor (For With /without research)	400-499	To be chosen from a pool of minors				4	Minor8
55	Dissertation (For With research)	BIC409	Dissertation on Biochemistry	0	0	12	12	
Total Semester Credit							**20**	
Total Credits of the Program after 4th Year							**172**	

*NOTE: With research is only allowed for Students ***who secure 75% marks and above in the first six semesters***

Minors to be offered by Department of Biological Sciences

Semester	Course Code	Courses	L	T	P	C
1	BIC151	Biomolecules	2	1	1	4
2	MIB152	Elementary cell science	2	1	1	4
3	BIC251	Basic metabolism	2	1	1	4
4	MIB252	Microbial Ecology	2	1	1	4
5	MIB351	Genetic engineering	2	1	1	4
6	BIC352	Basics of Nutrition and toxicology	2	1	1	4
7	BIC451	Introduction to Genomics and proteomics	2	1	1	4
8	MIB452	Fundamentals of Nanobiotechnology	2	1	1	4
9	BIC453	Drug Design and Development	2	1	1	4

List of Multi-disciplinary courses to be offered by Department of Biological Sciences

Semester	Course Code	Courses	L	T	P	C
2	MIB106	Microbes for sustainable development	2	0	1	3
3	MIB203	Biomaterial Sciences	2	0	1	3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIC151												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC102												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIT105												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
AEC101												
CO1	-	1	3	-	-	-	-	3	2	3	-	3
CO2	-	1	3	-	-	-	-	3	2	3	-	3
CO3	-	1	3	-	-	-	-	3	2	3	-	3
CO4	-	1	3	-	-	-	-	3	2	3	-	3
CO5	-	1	3	-	-	-	-	3	2	3	-	3
BIC151												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
VAC101												
CO1	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3

BIC103												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB104												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB106												
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
SEC144												
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
VAC105												
CO1	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
AEC102												
CO1	-	1	3	-	-	-	-	3	2	3	-	3
CO2	-	1	3	-	-	-	-	3	2	3	-	3
CO3	-	1	3	-	-	-	-	3	2	3	-	3
CO4	-	1	3	-	-	-	-	3	2	3	-	3
CO5	-	1	3	-	-	-	-	3	2	3	-	3
MIB152												
CO1	3	3	2	3	3	-	-	3	-	-	1	3

CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC201												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC202												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIT206												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
SEC144												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
VAC102												
CO1	-	2	-	-	-	2	-	3	1	3	3	3
CO2	-	2	-	-	-	2	-	3	1	3	3	3
CO3	-	2	-	-	-	2	-	3	1	3	3	3
CO4	-	2	-	-	-	2	-	3	1	3	3	3
CO5	-	2	-	-	-	2	-	3	1	3	3	3
PDC201												
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2

CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
BIC203												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC204												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB205												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
SEC146												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC251												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
PDC202												
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2

MIB301												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC302												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC303												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB351												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
SEC142												
CO1	3	3	3	2	3	3	3	3	2	3	3	2
CO2	3	3	3	2	3	3	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	3	2
CO4	3	3	3	2	3	3	3	3	2	3	3	2
CO5	3	3	3	2	3	3	3	3	2	3	3	2
PDC301												
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
MIB305												
CO1	3	3	2	3	3	3	3	3	1	3	3	3

CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
BIC306												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
BIC307												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
SEC147												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
PDC302												
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
BIC304												
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
BIC401												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3

CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

BIC402

CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

BIC403

CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

BIC404

CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3

BIC405

CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3

PDC401

CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2

MIB406

CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

BIC407

CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

MIB408

CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

MIB452

CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

BIC453

CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3

BIC409

CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
Total	585	690	540	565	660	175	165	735	80	210	310	706
Average	2.132	2.6	1.962	2.054	2.4	0.64	0.6	2.6	0.29	0.762	1.124	2.566

SEMESTER I

Course Objectives

1. To provide students a thorough knowledge on bio-macromolecules like carbohydrates, proteins and lipids.
2. It will also provide in depth knowledge of structural and functional diversity of carbohydrates, proteins and lipid.
3. Elaborating properties of enzymes and vitamins along with their importance.
4. Comprehend laws of thermodynamics and ionic equilibrium in relation to biochemical pathways.

BIC101	**MOLECULES OF LIFE**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	PLUS, TWO (12^{th}) LEVEL BIOLOGY				
Co-requisites	--				

Course Outcomes

On completion of this course, the students will be able to

CO 1: Knowledge: Define the basic principles of Bioenergetics and explain the energy flow in living systems.

CO 2: Comprehension: Explain how carbohydrates, proteins, lipids, and nucleic acids are synthesized and broken down in living organisms.

CO 3: Applying: Apply the knowledge of bioenergetics to analyze metabolic pathways involved in energy production.

CO 4: Analyzing: Analyze the structure-function relationships of molecules of life in different biological systems.

CO 5: Synthesis and Evaluation: Generate hypotheses and critically assess on the interplay between different molecules of life in maintaining cellular homeostasis.

Catalog Description

The core-course of 'molecules of life' will help to understand the structure and function of bio-macromolecules like carbohydrates, proteins and lipids. The syllabus includes all the properties of enzymes and vitamins which provide ample scope for their future utilization. The course also relate laws of thermodynamics and ionic equilibrium in biochemical pathways. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

MOLECULES OF LIFE

Theory (45 h)

Unit 1

Basic laws of Bioenergetics: Idea of thermodynamic functions (U, H, S, G). First law, second law. Acid, Base and Salt. pH concept. Buffer concept. Determination of pH of a buffer solution.

Families of monosaccharides: aldoses and ketoses, trioses, tetrodes, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit 2

Structure and functions of proteins; Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydro lysine, cystine and hydroxyproline, Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human hemoglobin structure, Quaternary structures of proteins, Ramachandran Plot. Enzymes: Definition, classification, active site, co-factors etc.

Unit 3

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides, Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers, structure of cholesterol and steroids.

Nucleoside and Nucleotide; DNA, RNA, Charguff'srule. Types and Functions of DNA-RNA.

List of the practical (15 h)

1. Basic understanding of different instruments in lab (microscopy, washing, autoclaving etc.).
2. Properties of water.
3. Buffer preparation.
4. Acid-Base Titrations.
5. Qualitative analysis of Carbohydrates.
6. Qualitative analysis of proteins.
7. Qualitative analysis of Lipids.

8. Assay of salivary amylase.

Text Book:

1. Nelson DL and Cox MM (2013) Lehninger principles of biochemistry, 6th edition, W.H. Freeman

Reference books

1. Campbell, MK (2012). Biochemistry, 7th edition, Cengage Learning
2. Berg JM, Tymoczko JL and Stryer L (2011). Biochemistry, 7th edition, WH Freeman
3. Voet D and Voet JG (2004). Biochemistry, 3rd edition, John Wiley and Sons

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC102	**Enzymes**	L	T	P	C
Version 1.0	**Contact Hours: 60**	2	1	1	4
Pre-requisites/Exposure	Class 12 level Biology knowledge				
Co-requisites	Amino acid: Structure & Function				

Course Objectives

1. Tounderstandtheenzymesaccordingtothebasisoftheir catalysedreactions. 1. To gain knowledge about the kinetic behaviour ofenzymes.
2. To generate the concept and determine about different patterns of inhibitions of enzymeactivity.
3. To understand the concept about the structures of active site of the enzymes and their mechanism of actions and their clinicalapplication.
4. To acquire the idea about regulation of enzymeactivity.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering:
- Define what enzymes are and how they function in biological systems.

CO2. Understanding:
- Explain the importance of enzymes in catalyzing biochemical reactions.

CO3. Applying:
- Apply knowledge of enzyme-substrate interactions to predict the effects of different factors on enzyme activity.

CO4. Analyzing:
- Analyze how enzyme kinetics can be used to study enzyme mechanisms and behaviours.

CO5. Evaluating:
- Evaluate the potential applications of enzymes in biotechnology and medicine.

Catalogue Description

Nomenclature and classification of enzymes Holoenzyme, apoenzyme , cofactors, coenzyme, prosthetic groups ,metallo enzymes, monomeric and oligomeric enzymes Activation energy and transitionstatetheory,enzymeactivity,specificactivity,commonfeaturesofactivesites,enzyme specificity: types and theories Factors affecting enzyme activity, E, S, temp and pH Enzyme substrate complex: Concept of E-S complex, binding sites, active site, specificity, kinetics of enzyme activity Michaelis- Menten equation and its derivation Different plots for the determination of KM and Vmax and their physiological significance Two substrate reactions (random, ordered and ping pong mechanisms), enzyme inhibition, types of inhibition,

determination of Ki, suicide inhibiton.

Course Content

Unit I Introduction to enzymes and **Features of enzyme catalysis**

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apo-enzyme, holoenzyme. IUBMB classification of enzymes. Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Enzyme Efficiency, Rate Enhancements, and Transition State Stabilization,

Unit II Mechanism of action of enzymes

Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. Effect of pH, temperature and metal ions on the activity of enzyme. Metal activated enzymes and metallo enzymes, Proteolytic cleavage-zymogen.

Unit III Enzyme kinetics

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant –mono substrate actions. Michaelis-Menten equation, Line weaver Burk plot, Eadie- Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number.

Unit IV Enzyme Inhibition

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors. Determination of Ki, Determination of Km and Vmax in the presence and absence of inhibitor; feed- back inhibition.

List of the Practical

1. Assay of enzyme activity and specific activity, e.g. acid phosphatase.
2. Effect of pH on enzyme activity.
3. Determination of Km and Vmax using Lineweaver-Burk graph.
4. Enzyme inhibition - calculation of Ki for competitive inhibition.

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1- 42923414-8.

2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York),ISBN:978-0-470-28173-4.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Continuous Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

BIT105	**Renewable Energy Resources**	**L**	**T**	**P**	**C**
Version 1.0	**CONTACT HOURS-45**	2	0	1	3
Pre-requisites/Exposure	PLUS TWO (12^{th}) LEVEL BIOLOGY, PHYSICS, CHEMISTRY				
Co-requisites	--				

Course Objectives

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation
3. Explain the concept of various forms of renewable energy
4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application
5. Analyse the environmental aspects of renewable energy resources.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remember: Recall and explain the fundamental principles of research methodologies in biochemistry.
CO2. Understand: Analyze and compare different research paradigms in biochemistry.
CO3. Apply: Design and implement appropriate study designs for biochemistry research projects.
CO4. Analyze: Evaluate the importance of Good Laboratory Practices (GLP) and work standards in biochemistry research.
CO5. Evaluate: Critically assess the validity and reliability of research findings in biochemistry.

Catalog Description

Renewable energy being the most important application area of engineering and technology in the twenty first century, this graduate programme is designed for quality learning in that sector. RE sector needs manpower with design and engineering skills in RE systems and components – this programme targets to impart these. The curriculum has an emphasis on solar, biomass, geothermal and wind energy systems, in tune with the Indian national missions on these. The energy has become an important and one of the basic infrastructures for the economic development of the country. it is imperative for the sustained growth of the economy. This course envisages the new and renewable source of energy, available in nature and to expose the students on sources of energy crisis and the alternates available, also stress up on the application of non-conventional energy technologies.

Course Content:

UNIT-I

Introduction to Energy: Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics, Energy flow diagram to the earth. Origin and time scale of fossil fuels, Conventional energy sources, Role of energy in economic development and social transformation. Global Energy Scenario: Energy consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear and hydroelectric power, impact of exponential rise in energy usage on global economy. Energy demand and Energy trilemma index, Classification of energy resources, Conventional-Nonconventional, Renewable-Non-renewable, Green energy, Clean energy (Definitions and examples), Green footprint, Carbon footprint, Ecological footprint concepts.

UNIT-II

Indian Energy Scene: Energy resources available in India, urban and rural energy consumption, energy consumption pattern and its variation as a function of time, nuclear energy - promise and future, energy as a factor limiting growth, need for use of new and renewable energy sources. National Green Tribunal (NGT) act, NGT activities. Environmental Effects : Environmental degradation due to energy production and utilization, air and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Environmental effects of thermal power station, nuclear power generation, hydroelectric power, Geothermal power, Ocean energy harvesting, Wind energy harvesting, Solar energy harvesting, Bioenergy.

UNIT-III

Solar constant, Solar Radiation spectrum, Classification of Solar cells, Solar thermal systems types, applications of Solar PV and Solar Thermal systems. Wind Energy: Introduction, Principle of wind energy conversion, Advantages and disadvantages of wind mills, Applications of wind energy.

UNIT-IV

Bio-Energy Energy from biomass, Sources of biomass, Different species as biomass feedstock, Conversion of biomass into fuels, Energy through fermentation, Pyrolysis, gasification and combustion, Biogas plants, Properties and characteristics of biogas, Biofuel production, Characterization of Biofuel and property analysis. Introduction Advantages and disadvantages of geothermal energy over other energy forms

List of the practical

Practical on production of some renewable energy and techniques.

References:

1. Solar Energy Principles, Thermal Collection &Storage, S.P.Sukhatme: Tata McGraw Hill Pub., NewDelhi.
2. Non-Conventional Energy Sources, G.D.Rai, NewDelhi.
3. Renewable Energy, power for a sustainable future, Godfrey Boyle,2004,
4. The Generation of electricity by wind, E.W.Golding.
7. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009.

8. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
9. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009. (Ch:6)
10. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016. (Ch:2, 4)
11. Solar Cells: From Materials to Device Technology edited by S. K. Sharma, Khuram Ali, Springer (2020)
12. Rational Design of Solar Cells for Efficient Solar Energy Conversion edited by Alagarsamy Pandikumar, Ramasamy Ramaraj, Wiley (2018).
13. Energy fables, Edited by edited by Jenny Rinkinen, Elizabeth Shove, Jacopo Torriti, Routledge a T&F group, (2019).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Continuous Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)
1=weakly mapped 2= moderately mapped
3=strongly mapped

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

AEC101	**Communicative English-I**	**L**	**T**	**P**	**C**
Version 1.0		2	0	1	3
Pre-requisites/Exposure	Basic Knowledge in English Language				
Co-requisites	--				

Course Description
The Communicative English course aims to equip the language learners with the knowledge of comprehension and production of English language. The course is designed to develop the primary aspects of any language learning: listening, speaking, reading, writing, grammar, and vocabulary. The modules indicate the gradual evolvement of the acquisition of English language and communication skills.

Course Outcomes:
CO1. Remembering
Recall key vocabulary and phrases used in everyday communication.
CO2. Understanding
Summarize main ideas from spoken and written texts.
CO3. Applying
Engage in conversations to practice effective communication skills.
CO4. Analyzing
Differentiate between formal and informal communication styles.
CO5. Evaluating
Critique peer presentations for clarity, coherence, and engagement.

Course content

Unit 1

- Listening: practice listening to short conversations and identifying the purpose of communication.
- Speaking: Exchanging greetings, introducing oneself and others, sharing personal and professional information.
- Grammar: parts of speech.
- Reading: Practice reading short passages. Reading words clearly with pause. Answering questions from the passage.
- Writing: Practice writing short meaningful sentences using different forms of tense.

Unit 2

- Listening: practice listening to longer conversations and the theme/s of communication.
- Speaking: describing people, places and objects; comparing people, places and objects.
- Grammar: articles and prepositions

- Vocabulary: synonym and antonyms.
- Reading: Practice reading short passages. Identifying the known and the unknown words. Answering questions from the passage.
- Writing: Practice writing descriptive and comparative sentences.

Unit 3

- Listening: practice listening to jumbled fragmented parts of a text and working together to put the parts coherently.
- Speaking: Narration. Talking about past (immediate and distant)
- Grammar: tense
- Reading: practice reading passages and Answering questions from the passage.
- Writing: practice writing short paragraphs, describing people place objects, narrating events

Unit 4

- Listening: Practice following instructions and directions
- Speaking: practice conversation on the following situations- instruction, suggestion, enquiring, requesting, seeking permission, invitations, apologize and complaints.
- Grammar: verbs. Subject verb agreement. Active and passive voice.
- Reading: practice reading passages and elicit information from the passages by identifying topic so on. Answering questions from the passage.
- Writing: practice replacing the sentences from given passages by new sentences (but no meaning change). Correcting incorrect sentences

Recommended Readings

1. Fluency in English-Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Grammar and Composition, Wren and Martin.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	1	3	-	-	-	-	3	2	3	-	3
CO2	-	1	3	-	-	-	-	3	2	3	-	3
CO3	-	1	3	-	-	-	-	3	2	3	-	3
CO4	-	1	3	-	-	-	-	3	2	3	-	3
CO5	-	1	3	-	-	-	-	3	2	3	-	3
Avg	-	1	3	-	-	-	-	3	2	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC151	**Biomolecules**	L	T	P	C
Version 1.0	**Contact Hours: 60**	2	1	1	4
Pre-requisites/Exposure	Knowledge of Organic Chemistry at 10+2 level				
Co-requisites	-				

Course Objectives

1. To gain a deeper understanding structure of different types of carbohydrates.
2. To acquire the knowledge structures of different types of aminoacids.
3. To acquire the knowledge about the different classes of lipids
4. To gain the knowledge about different types of nucleicacid.
5. To understand the properties of water and its essentiality in biochemistry.

Course Outcomes

On completion of this course, the students will be able to

CO 1: Knowledge: Define the basic of Biomolecules and its role in living systems.

CO 2: Comprehension: Explain how carbohydrates, proteins, lipids, and nucleic acids are synthesized and broken down in living organisms.

CO 3: Applying:- Apply the knowledge of bioenergetics to analyze metabolic pathways involved in energy production.

CO 4: Analyzing: Analyze the structure-function relationships of molecules of life in different biological systems.

CO 5: Synthesis and Evaluation: Generate hypotheses and critically assess on the interplay between different molecules of life in maintaining cellular homeostasis.

Catalog Description

Life is a condition through which living organisms can be differentiated from non-living matters. For example, growth, reproduction are the essential physiological phenomena of living organism. To support those physiological characteristics, some molecules are very much essential, which are considered as “molecules of life”. The learning of the detailed structures of those molecules are necessary for understanding the key of the life. So, the course consists of the structure of carbohydrates (energy source), amino acids (structural unit of protein), water (a major part of protoplasm of the cell), lipids (building block of the cell) and nucleotides (responsible for construction of energy currency and genetic material).

Course Content

Theory (45 h)

Unit I: Carbohydrates

Major elements and minor elements, Structure of atoms, molecules and chemical bonds, Stabilizing interactions, Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates.

Unit II: Lipids

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpho lipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments.

Unit III Amino acids

Structure and classification, physical, chemical and optical properties of amino acids and proteins.

Unit IV Nucleic acids

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Unit V: Water & Enzymes

Safety measures in laboratories and Properties of Water. Preparation of normal and molar solutions, Preparation of Buffer. Qualitative Analysis of Carbohydrates Qualitative Analysis of Proteins. Qualitative Analysis of Lipids. Assay of Alkaline Phosphatase. Nucleic acid Estimation.

List of the practical (15 h)

1. Preparation of buffer and adjusting pH with acid and base
2. Protein quantification: Bradford & Lowry assay
3. Nucleic Acid Quantification: **Spectrophotometric Analysis:** Measuring DNA/RNA/Protein concentration using absorbance at 260/280 nm

4. Enzyme activity: Breakdown of starch by amylase
5. Carbohydrate Analysis: **Benedict's Test:** Detecting reducing sugars

Reference Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., WH Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1- 42923414-8.
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons AsiaPvt. Ltd. (New Jersey), ISBN:978-1180-25024.
3. Biochemistry, LubertStryer, 8th Edition.
4. Organic Chemistry, Vol 1 &2., IL Finar.
5. Chemistry of Nucleic acids,Adams.
6. Organic Chemistry, Nasipuri.
7. Biochemical Calculations, IrwinSegel
8. Introduction to Practical Biochemistry: by Sawhney and Singh Biochemistry (2011) 4ed

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly map

VAC101	**Environmental Education-I**	**L**	**T**	**P**	**C**
Version 1.1	**Contact Hours – 30**	2	0	0	2
Pre-requisites/Exposure			Basic physics, chemistry, biology and mathematics		
Co-requisites			--		

Course Objectives

1. To understand the intrinsic relation between humans and environment, our position in the ecosystem around us
2. To comprehend the significance of the biodiversity surrounding us.
3. To figure out the importance and need for energy resources, various sources of energy, renewable and non-renewable sources, conventional and unconventional sources.
4. To have basic concepts about sustainability, our dependence on nature and the consequences of over exploitation.
5. To enable students to appreciate the importance and how much we owe to the earth systems for our survival.
6. To have a basic concept about the types of pollution and mitigate on procedures.
7. To have an overall idea about the environmental legal framework in our country and about the EIA and environmental and it procedures.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering

Identify key environmental concepts and terminology.

CO2. Understanding

Explain the interrelationships between humans and the environment.

CO3. Applying

Demonstrate sustainable practices in daily life.

CO4. Analyzing

Examine case studies of environmental issues.

CO5. Evaluating

Critique the effectiveness of various environmental policies.

Catalogue Description

To distinguish between various types of ecosystems, ecosystem dynamics ,perceive and appreciate the surrounding nature and feel connected, develop the concept of innate relationship of humans and biodiversity, need for conservation and different conservation strategies. The students will be developed in a way so that they can spontaneously comprehend the importance of studying about the various air pollutants, their significance and impacts, and develop the underlying concepts involved in various air pollution prevention and mitigation measures, understand fundamental water chemistry, deduce the relationship between various water pollutants, and understand the principles of various water and

wastewater treatment procedures.

They will understand the routes ofgeneration,classification,managementandenvironmentalsignificanceofsolidwaste,applythe basic concepts of waste management in their daily lives, understand the need of the 5Rs of waste management, importance of waste minimization.

Detailed syllabus

Unit I:

Multidisciplinary nature of environmental sciences; scope and importance; need for public awareness; concept of sustainability and sustainable development
Forest resources: Function of forests, cause and effects of deforestation, case studies.
Water resources: distribution of water, hydrological cycle, use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies
Food Resources: World food problems and environmental concern, Food security, case studies Energy resources: Concept of energy, SI Units of Work, Heat and Power, World energy use, Energy consumption pattern in India and U.S., Environmental aspects of energy utilization Renewable and non-renewable sources; Fossil fuel: types, use and environmental impacts, Solar energy: Solar Radiation – Passive and active solar systems – Flat Plate and Concentrating Collectors – Solar direct Thermal Application– Fundamentals of Solar Photo Voltaic Conversion-advantages and disadvantages of Solar Power generation, Solar energy status in India; Wind Energy: site selection, Wind turbine: basic working principle and types, Wind energy status in India, advantages and disadvantages of Wind Power generation; Hydroelectric power : How is it generated, advantages and disadvantages; Biomass energy: various types, generations of biofuel, Biogas plants, Bio diesel; Geothermal Energy: source, advantages and disadvantages, Nuclear Power: nuclear fission, moderation of reaction, nuclear reactor: pressurized water reactor, advantages and disadvantages

Unit II: Ecosystems

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Food chains, food webs and ecological pyramids, energy flow, ecological succession

Unit III: Biodiversity and its conservation

LevelsofBiodiversity:genetic,speciesandecosystemdiversity.Biogeographicalclassificationof India, Values of biodiversity, Biodiversity at global, National and local levels, India as a mega- diversity nation, Biodiversity hotspots, Threats to Biodiversity, In-situ and Ex-situ conservation of Biodiversity

Unit – IV: Environmental Pollution and Waste Management

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, marine pollution; case studies. Nuclear hazards and human health risks.
Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes (Hospital Wastes and Hazardous Wastes)Recycling of waste material. Waste minimization technologies. Hazardous Wastes Management and Handling Rules,1989

Unit – V: Global Issues and Environmental Acts

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity(CBD).

Text Books:

1. Principles of Environmental Science, 4th edition by Cunningham, W.P. and Cunningham,

M.A. (2002), Tata McGraw-Hill Publishing Company, New Delhi

2. Basic Environmental Engineering & Elementary Biology by Monidranath Patra and Rahul Kumar Singha, Aryan Publishing house

3. Introduction to Environmental Engineering and Science, by Masters, G.M., Prentice Hall of India, Second IndianReprint.

Reference Books:

1 Wastewater Engineering: Treatment and Reuse, 4th Edition, Metcalf and Eddy, Inc. McGraw- Hill, Inc., New York, 2002

2 Environmental Engineering‖, Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, McGraw-Hill Education (India) Private Limited, New Delhi

3 Introduction to Environmental Engineering, 2nd Ed. by Davis, M. L. and Cornwell D. A. McGraw Hill, Singapore.

4 Environmental Sciences: The Environment and Human Impact by Jackson, A.R.W. and Jackson, J.M., , Longman Publishers

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme: Components	**Continuous Assessment**	**End Term**
Weightage (%)	50	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
Avg	-	1	3	-	-	-	-	3	-	3	3	3

1=weakly mapped

2= moderately mapped

3=strongly ma

SEMESTER II

BIC103	Cell Biology	L	T	P	C
Version 1.0	Contact hours: 60	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge in cell biology				
Co-requisites	-				

Course Objectives

1. To **recall** and **extend** the basic idea of structure and function of prokaryotic and eukaryotic cells
2. To **discuss** detailed perspective of cell including physiological properties, cell composition, growth, metabolic processes, signalling pathways, lifecycle.
3. To **interpret** the applications of different microscopy as tools for understanding cell biology.
4. To **discuss** about cell cycles, cell division and apoptosis
5. To **apply** and **assess** the cell biology in microscopic and molecular level to understand of human health and disease.

Course Outcomes

On completion of this course, the students will be able to

CO1: Remembering: Recall and describe the basic structure and function of the cell, including organelles such as the nucleus, mitochondria, and endoplasmic reticulum.

CO2: Understanding: Explain how cells communicate with each other and how signals are transmitted within and between cells.

CO3: Applying: Apply knowledge of cell biology to analyse and interpret experimental data related to cellular processes such as cell division, protein synthesis, and cell signalling.

CO4: Analysing: Critically evaluate the impact of mutations and dysregulation in cellular processes on human health and disease.

CO5: Evaluating: Assess and compare different models of cell biology and cellular processes, and explain their relevance in understanding biological phenomena.

Catalog Description

This course deals with the biology of cells of higher organisms: The structure, function, and biosynthesis of cellular membranes and organelles; cell growth and oncogenic transformation; transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix, and cell movements; chromatin structure and RNA synthesis.

Course Content

Unit 1: Cell structure and Functions, Cell as basic unit of living organisms-bacterial, fungal, plant and animal cells. Ultrastructure of prokaryotic cell (cell membrane and plasmids, Nucleoid).

Ultrastructure of eukaryotic cell (cell wall, cell membrane, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, vacuoles) Fluid mosaic model, Sandwich model, Cell membrane permeability Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, nucleolus, nucleoplasm, and chromatin). Vacuole, Cytoskeletal structures (Microtubules, Microfilaments and Intermediate filaments). Assembly, organization and movement of cilia and flagella.

Unit 2: Structure of chromosome-morphology, structural Organization - centromere, secondary construction, telomere, chromonema, euchromatin and heterochromatin, components of chromosomes (histones and nonhistone), specialized chromosomes (Polytene, Lamp brush), Chromosomal aberrations- structural and numerical chemical composition and karyotype. Ultrastructure: Single-stranded hypotheses, folded-fibre and nucleosome models.
Unit 3: Cell cycle. Bacterial cell division. Eukaryotic cell cycle –phases. Mitosis - Stages (spindle assembly)-significance. Meiosis- Stages (synaptonemal complex)-significance. Senescence and necrosis. Apoptosis.

Unit 4: Protein trafficking. Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins

Unit 5: Microscopic observation of cells: bacteria, fungi, plant and animal. Preparation of different stages of Mitosis (onion root tips) Preparation of different stages of Meiosis (grasshopper testis) Preparation of Polytene chromosome from Drosophila salivary gland. Demonstration of Plasmolysis. Demonstration of Osmosis.

Reference Books

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASMPress& Sunderland (Washington DC), SinauerAssociates, MA, ISBN:978-0- 87893-300-6.

2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10:1-4641-0981-8.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped 3=strongly mapped

MIB104	Bacteriology and Virology	L	T	P	C
Version 1.0	Contact hours: 60	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge in biology				
Co-requisites	-				

Course Objective

This course aims to provide a comprehensive understanding of bacteriology and virology, focusing on the structure, function, genetics, and pathogenicity of bacteria and viruses. The course will cover both theoretical concepts and practical techniques, aligning with the National Education Policy (NEP) goals of fostering critical thinking, interdisciplinary learning, and application-based education.

Course Outcomes:

On successful completion of this course, students will be able to

CO1. Remembering
List major bacterial and viral pathogens and their characteristics.
CO2. Understanding
Describe the mechanisms of bacterial and viral infection.
CO3. Applying
Demonstrate laboratory techniques for isolating and identifying microorganisms.
CO4. Analyzing
Compare the structures and functions of bacteria and viruses.
CO5. Evaluating
Assess the effectiveness of various antimicrobial treatments and vaccines.

COURSE CONTENT

Unit I: Fundamentals of Bacteriology

Overview of Microbial Life: Bacteria vs. Archaea, Bacterial Cell Structure and Function, Bacterial Growth, Reproduction, and Metabolism, Differentiate between bacterial and archaeal cells. Describe bacterial cell structures and their functions. Understand bacterial metabolic pathways and growth patterns.

Unit II: Bacterial Genetics and Pathogenesis

Bacterial Genome Structure and Gene Expression, Horizontal Gene Transfer: Conjugation, Transformation, Transduction, Mechanisms of Bacterial Pathogenicity, Host-Pathogen Interactions

Unit III: Fundamentals of Virology:

Structure and Classification of Viruses: Viral Life Cycles: Lytic vs. Lysogenic; Virus-Host Interactions; Viral Pathogenesis: Mechanisms and Outcomes

Unit IV: Viral Genetics and Evolution

Organization of Viral Genomes: Mutation, Recombination, and Evolution in Viruses; Emerging and Re-emerging Viral Diseases; Case Studies: Influenza, HIV, SARS-CoV-2

UnitV: Immunology and Control of Microbial Infections

Immune System Responses to Bacterial and Viral Infections; Vaccines: Development, Types, and Mechanisms;

Antibiotics and Antiviral Drugs: Mechanisms and Resistance; Public Health Strategies for Controlling Infectious Diseases

List of Practicals

1. Bacterial Culture Techniques
2. Microscopy
3. Bacterial Growth Curve Analysis
4. Antibiotic Susceptibility Testing (Kirby-Bauer Method)
5. Plaque Assay for Virus Quantification
6. Case Study Analysis: Emerging Infectious Diseases

Recommended Readings

Books

Tortora, G. J., Funke, B. R., & Case, C. L. (2018). Microbiology: An Introduction (13th ed.). Pearson.
Madigan, M. T., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2020). Brock Biology of Microorganisms (16th ed.). Pearson.
Flint, J., Racaniello, V. R., Rall, G. F., &Hatziioannou, T. (2020). Principles of Virology (5th ed.). ASM Press.

Other References

Brooks, G. F., Carroll, K. C., Butel, J. S., & Morse, S. A. (2019). Jawetz, Melnick, & Adelberg's Medical Microbiology (28th ed.). McGraw-Hill Education

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

MIB106	Microbes for Sustainable Development	L	T	P	C
Version 1.0	Contact hours: 60	2	0	1	3
Pre-requisites/Exposure	Basic Knowledge in biology				
Co-requisites	-				

Course Objective

This Multi-Disciplinary Course (MDC) examines the critical roles that microbes play in promoting sustainable development. The course covers microbial applications in environmental conservation, agriculture, waste management, and renewable energy production. It aligns with the National Education Policy (NEP) by integrating interdisciplinary knowledge, fostering critical thinking, and emphasizing hands-on practical experiences that address real-world challenges.

Course Outcomes:

On successful completion of this course, students will be able to

CO1. Remembering
Identify key microbes that contribute to sustainable development.
CO2. Understanding
Explain the role of microbes in nutrient cycling and ecosystem health.
CO3. Applying
Utilize microbial techniques for bioremediation and waste management.
CO4. Analyzing
Evaluate the impact of microbial processes on sustainable agriculture practices.
CO5. Evaluating
Critique various microbial applications in renewable energy production.

COURSE CONTENT

Unit 1: Microbial Diversity and Ecology in Sustainable Development

Microbial Diversity and Classification, Microbial Ecology and Ecosystem Functions, Role of Microbes in Supporting Ecosystem Services, Sustainable Development Goals (SDGs) and Microbial Contributions

Unit 2: Microbes in Waste Management and Pollution Control

Biodegradation of Organic and Inorganic Pollutants, Microbial Bioremediation Strategies, Wastewater Treatment and Microbial Consortia, Microbial Fuel Cells for Converting Waste to Energy

Unit 3: Microbes in Sustainable Agriculture

Soil Microbiology and Nutrient Cycling, Plant-Microbe Interactions: Rhizosphere and Endophytes, Biofertilizers and Biopesticides, Microbial Applications in Organic Farming and Composting

Unit 4: Microbes in Renewable Energy Production

Microbial Production of Biofuels: Biogas, Bioethanol, Biodiesel, Algal Biomass Production for Bioenergy, Microbial Fuel Cells and Hydrogen Production, Emerging Technologies in Microbial Energy Production

Unit 5: Microbes in Environmental Conservation and Climate Change Mitigation
Microbial Roles in Carbon Sequestration and Nitrogen Cycling, Climate Change Mitigation through Microbial Technologies, Microbes in Biodiversity Conservation

List of Practical

Isolation and Characterization of Soil Microbes

1. Microbial Bioremediation of Pollutants
2. Wastewater Treatment Using Microbial Consortia
3. Microbial Fuel Cells: Electricity Generation from Organic Waste
4. Case Study Analysis: Microbes for Sustainable Development

Recommended Readings
Books
Bertrand, J. C., Caumette, P., Lebaron, P., Matheron, R., Normand, P., & Sime-Ngando, T. (2015). Environmental Microbiology: Fundamentals and Applications (2nd ed.). Springer.

Arora, P. K. (2021). Microbes and Sustainable Agriculture (1st ed.). Springer.

Other References
Singh, H. (Ed.). (2017). Microbial Biotechnology: Applications in Agriculture and Environment (1st ed.). CAB International.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

1=weakly mapped
2= moderately mapped 3=strongly mapped

SEC144	**FORENSIC BIOLOGY**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 45**	1	0	1	2
Pre-requisites/Exposure	UNDERSTANDING OF BASIC BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide students the basic understanding of forensic biology.
2. It will also provide in depth knowledge of forensic science.
3. Elaborating biophysical and biochemical techniques for forensics.
4. General overview of forensic genetics and advanced DNA forensics.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering
Identify key biological concepts and terminology relevant to forensic science.
CO2. Understanding
Describe the biological processes involved in DNA extraction and analysis.
CO3. Applying
Conduct laboratory techniques for analyzing biological evidence (e.g., blood, hair, tissue).
CO4. Analyzing
Interpret forensic data to determine its significance in a case investigation.
CO5. Evaluating
Assess the reliability of various forensic biological methods and their applications in court

Catalog Description

The core-course of 'forensic biology' will help to understand the fundamental components of forensic biology. This course is a step-by-step journey from the basic to modern concepts of forensic biology. Furthermore, students will be able to summaries tools and techniques of forensic biology. They will be able to outline the forensic genetics and advanced DNA forensics.

Course Content

Theory (45 h)

I) **ELEMENTARY FORENSIC SCIENCE**: Definition of Forensic Science, The Role of the Forensic Laboratory, History and Development of Forensic Science in India & Abroad, Pioneers in Forensic Science, Multidisciplinary nature, Forensic Technology solving crimes with advanced technology, Forensic intelligence and Interviews. Administration and Organizational Setup: DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB, NICFS, CDTS, NCRB, BPR&D, Qualifications and duties of Forensic Scientists Academic centres of education and research: Indian and

Academy of Forensic Science, American Board of Forensic Odontology, Interpol and FBI, Australian Academy of Forensic Sciences.

II) **GENERAL FORENSIC TOOLS AND TECHNIQUES**: Meaning and Terminology of Instrumentation; Definition, Need of Instrumentation in Forensic Science, Qualitative and quantitative methods of analysis, Destructive and Non-Destructive Methods. Centrifugation Techniques, Basic principles of sedimentation. Theory and basic principles, setup and Forensic applications of Compound, Comparison, Fluorescence, Polarized, Stereo-zoom microscope. Electron Microscopy- Theory and basic principles of Electron Microscopy. Introductory Chromatography: Definition, Chromatographic Techniques, History of Chromatography, Theoretical principles of Chromatography. Forensic Toxicology, Serology & Microbiology.

III) **FORENSIC GENETICS**: Concepts of Human Genetics; DNA Profiling: Introduction, History of DNA Typing, molecular biology of DNA, variations, polymorphism, SNPs.

IV) **ADVANCED DNA FORENSICS:**

DNA Extraction-Organic and Inorganic extraction, Comparison of Extraction methods, Commercial kits DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, YSTR, Mitochondrial DNA, Ancient DNA typing, Evaluation of results. Forensic Significance of DNA profiling, New and future technologies: DNA chips, SNPs and limitations of DNA profiling.

List of the practical (15 h)

1. To prepare gel plates for electrophoresis.
2. Organic extraction of DNA from blood.
3. Extraction of DNA from other body fluids and tissues.
4. Quantitation and purity check of Nucleic Acids
5. PCR for DNA samples.

Textbook:

1. Forensic Biology By Richard Li. 2nd Edition,CRC Press. Taylor & Francis Group.
2. Essential Forensic Biology, 3rd edition. Alan Gunn. ISBN: 978-1-119-14140-2.WILEY.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

VAC105	Community Engagement and Social Responsibilities	L	T	P	C
Version 1.0	**Contact Hours: 60**	1	0	1	2
Pre-requisites/Exposure	Knowledge of Environment and Ecosystem at 10+2 level				
Co-requisites	-				

Course Objectives

2.To gain a deeper understanding of community, social structure, social needs, ecological balance.

2. To acquire the knowledge of different community and their responsibilities for society development.

3. To acquire the knowledge about the importance of communication between communities and social work.

4. To gain the knowledge about social responsibilities and its importance.

5. To understand the need of social help (by human activities) for the benefit of entire lining beings (Human, animals, plants).

Course Outcomes

CO1. Remembering
Define key concepts related to community engagement and social responsibility.
CO2. Understanding
Explain the importance of community involvement in addressing social issues.
CO3. Applying
Participate in a community service project to apply learned principles.
CO4. Analyzing
Examine case studies of successful community engagement initiatives.
CO5. Evaluating
Assess the impact of various social responsibility programs on local communities.

Catalog Description

Social services can be both communal and individually based. This means that they may be implemented to provide assistance to the community broadly, such as economic support for unemployed citizens, environmental support (plantation), helping animals/birds to maintain ecological balance. This course also focus on specific need of an individual to support overall community and welfare. Ecological balance is also an important topic that is required to support via various human activities. Classes will also be conducted focusing on community health workers that promote wellness by helping people adopt healthy behaviors. Various new ideas from young minds will always be encouraged that are related to any king of healthy community service and that could be utilized for overall welfare to the society that ensures social security and social support.

Course Content

Unit I: Introduction **[12Lecture hours]**

Introduction to Community Service, social structure, group, community /social work. Understanding the process of Urbanization-Urban Social Problems-Slums, Types of Slums-Urban Poor-Understanding Urban Power Structure and identifying the resources of the

community (Community Mapping) and Modules for the community Service.

UnitII: Community & Groups [12 Lecture hours]

Identifying groups in the community such as women-children-youth-elders and persons with disabilities-Equipping with the skills to address issues such as Education, health, sanitation, Environment & livelihood issues. Special needs for environmental support, importance of plantation.

Unit III Community program

[12 Lecture hours]

Community Program Planning: Orientation on community program – Event process (Identifying the issues, Need based analysis on specific issues, Invitation, Pamphlets, Inviting participants, Content designing, identifying & Selection of tools, venue arrangements, tapping the resources and etc). Awareness / advocacy for an issue identified and build capacity to carry out that awareness and advocacy program. Importance of groupwise program for various types of community service for social /environmental support.

Unit IV Social Support [12 Lecture hours]

Importance of social support along with ecological balance, ecological balance, helping animals/birds. Relation between social support and social security, social help, social needs for specific animal species (like building nests for small birds). Campaign against alcoholism and substance addiction – Pros and cons of Social Media specially for young adults.

UnitV: Community Learning (Education) & social Help

[12 Lecture hours]

Importance of Education, Child rights ,Special Coaching (Easy English to all), Basic computer skill, Communication skill, Understanding various Govt. schemes related to urban poor - Creating livelihood opportunities – Basic App (in mobile). Rights of Women, children and others – marketing - Entrepreneurial skills & Schemes - Creating livelihood opportunities – Access to digital money (ATM, E-corner etc.,)

Reference Books

6. Community Service. by Frank Leroy Blanchard. Kessinger Pub. ISBN-10 : 1120180120, 2015
7. Managing Community Health Services by Allen Mc Naught.
8. In Quest of Humane Development. By B. Dasgupta et.al.
9. Practicing Social Work in Deprived Comminities (Springer) by Ana Opacic.
10. Service Learning Through Community Engagement by Lori Gardinier

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
Avg	-	1	3	-	-	-	-	3	-	3	3	3

1=weakly mapped
2= moderately mapped 3=strongly mapped

AEC102	Communicative English II	L	T	P	C
Version1.0		2	1	0	3
Pre-requisites/Exposure	Basic Knowledge in English Language				
Co-requisites	-				

Course Description
This course is the continuation of the Communicative English I course, which is offered in semester I. In this course, the learners will have repeated practice of what they have already acquired in the last course and will simultaneously develop news skills. The writing section of this course particularly focuses on academic writing and professional writing. The course intends to develop critical thinking ability of learners through various speaking tasks.

Course Outcomes:
CO1. Remembering
Recall key vocabulary and phrases used in everyday communication.
CO2. Understanding
Summarize main ideas from spoken and written texts.
CO3. Applying
Engage in conversations to practice effective communication skills.
CO4. Analyzing
Differentiate between formal and informal communication styles.
CO5. Evaluating
Critique peer presentations for clarity, coherence, and engagement.

Course content

Unit 1

- Listening: Practice listening to passages. practicing summarizing listening passages. Reading: practice reading and solving sample passages
- Speaking: Describing concepts and thoughts
- Grammar: practice tense practice types of sentences (declarative, negation, questions, active and passive voice)
- Writing: practice paraphrasing paragraphs from reading passages

Unit 2

- Speaking: asking for and giving opinion, agreeing and disagreeing with opinions, persuading and dissuading people. Describing concepts and thoughts
- Vocabulary: idioms
- Reading: practice reading and solving sample passages
- Writing: practice types of letter writing.

Unit 3

- Listening: Listen to passages and Speaking: expressing likes, dislikes, sympathy, emotions,

hopes, wishes, regrets, and concerns. practice solving questions of listening passages

- Speaking: expressing likes, dislikes, sympathy, emotions, hopes, wishes, regrets, and concerns
- Grammar: practice different forms of conjunctions, disjunctions, and articles.
- Writing: practice report writing and other professional writing styles

Unit 4

- Listening: practice collaborative discussion of those passages
- Speaking: explaining words and actions with reasons.
- Writing: practice sessions on sample academic writing

Recommended Readings

4. Fluency in English-Part II, Oxford University Press, 2006.
5. Business English, Pearson, 2008.
6. Grammar and Composition, Wren and Martin.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	1	3	-	-	-	-	3	2	3	-	3
CO2	-	1	3	-	-	-	-	3	2	3	-	3
CO3	-	1	3	-	-	-	-	3	2	3	-	3
CO4	-	1	3	-	-	-	-	3	2	3	-	3
CO5	-	1	3	-	-	-	-	3	2	3	-	3
Avg	-	1	3	-	-	-	-	3	2	3	-	3

1=weakly mapped
2= moderately mapped 3=strongly mapped

MIB152	Elementary Cell Science	L	T	P	C
Version1.0	Contact Hours -60	2	1	1	4
Pre-requisites/Exposure	12^{th} level Biology				
Co-requisites	--				

Course Objectives:

1. To correlate between the cellular organization and function
2. To categorize different ways of protein sorting and transport across membranes
3. To describe and illustrate cell signalling mechanisms
4. To investigate cell cycle, cell death, and cell renewal

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering

Identify the basic structures and functions of plant and animal cells.

CO2. Understanding

Explain the processes of cell division, including mitosis and meiosis.

CO3. Applying

Demonstrate the use of a microscope to observe cell structures.

CO4. Analyzing

Compare the differences between prokaryotic and eukaryotic cells.

CO5. Evaluating

Assess the effects of environmental factors on cell health and function.

Catalogue Description:

Cell biology is the study of eukaryotic cells. This course covers various aspects of structure and functions of cells and cellular processes such as cell division, cell transport, signalling, cell senescence among others.

Course Content: Theory (45 h)

Unit 1: Basics of Cell Biology (structure &

Discovery of cell and Cell theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome and microbodies; Ribosome; Centriole; Nucleus; Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Structure and organization of actin filaments, association of actin filaments with plasma membrane, inter mediate filaments, microtubules

Unit 2: Nucleus

Nuclear envelope, nuclear pore complex and nuclear Lamin; Chromatin – Molecular organization Nucleolus
Cytochemical staining of DNA – Feulgen, Identification and observation of mitochondria in human cheek epithelial cells using vital stain Jenus Green B and Methylene Blue

Unit 3: Protein Sorting and Transport

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

Unit 4: Cell Signaling

Signaling molecules and their receptors; Function of cell surface receptors; Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway

Unit 5: Cell cycle – An overview of cell cycle; Components of cell cycle control system

Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant. Mitosis and Meiosis; Development of cancer, causes and types Stem cells, embryonic stem cells, induced pluripotent stem cells

List of the practical (15 h)

1. Handling of compound microscope
2. Microscopic observation of animal cells and plant cells
   a. Human Buccal epithelial cells
   b. Human blood cells
   c. Onion epidermal cells
   d. Balsam leaf epidermal cell
3. Observation and Identification of different stages of Mitosis and Meiosis using root tip and flower bud of onion

Text Books

T1. AlbertsB.Bray D,HopkinK, JohnsonA,LewisJ,Raff M,RobertsK, Walter P(2013).Essential cell biology, 4th edition,Taylor&Francis

Reference Books

R1. HardinJ, Bertoni Gand KleinsmithLJ.(2010).Becker'sworldofthecell,8thedition,Pearson
R2. KarpG.(2010)CellandMolecularBiology:ConceptsandExperiments.6thedition,JohnWiley

Modes of Examination: Assignment/Quiz/Project/Presentation/Written
Exam Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

SEMESTER III

BIC201	Microbial Metabolism	L	T	P	C
	Contact Hours - 60	2	1	1	4
Pre-requisites/Exposure	PLUS, TWO (12th) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. Developing knowledge of microbial growth
2. To have general perception of microbial metabolism
3. To analyze roles of nutrients as carbon and nitrogen source and utilization
4. To identify photosynthesis and ETC as basis of energy metabolism
5.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering

Identify key metabolic pathways utilized by microorganisms.

CO2. Understanding

Describe the role of enzymes in microbial metabolic processes.

CO3. Applying

Illustrate the steps of glycolysis and fermentation in microbial metabolism.

CO4. Analyzing

Examine the differences between aerobic and anaerobic respiration in microbes.

CO5. Evaluating

Critique the impact of metabolic inhibitors on microbial growth.

Catalogue Description

The core-course of 'Microbial Physiology and Metabolism' will help to understand the basic concept and application of microbial growth and metabolism. This course includes comprehensive approach through studying impact of conditions on growth and metabolism. Furthermore, students will be able to classify based on nutritional parameters and elaborate energy metabolism. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Contents
Theory (45 h)

Unit 1: Microbial growth, Nutrient uptake and transport in microbial metabolism

Microbial growth stages, generation time, specific growth rate, effect of temperature, pH and salt on microbial growth, Passive and facilitated diffusion, Active transport, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake

Unit 2: Chemoheterotrophic Metabolism - Aerobic Respiration

Concept of aerobic respiration, Sugar degradation pathways, i.e., EMP, ED, Pentose phosphate pathway TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors.

Unit 3: Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 4: Chemolithotrophic and Phototrophic Metabolism

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria

Unit 5: Nitrogen and Amino acid metabolism- An overview

Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction,

Lab (15 h):
List of the practical

1. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E. coli*
6. Effect of salt on growth of *E. coli*
7. Growth of anaerobic bacteria and its characterization

8. Enrichment of phototrophic bacteria from natural sources

Experiential learning:

1. Consulting recent articles on microbial metabolism
2. Problem (numerical) solving
3. Video lectures:

SUGGESTED READING

Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons

Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India

Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written
Exam Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

)

Relationship between the Course Outcomes (COs) and Program Outcomes (POs

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

BIC202	BASICS OF PLANT AND ANIMAL SCIENCES	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	BOTANY BASIC FROM CLASS XII				
Co-requisites	--				

Course Objectives

1. To provide students the basic understanding of plant cell structure with emphasis to plant physiology.
2. To provide wholesome knowledge on plant specific biochemical pathways like photosynthesis and nitrogen metabolism.
3. Elaborating roles of phytohormones and secondary metabolites in growth and development of plants.
4. General overview of plant tissue culture.

Course Outcomes

On completion of this course, the students will be able to

CO 1. Remembering

List the major groups of plants and animals, including their characteristics.

CO 2. Understanding

Explain the basic life processes of plants and animals, such as photosynthesis and respiration.

CO 3. Applying

Demonstrate the use of classification systems to categorize different species.

CO 4. Analyzing

Compare the structure and function of plant and animal cells.

CO 5. Evaluating

Assess the impact of environmental changes on plant and animal populations.

Catalog Description

The core-course of 'Basics of Plant Sciences' is discipline specific elective subject which deals with the modern aspects of plant physiology and biochemistry. This course deals with plant cellular structure with emphasis to special organelles related to plant cells. It also includes topics related to plant specific biochemical pathways like photosynthesis, respiration and nitrogen fixation. Furthermore, it deals with the roles of phyto-hormones and secondary metabolites in plant growth and development. It also encompasses the very important industrially important plant tissue culture technique. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Basics of Plant and Animal Sciences

UNIT 1. Introduction to plant kingdom. Introduction to Plant cell structure: Plasma membrane, Vacuole and tonoplast membrane, cell wall, mitochondria, plastids and peroxisomes. Photosynthesis and Carbon assimilation: Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Respiration.

UNIT 2. Nitrogen metabolism, Introduction to plant hormones and their effect on plant growth and development. Secondary metabolites representative examples from each class, biological functions. Plant tissue culture: Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

UNIT 3:

Outline of classification of non-chordates and chordates up to sub classes and general features of all the major phyla. Special topics on non-chordates and chordates (Water Canal system in Porifera & Water Vascular system in Starfish, Parental care in Fish, Neoteny and Paedogenesis, Flight adaptations in birds, Dentition in mammals).

UNIT 4:

Digestive System: Functions of digestive organs, Modes of mechanical digestion, Chemical digestion (hormones, enzymes, pH), Absorption and elimination, Name parts of GI Tract and accessory organs, Nutrition and metabolism (production of ATP). Excretory System: Functions of urinary system, Kidney, ureter, bladder, urethra, Microanatomy and function of nephron, Formation of urine-steps involved.

Respiratory System: General structure of respiratory system and functions- Lungs and Trachea, Respiratory Pathways, Functional aspects and mechanics of respiration. Nervous System: Functions of nervous system, Organization of the Nervous System - Structural Classification, Functional Classification, and Nervous Tissue: Structure and Function –

UNIT 5:

Basics of Plant and Animal Sciences Applications: **Analyse**, appraise and discuss the topic with different tools and techniques.

List of practical:

1. Identification and Classification of the following:

Non-chordate specimens: Scypha, Obelia, Sea-anaemone, Ascaris, Hirudinaria, Scorpion, Bombyx mori, Acatina, Loligo, Starfish, Balanoglossus.

Chordate specimens: Branchiostoma, Petromyzon, Scolidon, Lates, Axolotl larva, Tylototriton, Gekko; Hemidactylus, Turtle, Naja, Chiroptera.

Plant speciments.

2. Visit to any national park/museum/zoological garden and prepare an ecological Note.
3. Identification of Different mammalian tissue sections of digestive system, excretory system and respiratory system.
4. Study of seed germination and plant pigments.

SUGGESTED READING:

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

Textbooks:

(1) Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5

[2] Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole.

[3] Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

[3] Charles E. Tobin, Basic Human Anatomy, McGraw Hill Publication.

[4] J. H. Green An Introduction to Human Physiology.

REFFERNCE BOOKS:

2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.

3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIT206	Introduction to Biomaterials	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	0	1	3
Pre-requisites/Exposure	Basic knowledge of Biology				
Co-requisites	--				

Course Objectives

1. Understand common use of biomaterials as metals, ceramics and polymers and its chemical structure, properties, and morphology.
2. Understand and account for methods for categorization of biomaterials.
3. Explain methods to modify surfaces of biomaterials and choose material for desired biological response.
4. Describe interactions between biomaterials, proteins and cells.
5. Understand the interaction between biomaterial and tissue for short term and long term implantations, distinguish between reactions in blood and in tissue.
6. Explain the types of material used to replace different organs & tissues of human body.

Course Outcomes

On completion of this course,

CO1. Remembering

Identify different types of biomaterials and their common applications.

CO 2. Understanding

Describe the properties and functions of various biomaterials used in medical devices.

CO 3. Applying

Demonstrate the selection of appropriate biomaterials for specific biomedical applications.

CO 4. Analyzing

Examine the interactions between biomaterials and biological tissues.

CO 5. Evaluating

Assess the performance and biocompatibility of various biomaterials in clinical settings.

Catalogue Description

The purpose of this course is to acquaint each student with the field of material Science and the bio materials that are used in medical devices or in contact with biological systems. The effectiveness of the technology depends on the behaviour of the Bio materials and the Medical devices.

Course Content

Unit-1 Properties of Materials Bulk properties and Surface properties of Materials Characterization methods of surface properties of Biomaterials Materials Used In Medicine: Metals; Polymers; Hydrogels; Bioresorbable and Biodegradable Materials.

Unit-2 Materials Used in Medicine Fabrics

Biologically Functional Materials; Ceramics; Natural materials; Composites, thin films, grafts and coatings; Pyrolytic Carbon for long-term medical Implants; Porous materials; Nano biomaterials.

Unit-3 Host Reactions to Biomaterials Inflammation

Wound healing and the Foreign body response; Systemic toxicity and Hypersensitivity; Blood

coagulation and Blood-materials Interactions; Tumorigenesis. Degradation of Materials in Biological Environment: Degradation of Polymers, Metals and Ceramics.

Unit-4 Application of Biomaterials
Cardiovascular Applications; Dental implants; Adhesives and Sealants; Opthalmologic Applications; Orthopedic Applications; Drug Delivery System; Sutures; Bioelectrodes; Biomedical Sensors and Biosensors.

List of Experiments: (Outlines)
1. Extraction of biopolymers from natural origins
2. Fabrication of 2D/3D biomaterials
3. Characterization of biomaterials: morphology, stability, solubility, degradibility.

Course Materials:
Required Text: Textbooks
1. Schoen, F. J., Ratner, B. D., Hoffman, A. S., Lemons, J. E. (2004). Biomaterials Science: An Introduction to Materials in Medicine. Netherlands: Elsevier Science.
2. Hench, L. L., Ethridge, E. C. (1982). Biomaterials: an interfacial approach. United Kingdom: Academic Press.

Optional Materials: Reference Books
1. Bronzino, J. D. (2000). The Biomedical Engineering Handbook. Germany: CRC Press.

Experiential learning:

1. Flip classes
2. Presentation on relevant topics
3. Attending seminars and research talks

Extra credit in offer:

NPTEL course: Introduction to Biomaterials (https://nptel.ac.in/courses/113104009)
Or a relevant one (up on due approval)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

SEC144	Clinical Biochemistry	L	T	P	C
Version 1.0	Contact Hours - 30	1	0	1	2
Pre-requisites/Exposure	BSc. Level Biochemistry Knowledge				
Co-requisites	--				

To provide students basic idea about instrumentation and automation in clinical biochemistry laboratories safety regulations. It will also provide in depth knowledge about different biochemical reactions that are used to determine different disease parameters. Outlining the types of specimens for biochemical analysis. To provide students different parameters like precision, accuracy, quality control, precautions and limitations that are used in clinical biochemistry.

Course Outcomes

CO1. Remembering
Identify key biochemical markers used in clinical diagnosis.
CO2. Understanding
Explain the metabolic pathways relevant to human health and disease.
CO3. Applying
Interpret laboratory results to assess patient biochemical status.
CO4. Analyzing
Analyze the relationship between biochemical imbalances and specific diseases.
CO5. Evaluating
Evaluate the effectiveness of various biochemical tests in diagnosing medical conditions.

Catalog Description

The core-course of 'Clinical Biochemistry' will help to understand the basic idea about instrumentation and automation in clinical biochemistry. This course includes comprehensive approach through studying different biochemical reactions that are used to determine different disease parameters. Furthermore, the implication of precision, accuracy, quality control, precautions and limitations in different test results will also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Theory (45 h)

Unit I: Fundamentals of Diagnostic Biochemistry: Organization of clinical laboratory, Introduction to instrumentation and automation, validation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimens for biochemical analysis. Linearity, specificity, sensitivity, coefficient of variation (CV), Precision, accuracy, quality control, Westgard rules, systematic and random error, Calibration, standards, and reference ranges, RCA, CAPA, precautions and limitations, IQC, EQAS, concept of NABL,

Unit II: Biochemical Markers of Organ Function: Liver Function Tests: Enzymes: ALT, AST, ALP, GGT, LDH Bilirubin metabolism, Estimation of bilirubin (direct and indirect), Clinical interpretation of liver function tests. Kidney Function Tests: Urea, creatinine, and electrolytes, Glomerular filtration rate (GFR), Proteinuria and microalbuminuria, Use of urine strip / dipstick method for urine analysis. Pancreatic Function Tests: Amylase and lipase, Glucose metabolism and insulin function, Diagnostic tests for diabetes

Unit III: Cardiovascular and Lipid Profiles: Lipid Profile and Cardiovascular Risk, Cholesterol: total, HDL, LDL, triglycerides, Apolipoproteins and lipoprotein(a), Risk assessment for cardiovascular diseases. Cardiac Biomarkers: troponins, CK-MB, Isoenzymes of CK, BNP, NT-proBNP

Unit IV: Endocrine and Metabolic Disorders: Thyroid Function Tests, TSH, free T3, free T4, Interpretation in thyroid disorders, Adrenal and Pituitary Function Tests, Bone and Mineral Metabolism: Calcium, phosphate, magnesium, Vitamin D, parathyroid hormone

List of the practical (15 h)

1. Collection of blood and storage
2. Separation and storage of serum
3. Analysis of Cell Morphology
4. Estimation of uric acid
5. Urine benedict test
6. Microscopic observation of urine components
7. LDL & HDL estimation
8. Estimation of blood glucose by glucose oxidase peroxidase method
9. Estimation of triglycerides
10. Estimation of bilirubin (direct and indirect).
11. Assessment of hypertension by blood pressure measurement

SUGGESTED READINGS

Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol.I(2010),Mukherjee,K.L.,TataMcGraw–HillPublishingCompanyLimited (New Delhi). ISBN:9780070076594 / ISBN:9780070076631

Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests VoI.II(2010),Mukherjee,K.L.,TataMcGraw–HillPublishingCompanyLtd.(New Delhi), ISBN:9780070076648.

Medical Biochemistry (2005) 2nded., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia),ISBN:0-7234-3341-0.

Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi),ISBN:81-88237-41-8.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Continuous Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped 2= moderately mapped 3=strongly maped

Course Id	VAC102
Course Title	Human Values and Ethics
Credits	2
Contact Hours (L-T-P)	2-0-0

Course Objective

To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. To achieve sustainable development goals by fostering a sense of responsibility and awareness among students about the impact of their actions on the world around them.

Course Outcomes:

On successful completion of this course, students will be able to

CO1. Remembering
Define key concepts and terminology related to human values and ethics.
CO 2. Understanding
Describe various ethical theories and their implications in real-life situations.
CO 3. Applying
Demonstrate ethical decision-making in hypothetical scenarios.
CO 4. Analyzing
Examine case studies to identify ethical dilemmas and the values at play.
CO 5. Evaluating
Critique the ethical implications of policies or actions in a societal context.

COURSE CONTENT

Unit I Value Education, Love, Compassion and Truth

Understanding value education. Love and its forms: love for self, parents, family, friend, spouse, community, nation, humanity and other beings—living and non-living. Affect theory
Love and compassion and inter-relatedness**:** relationship between love and compassion and other related feelings and emotions like empathy, sympathy, and non-violence. Value education to achieve SDGs.
Individuals who are remembered in history or collective memory for practicing compassion and love: (such as the Buddha, and Jesus Christ)

What is truth? A Universal truth, truth as value (a*rtha*), truth as fact (*satya*) (veracity, sincerity, honesty among others)
Individuals who are remembered in history for practising this value (Raja Harishchandra, Dharmaraja Yudhishthira, Gautama Buddha, Socrates, and Mahatma Gandhi, among others)

Unit II Non-Violence, Righteousness and Peace

Non-violence and its need. *Ahimsa* is non-violence and non-killing. Individuals and organizations that are known for their commitment to non-violence.
What is righteousness? Righteousness and *dharma*, righteousness and propriety. Individuals who are remembered in history for practising righteousness.
What is peace and its need? Peace, harmony and balance. Individuals and organizations that are known for their commitment to peace (Mahatma Gandhi, United Nations).

Unit III Harmony in the Family and Society

Harmony in the human being. Understanding harmony in the self.

Family: Meaning and constitution. Importance of family relationships. Characteristics of a strong family. Build strong family relationships

Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence; The meaning of Respect; Difference between respect and differentiation; the other salient values in relationship.

Meaning of Society. Social roles — Meaning and various types. Individual as a Social Being. Responsibilities as Social Being. Role conflict versus role strain. Harmony in the society (society being an extension of family; Visualizing a universal harmonious order in society - from family to world family

Unit IV: Love and Sensitivity for Nature and Environment

The harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space

Unit V: Ethics and Integrity

Ethics and its importance. Ethical decision making. Personal and professional moral codes of conduct. Competence in professional ethics. Ethical human conduct. Strategies for Transition towards Value-based Life and Profession. Creating a harmonious life.

What makes an individual great? Understanding the persona of a leader for deriving holistic inspiration.

Recommended Readings

Books

1. R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019.

Other References

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow.
2. A.N. Tripathy, 2003, Human Values, New Age International Publishers.
3. PL Dhar, RR Gaur, Science and Humanism, Commonwealth Purblishers.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	2	-	-	-	2	-	3	1	3	3	3
CO2	-	2	-	-	-	2	-	3	1	3	3	3
CO3	-	2	-	-	-	2	-	3	1	3	3	3
CO4	-	2	-	-	-	2	-	3	1	3	3	3
CO5	-	2	-	-	-	2	-	3	1	3	3	3
Avg	-	2	-	-	-	2	-	3	1	3	3	3

1=weakly mapped 2= moderately mapped 3=strongly maped

PDC201	Professional Development Course-I (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	--				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course learning outcomes:

CO1. Remembering
Identify key concepts and principles of professional development.
CO 2. Understanding
Explain the importance of lifelong learning and continuous improvement in a professional context.
CO 3. Applying
Utilize effective communication strategies in professional interactions.
CO 4. Analyzing
Assess personal strengths and weaknesses to create a targeted development plan.
CO 5. Evaluating
Critique case studies of successful professional development initiatives.

Course Contents:
The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

1=weakly mapped 2= moderately mapped 3=strongly mapped

SEMESTER-IV

BIC203	Advanced Microbiology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	12th level Biology				
Co-requisites	--				

Course Objectives:

CO1. Remembering
Recall key microbial organisms and their classification.
CO 2. Understanding
Explain advanced concepts in microbial physiology and genetics.
CO 3. Applying
Implement laboratory techniques for isolating and characterizing microorganisms.
CO 4. Analyzing
Analyze the interactions between microbes and their environments.
CO 5. Evaluating
Evaluate current research methodologies in microbiological studies.

Course Outcomes

On completion of this course, the students will be able to

1. The students will **develop** basic concept of environment management and categorize the interactions of microbes present in different ecosystems.
2. This conception will enable them to understand and if required to **apply** biotechnological techniques for remediation of damage caused to the environment caused by pollution and accumulation of toxic chemicals and heavy metals
3. The knowledge of the subject will encourage students to **formulate** proposal for environmental remodelling.
4. The knowledge of the subject will enable students to **appraise** the regulations associated with waste management, and **apply** the knowledge to judge the potability of water samples

Catalogue Description

The student will be able to use the knowledge obtained from the core course "Environmental Microbiology" to understand different components of the ecosystem and the interrelationship between them along with the significance of ecological balance for existence of life. Also, the awareness about different forms of pollutions and environmental deterioration attributed to man-made as well as natural causes will be enhanced. The knowledge gained will be helpful in implementing different preventive strategies to protect the environment from the harmful effect of pollutions. Information regarding historical and contemporary laws and regulations will help the students to use application of biotechnology for environmental protection and also to reprimand the harmful effects of pollutions. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit I: Air Soil and Water Microbiology (12 Hrs)

1. Diversity of microorganisms & their natural habitats

i). Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora, humus, composting

ii). Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats

iii). Atmosphere: Stratification of the Atmosphere, Aeromicro flora, Dispersal of Microbes

iv). Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.

v). Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Techniques of studying Air and Soil Microflora.

Unit II: Microbial interaction in different ecosystem (12Hrs)

1. Succession of microbial communities in the decomposition of plant organic matter

2. Biological Interactions: i). Microbe–Microbe Interactions; Mutualism, Synergism, Commensalism, Competition, Ammensalism, Parasitism, Predation, Biocontrol agents, microbial succession

Microbe–Plant Interactions; Roots, Aerial Plant surfaces, Biological Nitrogen fixation, Defense response, Pathogenicity in plants, Tools for infectious Phytotoxins. Mycorrhyza.

Microbe–Animal Interactions; Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as Symbiont

Unit III: Role of microorganisms in biogeochemical cycles (12 Hrs)

Contribution of Microorganisms in C, N, P S cycle

Unit IV: Role of microorganisms in waste water management (12 Hrs)

Water purification & sanitary analysis. Waste water Microbiology, Measurement of waste water quality, Waste water treatment.

Unit V: Role of microorganisms in bioremediation (12 Hrs)

Bioremediation: Bioleaching, Biopesticides, cleaning of oil spills, biogas production

List of experiments to estimate of role of microorganisms in environment

1. Analysis of soil

pH, moisture content, water holding capacity, percolation, capillary action.

2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC) -by serial dilution and pour-plate/spread plate method

3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.

4. Assessment of microbiological quality of water (a) Presumptive test b) Confirmatory test c) Completed test for coliform d) IMViC reactions.

5. Determination of BOD of waste water sample.

6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

Text Books

T1. Fundamentals of Ecology (2010), 5th edition, Eugene. P. Odum, Gary W. Barrett, Saunders,

T2. Ecology and environment, (2017), 13th edition, P.D. Sharma, Rastogi Publications, ISBN: 9789350781227, 9350781220

T3. Environmental Microbiology (2015), 3rd Edition, Ian L. Pepper, Charles P. Gerba, Terry J. Gentry. Elsevier

T4. Pepper IL, Gerba CP, Gentry TJ (2014). Environmental Microbiology, 3rdedition, Academic Press

Reference Books

R1. Prescott's Microbiology, 10 edition (2017) McGraw-Hill Education;
Christopher J. Woolverton, Joanne Willey, and Linda Sherwood, ISBN-10: 9813151269
ISBN-13: 978-9813151260
R2. Brock Biology of Microorganisms, 14th edition, (2014) Pearson, Madigan MT, Martinko JM and Parker J.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC204	Metabolism of amino acids and Nucleotides	L	T	P	C
Version 1.0	**Contact Hours – 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of Biomolecules and Enzymology of B.Sc.				

Course Objectives:

1. The main focus of the course is to cover the metabolic pathways regulating amino acid catabolism and anabolism.
2. It will provide a basic understanding about the biosynthesis and degradation of purines and pyrimidine.
3. The course will finally give an insight about the inter-connections between carbohydrates, proteins, lipids and nucleic acid metabolic pathways.

Course outcome:

The students will be able to

CO1. Remembering: Recall the metabolic pathways involved in the breakdown and synthesis of amino acids and nucleotides.
CO2. Understanding: Explain the key enzymes and co-factors involved in the metabolism of amino acids and nucleotides.
CO3. Applying: Apply knowledge of amino acid and nucleotide metabolism to understand physiological processes such as protein synthesis, energy production, and nucleic acid synthesis.
CO4. Analyzing: Analyze how defects in amino acid and nucleotide metabolism can lead to metabolic disorders and diseases.
CO5. Evaluating: Evaluate the relationship between amino acid and nucleotide metabolism and overall cellular function and homeostasis.

Catalogue Description:

The course is going to provide an understanding about the concept of anabolism and catabolism of amino acids and nucleotides and their role as high energy compounds in the cell. They will acquire knowledge related to regulation of various pathways. The course will teach about the importance of biosynthesis and degradation of amino acids and their regulation. The importance of high energy compounds, synthesis of ATP under aerobic and anaerobic conditions will be understood. The role of Urea cycle and its regulation in catabolism of amino acids and related in- born errors of amino acid metabolism as storage molecules will be taught. Further students will acquire the knowledge for biosynthesis and degradation of purines and pyrimidines. The course will teach about the regulatory pathways of purine and pyrimidine biosynthesis along with biosynthesis of ribonucleotides, DNA and polynucleotides. Finally, the student will gain insights into metabolic engineering for the production of useful biomolecules.

Course Content
Theory (45 h)

Unit I

Overview of amino acid metabolism: Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkor and Marasmus. Nitrogen balance, transamination, role of pyridoxal phosphate, glucose-alanine cycle, Krebs's bicycle, urea cycle and inherited defects of urea cycle.
(Lecture Hours 12)

Unit II

Catabolism of amino acids: Catabolic pathways of individual amino acids. Glycogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methyl malonic acidemia (MMA), homocystinuria and Hartnup's disease. Biosynthesis of amino acids: Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation.
(Lecture Hours 12)

Unit III

Biosynthesis of purine and pyrimidine nucleotides: De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Deoxyribonucleotides and synthesis of nucleotide triphosphate: Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.
(Lecture Hours 9)

Unit IV

Degradation of purine and pyrimidine nucleotides: Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism–Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency. Integration of metabolism: Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).
(Lecture Hours 12)

List of the practical (15 h)

1. Estimation of SGPT & SGOT.
2. Estimation of serum Urea and BUN.
3. Estimation of serum Uric acid
4. Estimation of serum Creatinine.

5. Estimation of serum Bilirubin
(Lecture Hours 30)

Suggested Readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1 / ISBN:10:1-4641- 0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M.,Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston),ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13:978-0470-23396-2

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Class Assessment and Attendance	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

MIB205	MOLECULAR BIOLOGY	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of Biology				
Co-requisites	--				

Course Objectives

1. Understand the basic concepts of central dogma of molecular biology and the structural aspects of DNA, RNA and Protein.
2. Study the process of replication transcription and translation.
3. Compare between the processes w.r.t. prokaryotes and eukaryotes

Course Outcomes

On completion of this course,

CO1. Remembering

Identify the fundamental components of DNA, RNA, and proteins.

CO 2. Understanding

Describe the processes of DNA replication, transcription, and translation.

CO 3. Applying

Apply techniques such as PCR and gel electrophoresis to analyze nucleic acids.

CO 4. Analyzing

Compare the mechanisms of gene regulation in prokaryotic and eukaryotic organisms.

CO 5. Evaluating

Assess the implications of genetic mutations on protein function and organismal traits.

Catalogue Description

The core-course of molecular biology is a fundamental course that deals with the major molecules of life form i.e., DNA, RNA and protein. It also deals with the process of regulation of gene expression.

Course Content

Unit 1 Structures of DNA and RNA / Genetic Material (9 h)

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation of DNA, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA in

Prokaryotes, Viruses, Eukaryotes; RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit 2 Replication of DNA (Prokaryotes and Eukaryotes) (9 h)

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication; Meselson-Stahl experiment, Mechanism of DNA replication:Enzymes and proteins involved in DNA replication –DNA polymerases, Helicase, SSB protein, DNA ligase, primase, telomerase, RNA primers – for replication of linear ends, Okazaki fragments, Leading and Lagging strands, Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ(theta) mode of replication and other accessory protein, Mismatch and excision repairs, Photoreactivation

Unit 3 Transcription in Prokaryotes and Eukaryotes (9 h)

Transcription: Definition, difference from replication, promoter - concepts. Sigma factor, RNA Polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors **Post-Transcriptional Processing** Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping.

Unit 4 Translation (Prokaryotes and Eukaryotes) (9 h)

Translational machinery, Charging of tRNA, aminoacyltRNAsynthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote, clover leaf structure of tRNA, Genetic Code – Concept and Characteristics, Wobble hypothesis, Post-translational modifications

Unit 5 Regulation of gene Expression in Prokaryotes and Eukaryotes (9 h)

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp*-operons. Inducible and repressible operons. Outline of epigenetic regulation: histone modification.

Experiential learning:

1. Flip classes
2. Divulging experimental data
3. Presentation on relevant topics
4. Attending seminars and research talks

Extra credit in offer:

NPTEL course:

Molecular Biology Prof. Vishal Trivedi, IITG

Or a relevant one (up on due approval)

Text books:
T1. Weaver R. (2011). Molecular biology.4th edition, McGraw-Hill

Reference books:
R1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008).
R2. Molecular Biology of theGene, 6th edition, Pearson
R3. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009). The World of the Cell, 7th edition,Pearson.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment and Attendance	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

SEC146	**Molecular diagnostics**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 30**	1	0	1	2
Pre-requisites/Exposure	UNDERSTANDING OF BASIC LEVEL OF BIOLOGY				
Co-requisites	A Bachelor's degree in any branch of Life Sciences / Technology				

Course Objectives

1. To familiarize students with molecular diagnostic technologies,
2. To increase students' intuition and understanding of computational methods used to analyze molecular diagnostic data
3. To build students' abilities to interpret molecular diagnostic testing and to integrate results into clinical decision making
4. Build skills in appropriately choosing and evaluating diagnostic tests for patients

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering
Identify key techniques and tools used in molecular diagnostics.
CO 2. Understanding
Explain the principles behind molecular diagnostic methods, such as PCR and sequencing.
CO 3. Applying
Conduct molecular diagnostic tests to detect specific pathogens or genetic disorders.
CO 4. Analyzing
Interpret test results and evaluate their clinical significance in diagnosis.
CO 5. Evaluating
Assess the advantages and limitations of various molecular diagnostic technologies.

Catalogue Description

Diagnosis of disease has become a more precise science involving a combination of genetic, proteomic and biochemical tools. Understanding of these multi-disciplinary areas is essential for the diagnostic service industry. The course is designed to teach the technology, theory and practical approaches of molecular genetic methods to the diagnosis and understanding of human disease. Students would be taught scientific approaches to identify molecular biomarkers, develop and validate diagnostic assays.

Course Content

Microbial and Molecular diagnostics (SEC141)

Unit 1: Molecular typing methods

Restriction fragment length polymorphism (RFLP) - Amplified fragment length polymorphism (AFLP)- PCR (Polymerase Chain Reaction) Fundamentals, RT PCR and qPCR, Modifications of PCR-Hot start, Touch down, nested PCR, Multiplex, Modifications of PCR 2-Long-range PCR,Single-cell PCR,Fast-cycling PCR, Methylation-specific PCR (MSP), Digital Droplet PCR-

modern implications, PCR-based mutation analysis DNA primers, linkers, adapters, ribotyping – Pulse field gel electrophoresis (PFGE) and Microarray.

Unit 2: Microbial Molecular Epidemiology

Definition of epidemiology– molecular epidemiology- Multi locus sequence typing (MLST). Targets of molecular epidemiology-relevant species subspecies, strains clones and genes. DNA analysis in Duchenne Muscular Dystrophy – Molecular diagnostic method for Sickle cell anemia, Cystic fibrosis, X-linked CGD. Molecular cytogenetics: FISH. Molecular detection of *Mycobacterium tuberculosis* & HIV–variable number of tandem repeats (VNTR). Molecular methods & detection of H5N1, Corona Virus.

Unit 3: Infectious diseases and diagnosis:

Detection & differentiation of pathogens – bacterial, viral, fungal, zoonotic, protozoan, Drug susceptibility testing, drug resistance testing, Point of care testing, Cellular and functional genomics in diagnostics. Serological and ELISA based methods. Discrimination of foodborne pathogens- Repetitive element palindromic, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPRs). DNA sequencing methods, Next-generation sequencing (NGS). Transcriptome and Proteome analysis.

Unit 4: Omics in Diagnostics:

Clinical Applications Overview of proteomics techniques and workflows, Protein separation techniques-brief discussion of gel electrophoresis and chromatography, mass spectrometry, label-free and isotope labelling methods, role of metabolomics in laboratory diagnosis. Advanced topics in Clinical Proteomics High throughput proteomics like-Shotgun and data independent acquisition (DIA), Single cell proteomics and spatial profiling, methods to detect post translational modification and protein-protein interaction, proteomic data analysis and bioinformatic tools, Luminex multiplex assays and its application in biomarker analysis.

Unit 5: Quality control and Ethical Concerns:

Quality control and Ethical Concerns in and Futuristic Trends Quality control in molecular diagnostics, Ethical Concerns in Molecular Diagnostics, Microfluidics and Lab-on-chip in molecular diagnostics, AI and ML in molecular diagnostics, Nanotechnology based molecular diagnostics, Single cell Analysis, Integration of Multi-omics Data.

List of Practicals:

1. Isolation of genomic DNA from bacteria
2. Designing of PCR primers
3. PCR amplification of 16s rRNA genes
4. Isolation of DNA fragments from Agarose gel
5. Study on the restriction digestion pattern of different bacterial DNA on Agarose gel

6. Antibiotic susceptibility testing by broth microdilution method

Textbooks:

1. Principles of Biochemistry (Lehninger) (5th edition), MM Cox and DL Nelson, CBS Publishers.
2. Genomes (3rd edition) TA Brown, Wiley-Liss Publications.
3. Human Chromosomes by Miller & Tharman, Springer Publishing Company
4. "Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory" by Wayne W. Grody and Robert M. Nakamura
5. "PCR (The Basics)" by Michael L. Mader
6. "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri

Reference:

1. Molecular Cell Biology, (6th edition) Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, and James Darnell. WH Freeman Publication

3. Ringsrud, Karen Munson; Linné, Jean Jorgenson Linné & Ringsrud's Clinical laboratory science: the basics and routine techniques Turgeon, Mary L.5ISBN:0-323-03412-8
4. "Real-Time PCR: Advanced Technologies and Applications" by Nick A. Saunders and Martin A. Lee
5. "Next-Generation Sequencing: Translation to Clinical Diagnostics" by Alireza Heravi-Moussavi
6. "Genetic Testing and Molecular Biomarkers" by George P. Patrinos and William B. Coleman

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC251	Basic Metabolism	L	T	P	C
	Contact Hours - 60	2	1	1	4
Pre-requisites/Exposure	PLUS, TWO (12th) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives:

1. Understand the fundamental concepts of metabolism.
2. Explore the major metabolic pathways.
3. Analyze the regulation of metabolic processes.
4. Apply metabolic concepts to health and disease.
5. Develop critical thinking and problem-solving skills.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering
List the key metabolic pathways and their main substrates and products.
CO 2. Understanding
Describe the roles of carbohydrates, lipids, and proteins in metabolism.
CO 3. Applying
Demonstrate the processes of glycolysis and the Krebs cycle using biochemical diagrams.
CO 4. Analyzing
Examine the regulatory mechanisms that control metabolic pathways.
CO 5. Evaluating
Assess the effects of metabolic disorders on overall health and well-being.

Catalogue Description

The core-course of 'Baasic Metabolism' will help to understand the basic concept and application of metabolism. This course includes comprehensive approach through studying impact of conditions on metabolism. Furthermore, students will be able to classify based on nutritional parameters and elaborate energy metabolism. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Contents

Theory (45 h)

Unit 1: Introduction to Metabolism

Definition and importance of metabolism, Overview of anabolic and catabolic pathways, Role of enzymes and energy transfer in metabolic reactions, enzymes roles in regulation of metabolism

Unit 2: Carbohydrate Metabolism

Glycolysis: steps, regulation, and energy yield, Gluconeogenesis: pathway and regulation, Glycogen metabolism: synthesis and breakdown, Integration of carbohydrate metabolism

Unit 3: Citric Acid Cycle and Oxidative Phosphorylation

Detailed steps of the citric acid cycle, Electron transport chain and ATP synthesis, Regulation and significance of oxidative phosphorylation

Unit 4: Lipid, Protein and Amino Acid Metabolism

Fatty acid oxidation: beta-oxidation pathway, Lipid synthesis: fatty acid and triglyceride synthesis, Ketone bodies: formation and utilization, Regulation of lipid metabolism, Amino acid catabolism: transamination and deamination, Urea cycle: pathway and regulation, Integration of protein metabolism with other metabolic pathways

Unit 5: Regulation of Metabolism and Health

Hormonal regulation: insulin, glucagon, and other hormones, Feedback mechanisms in metabolic pathways, Metabolic syndrome: causes and consequences, Case studies in metabolic research and disease

Lab (15 h):
List of the practical

1. Determination of Km and Vmax of Alkaline Phosphatase.
2. Effect of pH on Alkaline Phosphatase Activity
3. Effect of Temperature on Alkaline Phosphatase Activity
4. Determination of Enzyme Kinetics Using Different Inhibitors

Experiential learning:

1. Consulting recent articles on microbial metabolism
2. Problem (numerical) solving
3. Video lectures:

Extra credit in offer:

NPTEL course:

Overview And Integration of Cellular Metabolism, IIT Kharagpur
Dr. Arindam Ghosh, Dr. Aritri Bir

Or a relevant one (up on due approval)

https://nptel.ac.in/courses/104105139

SUGGESTED READING

1. Biochemistry - by Jeremy Berg, John Tymoczko and Lubert Stryer
2. Biochemistry - by Donald J. Voet and Judith G. Voet
3. Lehninger Principles of Biochemistry - by David L. Nelson and Michael M. Cox

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1= weakly mapped
2= moderately mapped
3= strongly mapped

PDC202	Professional Development Course-II	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDC-1 course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course learning outcomes:

CO1. Remembering
Identify key concepts and principles of professional development.
CO 2. Understanding
Explain the importance of lifelong learning and continuous improvement in a professional context.
CO 3. Applying
Utilize effective communication strategies in professional interactions.
CO 4. Analyzing
Assess personal strengths and weaknesses to create a targeted development plan.
CO 5. Evaluating
Critique case studies of successful professional development initiatives.

Course Contents:
The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

1=weakly mapped 2= moderately mapped 3=strongly mapped

SEMESTER-V

MIB301	IMMUNOLOGY	L	T	P	C
Version 1.0	**Contact Hour:60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and life science				
Co-requisites	--				

Course Objectives

1. To provide those students with apt understanding of innate and adaptive immunity.
2. It will also provide in depth knowledge about antigen-antibody interaction and their effects.
3. Students will be able to elaborate organization and expression pattern of components of immune system and the medical conditions that may arise due to anomaly in expression of components of immune system.
4. Students will be proficient in application of various immunologic techniques in the field of research and medical science.

Course Outcomes

CO1 Remembering- Recognize the components and steps of the immune response
CO2 Understanding- Explain the interaction between antigens and antibodies
CO3 Applying- Apply knowledge of antigens and antibodies in diagnosing and treating immunological disorders
CO4 Analysing- Evaluate the effectiveness of different antigens in eliciting immune responses
CO5 Evaluate- Assess the effectiveness of immune responses in combating infections and diseases

Catalogue Description

The core-course of 'immunology' will help to understand the classification, components and organization of components of immune system. This course comprehends the function of all components of immune system and effect of different form of interactions of antibodies, complement components, cytokines in response to invasion of antigen. Furthermore, the application of immune system in carcinogenesis, therapeutics and gene delivery would also be illuminated. Medical conditions arising from malfunctioning of one or more component of immune system would also be illustrated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Immunology

Course Content:

Unit 1 Introduction to Innate & adaptive immunity and components of the immune system (12Hrs)

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter, Louis Pasteur and Susumu Tonegawa
Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage,

Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT, hematopoietic stem cells
Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells

Unit II Antigen, Antibody, Ag-Ab interaction (12Hrs)
Characteristics of an antigen; Haptens; Epitopes (T & B cell epitopes); Adjuvants – complete and incomplete
Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies
Antigen processing and presentation (Cytosolic and Endocytic pathways), isotype switching, affinity maturation
Ag-Ab interaction, Affinity, Avidity, Cross-reactivity, Precipitation, Agglutination, Widal Test

Unit III Complement system & Major Histocompatibility Complex (12Hrs)

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation
Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules

Unit IV Immunological Techniques (12Hrs) Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.
Vaccine

Unit V Immunological Disorders (12Hrs)
Types of Autoimmunity and Hypersensitivity with examples

Practical applications of immunology
1. Identification of human blood groups.
2. To perform Total & Differential Leukocyte Count of the given blood sample.
3. To separate serum from the blood sample (demonstration).
4. To perform immunodiffusion by Ouchterlony method.
5. To perform radial immunodiffusion assay.
6. To perform immunoelectrophoresis

Text Book:
Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology.6th edition W.H. Freeman and Company, New York.

Reference books:
1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology.6th edition Saunders

Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology.7th edition Garland Science Publishers, New York.
4. Peakman M, and Vergani D. (2009).Basic and Clinical Immunology.2nd edition Churchill Livingstone Publishers, Edinberg.
5. Richard C and Geiffrey S. (2009). Immunology.6th edition. Wiley Blackwell Publication.
6. Owen, J.A.; Punt, J.; Kuby, J.; Stranford, S.A. Kuby immunology. W.H. Freeman: 2013.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped 2= moderately mapped
3=strongly mapped

BIC302	Human physiology	L	T	P	C
Version 1.0	**Contact Hours – 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of Biomolecules and Enzymology of B.Sc.				

Course Objectives:

1. The main focus of the course is to cover the structure and function of major human organs.
2. It will provide a basic understanding the interplay between different organ systems.
3. The course will finally give an insight about organs and cells interact to maintain biological equilibria in the face of a variable and changing environment.

Course outcome:

The students will be able to

CO1: Remembering-Conceptualize the cardiovascular, respiration physiology, and their interconnections.
CO2: Understanding-Understand the Renal physiology and its effect on blood pressure regulation.
CO3: Applying-Analyze the Gastrointestinal and hepatic function and their importance.
CO4: Analyzing-Explain fundamental process of reproduction in terms of cells, tissue and hormonal regulation.
CO5: Evaluate- Estimate RBC, WBC count and other physiological parameters using experimental techniques

Catalogue Description:

This course is designed to impart a fundamental knowledge on the structure and functions of the human body. It also helps in understanding both homeostasis mechanisms and homeostatic imbalances of various body systems. The course would enhances the understanding of how different drugs act on the various organs to improve the disease state of the organs. The course covers functions of important physiological

systems including the digestive, endocrine, cardio-respiratory, renal, reproductive and metabolic systems. Student would be also able to perform, analyse and report on experiments and observations in physiology.

Course Content

Unit 1: General introduction to Physiology, Functional Organization of human body, Control of internal environment-homeostasis, Cardiovascular physiology: Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, atomicity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction. Respiration: Organization of the pulmonary system. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport.
[12 lecture hours]

Unit 2: Renal physiology: Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowman's' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Regulation of electrolyte and water content, blood volume and long term blood pressure. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance.
[12 lecture hours]

Unit 3 : Gastrointestinal and hepatic physiology: Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile, metabolic importance of liver. Liver function tests.
[9 lecture hours]

Unit 4: Musculoskeletal system: Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle. nerves and endocrine system, different endocrinal glands and their function. Reproductive physiology: Spermatogenesis, capacitation and transport of sperm, blood testis barrier. Ovarian function and its control. Hormonal regulation of Menstruation cycle, Uterine changes, fertilization and implantation. Placenta as a feto- maternal unit, gestation and parturition.
[12 lecture hours]

List of the practicals

1. Recording of Blood pressure using sphygmomanometer
2. Estimation of bleeding time and clotting time
3. Introduction to hemocytometry and RBC count
4. WBC: total count (TC) and differential count (DC)
5. Determination of blood group.
6. Introduction to slide preparation and staining of epithelial cells.

[30 lecture hours]

Reference Books

1. Vander's Human Physiology (2008) 11 thed., Widmaier, E.P., Raff, H. and Strang,K.T., McGraw Hill International Publications (New York), ISBN:978-0-07-128366-3.
2. Harper's Biochemistry (2012) 29 th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill.ISBN:978-0-07-176-576-
3. Textbook of Medical Physiology (2011) 10 th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
4. Fundamental of Anatomy and Physiology (2009), 8 th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13:978-0321- 53910-6.Chemistry of Nucleic acids,Adams.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Class Assessment and Attendance	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

BIC303	RDT and Genetic Engineering	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and biochemistry				
Co-requisites	--				

Course Objectives

1. To acquaint the students to versatile tools and techniques in recombinant DNA technology
2. To implement skills about restriction and modification systems
3. To impart knowledge about polymerase chain reactions and their applications
4. To apply the knowledge of techniques for analysis of gene expression.
5. To outline concepts of transcriptomics, genomics and their application in recombinant DNA technology.

Course Outcomes

CO1: Remembering-Recall the fundamental principles, tools, and techniques of recombinant DNA technology, including vectors, enzymes, and gene cloning methods.

CO2: Understanding-Explain the mechanisms and applications of gene manipulation and molecular cloning in biotechnology and genetic research.

CO3: Applying-Apply recombinant DNA techniques to solve problems in genetic engineering, such as gene expression, sequencing, and the creation of genetically modified organisms (GMOs).

CO4: Analyzing-Analyze experimental data from recombinant DNA experiments, including gene splicing, cloning, and transformation, to draw valid conclusions.

CO5: Evaluating-Design and develop recombinant DNA-based solutions for real-world challenges, such as gene therapy, vaccine development, or agricultural improvements.

Catalogue Description

This course will cover strategies for cloning and expression of proteins, library construction, PCR strategies and troubleshooting, blotting techniques and recombinant gene expression systems.

Course Content

Unit 1 Basics of DNA cloning (8 hours)

Simple cloning and cloning using linkers and adaptors.Gene Isolation and expression, Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs.Selection

and screening of clones.

Unit 2 Methods of DNA and Protein Analysis (7 hours)
Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA, Southern and Northern Blotting. Radio labelling probes. Isolation and purification of DNA.RFLP, RAPD analysis.DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains.Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins.Western Blotting analysis.

Unit 3 Polymerase Chain Reaction (7 hours)
Concept of PCR and various thermophilic enzymes used in PCR.Gradient PCR versus Touchdown PCR.Designing primers. Cloning PCR products. Long PCR, Inverse PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology.

Unit 4 Construction of cDNA and Genomic DNA Libraries (7 hours)
Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR.Screening expression libraries. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

Unit 5 Transcriptional Analysis of Gene Expression and Transcriptomics(8 hours)
Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes.Enzymatic and bioluminescent reporters. Reporters used in protein localization and trafficking studies. Promoter analysis – deletion analysis and linker scanning analysis coupled to reporter assays, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies or 5' RACE. Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expresion (SAGE).

Lab (15 h):

List of Practicals

1. Competent Cell Preparation	2 hrs
2. Isolation of plasmid DNA	2hrs
3. Restriction digestion analysis by agarose gel electrophoresis	2hrs
4. Transformation of ligation mix	2hrs
5. PCR and primer designing	4 hrs
6. Restriction mapping analysis	3hrs

Experiential learning:

1. Attending online small workshops on RDNA
2. Small project works

Text Book: Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick 2009

Reference Books:

1. Recombinant DNA: Genes and Genomes - a Short Course by James D. Watson, 2006
2. Principles of Gene Manipulation and Genomics by Sandy Primrose and Twyman, 2006
3. From genes to genomes concepts and applications of DNA technology by Jeremy W dale and Malcolm von Scrantz, 2011
4. Genomes 3 by T.A. Brown, 2006

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MIB351	Genetic Engineering	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and computer				
Co-requisites	--				

Course Objectives

6. To acquaint the students with versatile tools and techniques in genetic engineering
7. To implement skills in restriction and modification systems
8. To impart knowledge about polymerase chain reactions and their applications
9. To apply the knowledge of techniques for analysis of gene expression.
10. To outline concepts of transcriptomics, genomics, and their application in genetic engineering.

Course Outcomes

CO1. Remembering-Recall appropriate strategies for cloning
CO2. Understanding-Compare and contrast between different types of blotting techniques
CO3. Applying-Design polymerase chain reaction for amplification of target DNA
CO4. Analysing-Construct genomic and cDNA library as relevant to rDNA technology

CO5. Evaluate-Apply the concepts of transcriptomics and DNA microarray

Catalogue Description

This course will cover strategies for cloning and expression of proteins, library construction, PCR strategies and troubleshooting, blotting techniques and recombinant gene expression systems.

Course Content

Unit 1 Basics of DNA cloning (8 hours)

Basics of cloning and cloning using linkers and adaptors. Gene Isolation and expression, Cloning into various kinds of vectors – plasmids, phages lambda and M13, Selection and screening of clones.

Unit 2 Methods of DNA and Protein Analysis (7 hours)

Agarose, polyacrylamide and pulsed-field gel electrophoresis of DNA, Southern and Northern Blotting.Native PAGE, SDS-PAGE, and two-dimensional PAGE analysis of proteins.Western Blotting Analysis.

Unit 3 Polymerase Chain Reaction (7 hours)

Concept of PCR and various thermophilic enzymes used in PCR.Gradient PCR versus Touchdown PCR.Designing

primers.

Unit 4 Construction of cDNA and Genomic DNA Libraries (7 hours)
Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries.

Unit 5 Transcriptional Analysis of Gene Expression and Transcriptomics(8 hours)
Gene expression analysis by Northern Blotting, RT-PCR, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene expression (SAGE).

Lab (15 h):

List of Practicals

1. Competent Cell Preparation	4hrs
2. Isolation of plasmid DNA	4hrs
3. Restriction digestion analysis by agarose gel electrophoresis	4hrs
4. PCR and primer designing	3hrs

Experiential learning:

1. Attending online small workshops on Genetic Engineering
2. Small project works

Text Book: Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick 2009
Reference Books:
1. Recombinant DNA: Genes and Genomes - a Short Course by James D. Watson, 2006
2. Principles of Gene Manipulation and Genomics by Sandy Primrose and Twyman, 2006
3. From genes to genomes concepts and applications of DNA technology by Jeremy W dale and Malcolm von Scrantz, 2011
4. Genomes 3 by T.A. Brown, 2006

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

SEC142	Intellectual Property Right & Biosafety	L	T	P	C
Version 1.0	**Contact Hours - 30**	1	1	0	2
Pre-requisites/Exposure	Basic knowledge of Biology				
Co-requisites	--				

Course Objectives

The main objective of this course is to orient, popularize, create awareness and get knowledge about the domain of IPR.

1. Students will be able to categorize biosafety levels.
2. Students should acquire knowledge in the domain of IPR.
3. Students will be able to differentiate between various components of IPR.
4. Students will be able to apply their field of knowledge/ innovation to various forms of IPR.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Remembering-Recall various biosafety levels and biosafety norms for research.

CO2. Understanding-Understand, search, interpret, draft patent and industrial design

CO3. Applying- Identify scope of copyright and trademark

CO4. Analysing-Explore the role of GI

CO5. Evaluate-Evaluate the importance and application of IPR

Catalog Description

The course is designed as an elementary course on Biosafety and IPR. This course outlines various levels of biosafety, biohazard and regulatory requirements for conducting microbiological research. The course further discusses all types of IPR to a moderate level of depth. Patent, copyright, trademark, industrial design and GI, theirs criteria, application, process, duration and application has been dealt in the course.

Course Content

UNIT I: Biosafety

Biosafety Levels of Specific Microorganisms; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Recommended Biosafety Levels for Infectious Agents; Biosafety guidelines, Ethics committee on research: Human, Ethical and Animal usage. Overview of Biotechnology Regulations and relevant International Agreements including Cartegana Protocol.

UNIT II: Patent and Industrial Design

Nature of rights, Origin, need and development, Patentability Standards: Novelty, Non- obviousness, Utility; Patentable subject matter, Patent Prosecution, Patent Application, Pre and Post grant opposition, International Patent

prosecution : Patent Co-operation Treaty, Patent specification, Patent revocation, Patent term and enforcement, Term of patent – Patent term extension and adjustment, Patent infringement – Literal and non-literal infringement, Doctrine of Equivalents, Defences to patent infringement claims, Remedies – Civil and criminal, Compulsory licensing of patents in India. Industrial Design, types and application.

UNIT III: Copyright & Trademark

Concept of Copyright and Trademarks; Nice classification, Types of Trademark, International conventions; Indian statutes; Trademark search filing, examination, opposition, drafting; trademark infringement and passing off, Copyright, works in which copyright subsists, basic features of copyright; originality, skill and labour, idea-expression dichotomy, infringement of copyright, limitations and exceptions.

UNIT IV: Geographical Indications

Introduction to GI and certification mark, International Agreements Concerning Geographical Indication, Paris Convention, LISBON Agreement, TRIPS (relevant articles), Registration of Geographical Indication and effect of registration, Geographical Indication that cannot be registered, Homonymous Geographical Indication, Opposition to registration,Correction/amendments to registrations, Conditions on registrations, Registration as authorized user of GI, Duration, Renewal etc. Of geographical indication, authorized user, Effect, and benefit of Registration.

UNIT V: Application of IPR

WIPO: Formation, activities. Role of IPR in start-up, business, academic institutions. Global Innovation Index. IP Schemes of India: NIPAM, KAPILA and others. Jobs in IP sector: IP agent, IP attorney, IP examiner etc.

List of Activities (Experiential Learning)

9. Basic Patent Search: Indian, European, US.
10. Reading/ Analyzing granted patent
11. Basic drafting of patent
12. IP awareness and sensitization
13. Patent application process

SUGGESTED READING:

1. Intellectual Property Right, Bharat Publisher, 2nd Ed 2024
2. Ganguli, Prabuddha. *Intellectual Property Rights: Unleashing the Knowledge Economy*. Tata McGraw-Hill Education, 2001.
3. Narayanan, P. *Intellectual Property Law*. Eastern Law House, 2017.
4. Basheer, Shamnad, et al. *Intellectual Property Rights: An Overview and Implications in Pharmaceutical Industry*. CCH India, 2010.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	2	3	3	3	3	2	3	3	2
CO2	3	3	3	2	3	3	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	3	2
CO4	3	3	3	2	3	3	3	3	2	3	3	2
CO5	3	3	3	2	3	3	3	3	2	3	3	2
Avg	3	3	3	2-	3	3	3	3	2	3	3	3

1=weakly mapped

2= moderately mapped
3=strongly mapped

PDC301	Professional Development Course-III	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDC-2 course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course learning outcomes:

CO1. Remembering
Identify key concepts and principles of professional development.
CO 2. Understanding
Explain the importance of lifelong learning and continuous improvement in a professional context.
CO 3. Applying
Utilize effective communication strategies in professional interactions.
CO 4. Analyzing
Assess personal strengths and weaknesses to create a targeted development plan.
CO 5. Evaluating
Critique case studies of successful professional development initiatives.

Course Contents:
The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written

Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

1=weakly mapped 2= moderately mapped 3=strongly mapped

SEMESTER-VI

MIB305	Bioinformatics	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and computer				
Co-requisites	--				

Course Objectives

1. To provide those students with apt understanding of informatics for biological data.
2. It will also provide in depth knowledge of data basses, sequence analysis, alignment and phylogeny.
3. It will also offer an outline of basic prediction methods for biological system.
4. In depth understanding of structure prediction for proteins and RNA.

Course Outcomes

CO1. Remembering:
- List and describe the basic databases used in bioinformatics.

CO2. Understanding:
- Explain the concepts of sequence alignment and its importance in bioinformatics.

CO3. Applying:
- Implement prediction models in bioinformatics to make inferences about biological data.

CO4. Analyzing:
- Critically assess the quality of structure prediction models and interpret the results.

CO5. Evaluating:
- Evaluate the effectiveness of various bioinformatics tools in performing sequence alignment, phylogenetic analysis, and structure prediction tasks.

Catalogue Description

The course of 'bioinformatics' will help to understand the basic concept and application of computational biology. This course includes comprehensive approach through studying data bases, sequence alignment and phylogenetic analysis. Furthermore, the application of computation structure prediction will also be elaborated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing

on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 Introduction to bioinformatics (9h): RDBMS - Definition of relational database Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer. Relational an object oriented data bases. OS, Codes and languages.

Unit 2 Introduction to Bioinformatics &Biological Databases (9 h)

Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage – File formats - FASTA, Genbank, PDB. Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB and specialized databases.

Unit 3Molecular Phylogeny (9 h)

Sequence Alignments, Phylogeny and Phylogenetic trees- Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, Gap penalties, ClustalW, scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA,Neighbour joining, Maximum Parsimony, Maximum likelihood

Unit 4 Genome organization and analysis (9 h)

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes, Genome, transcriptome, proteome, Major features of completed genomes: *E.coli, S.cerevisiae, Arabidopsis*, Human

Unit 5 Predictions regarding protein structures (9 h)

Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot
Protein structure and rational drug design

Lab (15 h):

List of Practical

1. Exploring biological data bases, down loading sequences and structure data.
2. Pairwise and multiple sequence alignment, BLAST
3. Molecular phylogenetic analysis: NJ and ML trees
4. Outline of gene prediction and genome annotation
5. Homology modelling, structure prediction and evaluation of predicted models

Experiential learning:

1. Attending on line small workshops on bioinformtics
2. Small project works

Extra credit in offer:

NPTEL course:

BioInformatics: Algorithms and Applications Prof. Michael Gromiha, IITM

Or a relevant one (up on due approval)

Text Book:

1. Essential Bioinformatics, Jin XIONG, CAMBRIDGE

Reference Books:

1. Sanjay S (2003). A First Course in Computers, Vikas Publishing House
2. Pradeep and SinhaPreeti (2007). Foundations of Computing, 4th ed., BPB Publications
4. Rastogi SC., Mendiratta N. and Rastogi P. (2007). Bioinformatics: methods and applications,genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
5. Primrose and Twyman (2003). Principles of Genome Analysis & Genomics.Blackwell

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC306	BIOENERGETICS	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	GRADUATION IN BIOCHEMISTRY				
Co-requisites	FUNDAMENTAL KNOWLEDGE IN BIOENERGETICS AND METABOLISM				

Course objectives

To provide students the basic understanding of laws of thermodynamics in membrane metabolism.
To provide in depth knowledge of carbohydrate metabolism.

Course Outcomes

CO1. Knowledge:
- Define bioenergetics and explain its significance in living organisms.

CO2. Comprehension:
- Discuss the role of energy-rich compounds such as ATP, NADH, and FADH2 in cellular metabolism.

CO3. Application:
- Analyze how mitochondria and chloroplasts function in cellular energy production.

CO4. Analysis:
- Evaluate the efficiency of oxidative phosphorylation compared to glycolysis in ATP production.

CO5. Synthesis:
- Create a concept map showing the interplay between bioenergetics, aerobic vs. anaerobic respiration, and metabolic processes.

Catalog Description

The core-course of ‘bioenergetics and metabolism’ deals with intrinsic laws of thermodynamics in the field of

metabolism. The syllabus includes different types of anabolic and catabolic pathways as well as their relation to our lives. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Bioenergetics

Unit 1. Bioenergetics (10 h)
Concepts of systems and surroundings, Zeroth Law, First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy,and Entropy and mathematical relationship among them, Standardfree energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Redox reactions and redox potential, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP, Numerical problems

Unit2. Electron transport chain
Electron transport chain: components of ETC, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors. Oxidative phosporylation

Unit 3. Aerobic Respiration (10h)
Concept of aerobic respiration, Sugar degradation pathways i.e. Glycolysis, EMP, ED, Pentose phosphate pathway, TCA cycle.

Unit 4 . Anaerobic respiration and fermentation (10h)
Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction); Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5. Photosynthesis: (9h)
Major groups of photosynthetic prokaryotic microbes. Ultrastructure of reaction centre, arrangements of light harvesting pigments, light reaction & electron flow in photosynthesis, photophosphorylation, and bioenergetics. CO2 fixation pathways.

Lab (15 h):
List of practical

1. Isolation of Mitochondria from Rat Liver

2. Viability assays: MTT and resazurin

3. Ethyl alcohol fermentation by Saccharomyces cerevisiae

4. Study the Photosynthetic Oxygen (O2) Evolution: cyanobacteria

5. Isolation of Chloroplast from Spinach Leaves and Estimation of total Chlorophyll

6. Extraction and Separation of Photosynthetic Pigments by Partition Chromatography

Experiential learning:

1. Consulting recent articles on bioenergetics
2. Problem (numerical) solving
3. Video lectures:
https://www.youtube.com/watch?v=xxydY73V9bQ&ab_channel=MITOpenCourseWare

Extra credit in offer:

NPTEL course:

.
Thermodynamics for Biological Systems : Classical and Statistical Aspects Prof. G. K. Suraishkumar
Prof. Sanjib Senapati, IITM

Or a relevant one (up on due approval)

Reference books:

Biochemistry Voet and Voet, CBS
Biochemical Calculations: Segel, Wiley
Biochemistry: Pratt, Wiley
Biophysical Chemistry: Atkins, dePaula, Freeman

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Continuous Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped 3=strongly mapped

BIC 307	**NUTRITION AND TOXICOLOGY**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	BASIC UNDERSTANDING OF BIOCHEMISTRY AND METABOLISM				
Co-requisites	--				

Course Objectives

5. To provide students the basic understanding of nutrition, energy metabolism and toxicology.
6. It will also provide in depth knowledge of functional aspects food and drug interactions with nutriceuticals.
7. Elaborating dietary components of health and diseases.
8. General overview of nutritional and toxicological assessment.

Course Outcomes

CO 1: Knowledge: Define the basic principles of nutrition and toxicology.
CO 2: Comprehension: Explain how dietary components are synthesized and broken down in living organisms.
CO 3: Applying:- Apply the knowledge of toxicology to analyze different food stuffs.
CO 4: Analyzing: Analyze the function of nutraceuticals and toxins in biological systems.
CO 5: Synthesis and Evaluation: Generate hypotheses and critically assess on different aspects of nutrition and toxicology.

Catalog Description

The core-course of 'Nutritional Biochemistry' will help to understand the classification, structure and properties of foods and nutraceuticals. Nutritional biochemistry has also helped to reveal facts about how nutrients influence the growth, development, and function of cells and tissues. Therefore, studying the biochemistry of nutrition has a significant real-world impact. It has the potential to greatly influence the future of preventative and therapeutic strategies for mental and physical illness.

Course Content

Nutritional Biochemistry **(BIC21551)**

Unit I Introduction to Nutrition and Energy Metabolism

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. measurement of energy content of food, Physiological energy value of foods, SDA. Measurement of energy expenditure, estimating energy requirements, BMR factors Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II Dietary components and health

Review functions of carbohydrates, lipids, proteins and vitamins. Digestion, absorption. Their classification, sources, functions, digestion, absorption, utilization and storage. Deficiency diseases (Kwashiorkor, Scurvy, Rickets, Xeropthalmia etc.).Minerals (Ca,P,Fe etc.) absorption, importance and

deficiency disease.
Anthropometric measurements; Z scores, BMI, skinfold, circumference ratios. Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC, Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

Unit III Food, Drug interactions, Nutriceuticals and Toxicology

Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Anti-depressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.

Unit IV Toxicology

Classification of Food Toxicants. Food, Law and Safety. Principles of Toxicology I: Exposure, the Dose-Response Curve. Absorption, Distribution and Elimination of Toxicants. Biotransformation Reactions (Phase I & Phase II).Carcinogenesis, Mutagenesis, Teratogenesis. Organ Toxicity.Natural Toxins in Foods of Plant Origin I. Risk Assessment. Pesticides in Foods. Marine,Toxinns Poisonous Mushrooms , Mycotoxins ,Toxicants Resulting from Food Processing I , Food Additives I , Food Adulteration Pesticides .

UNIT V

Applications in Nutrition and Toxicology. Experiential learning activities and practicals.
Lab: 1. To prepare gel plates for electrophoresis.
2. Organic extraction of DNA from blood.
3. Extraction of DNA from other body fluids and tissues.
4. Quantitation and purity check of Nucleic Acids
5. PCR for DNA samples.
6. Serology Test.

Textbook:

1. Nutriional Biochemistry 1st Edition, ISBN: 978-93-90699-76-6, Nitya Publication. Dr.Renu Verma.
2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.

Reference books:

1. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
2. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

SEC147	**AI IN BIOLOGY**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 60**	1	0	1	2
Pre-requisites/Exposure	PLUS, TWO (12th) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

9. To provide students the basic understanding of Artificial Intelligence in Biology.
10. It will also provide in depth knowledge of how AI can be used in the Biotech & healthcare industry.
11. Elaborating how New Companies are being built by combining Biology & Artificial Intelligence.
12. General overview of Artificial Intelligence in revolutionizing health care.

Course Outcomes

CO1: Remembering : Demonstrate a foundational understanding of artificial intelligence principles and techniques, including machine learning, neural networks, and data mining.

CO2: Understanding: Utilize AI tools and software to analyze biological data, including genomic, proteomic, and ecological datasets.

CO3: Applying: Apply AI methodologies to solve complex biological problems, such as predicting protein structures, modeling ecosystems, and identifying genetic markers for diseases.

CO4: Analyzing: Integrate knowledge from biology and computer science to develop innovative solutions for research and practical applications in fields like bioinformatics, medical diagnostics, and personalized medicine.

CO5: Evaluating: Critically evaluate existing research and case studies that utilize AI in biology, assessing their methodologies, results, and implications for the field.

Catalog Description

The core-course of 'AI in Biology' will help to understand and enhance the knowledge of Artificial Intelligence in Biology. The course examines how Artificial Intelligence has rapidly become ubiquitous in daily life and been applied to diverse areas of Biology.

Course Content

AI IN BIOLOGY

Unit 1- Biological Intelligence Vs Artificial Intelligence. AI Basics: concepts of generative and discriminative AI- terminologies and workflow, ML, DL.

Unit 2- Neural Networks (NN), Basics of deep Learning, decision tree and random forest, SVM, K-mean clustering. Matlab programming, Exploratory data analysis, Plotting and data visualization, Handling big-data sets, Hypothesis testing, Unsupervised learning and clustering.

Unit 3- AI in shaping the future of Bioinformatics. AI in health diagnostics / Confluence of AI and Smart

Devices for Monitoring Health and Disease. AI in medical imaging. applications of AI in medical imaging, neural engineering, systems biology, microbiome and data mining. Artificial Intelligence and Synthetic Biology. Transforming Agriculture with AI.

Unit 4- Applications of AI in the Pharmaceutical Industry. AI-driven applications for drug design, lead optimization, and clinical trials. Artificial Intelligence for Biomarker Discovery. AI in Precision Medicine. AI in biology: Risks involved and ethical concerns. Future Prospects of AI in healthcare and research.

Unit 5- Lab- i) Video Demonstration of AI in Healthcare. ii) Video Demonstration of AI in Industry. iii) computational methods to analyse and predict (a) mutational (DNA) interactions, and (b) transcriptional (RNA) trajectories, during cancer initiation. iv) Development of causal (non-)parametric stastitical and machine learning techniques for applications.

Textbook:

1. Artificial Intelligence - Applications in Medicine and Biology: PRINT ISBN978-1-78984-017-9. Marco Antonio Aceves-Fernández, Andries Engelbrecht. Intech Open.
2. Artificial Intelligence and Molecular Biology. Lawrence Hunter. Publisher: AAAI Press 1993.ISBN/ASIN: 0262581159

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

PDC302	Professional Development Course-IV	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDC-3 course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course learning outcomes:

CO1. Remembering
Identify key concepts and principles of professional development.
CO 2. Understanding
Explain the importance of lifelong learning and continuous improvement in a professional context.
CO 3. Applying
Utilize effective communication strategies in professional interactions.
CO 4. Analyzing
Assess personal strengths and weaknesses to create a targeted development plan.
CO 5. Evaluating
Critique case studies of successful professional development initiatives.

Course Contents:
The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

1=weakly mapped 2= moderately mapped 3=strongly mapp

BIC304	Industry Internship	L	T	P	C
Version 1.0		0	0	4	4
Pre-requisites/Exposure	Basic concept about microbial techniques				
Co-requisites	-				

Course Objectives

1. To provide students the opportunity to test their interest in a particular career before permanent commitments are made.
2. To develop skills in the application of theory to practical work situations.
3. To develop skills and techniques directly applicable to their careers.
4. Internships will increase a student's sense of responsibility and good work habits.
5. To expose students to real work environment experience gain knowledge in writing report in technical works/projects.

Course Outcomes

On completion of this course, the students will be able to

- **Remember**: Identify and describe key concepts, terminology, and practices within the industry related to their internship experience.
- **Understand**: Explain the significance of industry standards and practices, and how they apply to real-world scenarios encountered during the internship.
- **Apply**: Demonstrate the ability to apply theoretical knowledge to practical tasks and projects within the workplace, showcasing problem-solving skills.
- **Analyze**: Evaluate workplace dynamics and processes, identifying areas for improvement and articulating insights gained from hands-on experience.
- **Evaluate**: Assess the effectiveness of various strategies used in the industry, providing constructive feedback based on internship experiences and outcomes.

Catalogue Description

The purpose of Industrial Internship is to expose students to real industry experience and also to gain the knowledge through hands on observation and job execution. From the industrial training, the students will also develop skills in work ethics,communication, management and others. Moreover, this practical training program allowsstudents to relate theoretical knowledge with its application in the industry.

Course Content

1. Visit industry or labs or research institutes related to Microbiology or allied life sciences and gain hands on experience related to practical work.

Modes of Evaluation: Quiz/Assignment/ presentation/ Extempore/ Written Examination
Examination Scheme:

Components	**Report**	**Presentation**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
Avg	3	3	3	1	3	3	3	3	3	-	-	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

SEMESTER VII

BIC401	**Plant Biochemistry**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	BOTANY BASIC FROM CLASS XII				
Co-requisites	--				

Course Objectives

2. To provide students the basic understanding of plant cell structure with emphasis to plant physiology.
3. To provide wholesome knowledge on plant specific biochemical pathways like photosynthesis and nitrogen metabolism.
4. Elaborating roles of phytohormones and secondary metabolites in growth and development of plants.
5. General overview of plant tissue culture.

Course Outcomes

CO1. Knowledge: Define and explain the basic principles of plant biochemistry including photosynthesis, respiration, and nitrogen metabolism.

CO2. Comprehension: Interpret and explain the impact of various abiotic and biotic stressors on plant physiology and biochemistry.

CO3. Application: Apply knowledge of plant transport processes to describe how nutrients and other molecules are transported within plants.

CO4. Analysis: Analyze the molecular mechanisms underlying plant stress responses at the biochemical level.

CO5. Evaluation: Critically evaluate the current research on plant stress responses and propose future directions for investigation.

Catalog Description

The core-course of 'Basics of Plant Sciences' is discipline specific elective subject which deals with the modern aspects of plant physiology and biochemistry. This course deals with plant cellular structure with emphasis to special organelles related to plant cells. It also includes topics related to plant specific biochemical pathways like photosynthesis, respiration and nitrogen fixation. Furthermore, it deals with the roles of phyto-hormones and secondary metabolites in plant growth and development. It also encompasses the very important industrially important plant tissue culture technique. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Plant Biochemistry

UNIT 1. Introduction to Plant cell structure: Plasma membrane, Vacuole and tonoplast membrane, cell wall, mitochondria, plastids and peroxisomes. Elementary idea of water potential, turgor pressure etc.

UNIT 2. Photosynthesis and Carbon assimilation: Structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.
Respiration: Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

UNIT 3. Nitrogen metabolism: Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase- glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals. Regulation of plant growth: Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.

UNIT 4. Secondary metabolites: Representatives alkaloid group, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids. Plant tissue culture: Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somaclonal variation.

UNIT 5. Applications of Plant Sciences. Experiential learning activities and experiments.

List of Labs: i) Study of seed germination.

ii) Qualitative study of carbohydrates in fruits.
iii) Study of Photosynthesis in plants.
iv) Molecular Biology of plants.
v) Tissue Culture Techniques.

TEXTBOOKS:

1. Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5

REFFERNCE BOOKS:

2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.
3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped

2= moderately mapped
3=strongly mapped

BIC402	**Developmental Biology**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY + Zoology				
Co-requisites	--				

Course Objectives

1. The objective of this course is to provide a comprehensive explaining of the concepts of early animal development. Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.
2. In this course a particular model system will not be discussed in detail. Instead, different concepts of animal development will be elaborated in one model system or the other. Once the concepts are taught the students will be made familiar with different approaches that have been used to study such concepts.
3. Further topics that will be discussed are stem cells and regeneration, the developmental basis of diseases as well as the developmental mechanisms of evolutionary change.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remembering- Recall the process of spermatogenesis, oogenesis and fertilization process.

CO2. Understanding-Explain about cleavage, blastulation, gastrulation fate map and perceive the knowledge to draw and analyse fate map in early embryos.

CO3. Applying-Explain and **correlate** the formation and differentiation of exoderm, endoderm and mesoderm. They will know about cell commitment and determination.

CO4. Analyzing-Perceive the knowledge how notogenesis, neurulation and development of eye in developmental biology is having a significant impact on our explaining of evolution and modern medicine, including the treatment of birth defects, infertility and cancer in humans.

CO5. Evaluating- Analyse appraise and discuss animal development to understand how evolution plays key role in developmental process using different tools and techniques

Course Description

Developmental biology is a multidisciplinary field that integrates genetics, molecular biology, biochemistry, cell biology, anatomy, physiology and computer modeling, giving students a scope in a

range of biological disciplines. In this course, use of stem cells to engineer replacement tissues and organs could revolutionize medicine. Continuation onto the modern language, integrated master's or industrial/professional experience course is dependent on certain academic criteria. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Developmental Biology

UNIT I: (25 hr)

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: (20 hr)

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism. Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: (15 hr)

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: (10 hr)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers.

UNIT V: (5 hr)

Developmental Biology **Applications**: **Analyse appraise** and **discuss** animal development to understand how evolution plays key role in developmental process using different tools and techniques

Proposed List of practicals:

1. Preparation of a temporary stained mount of chick embryo
2. Study of developmental stages of Chick embryo.
3. Study of different stages of Frog embryo.
4. Study of the developmental stages of *Drosophila* from photographs.
5. Drosophila culture in Lab
6. Study of different types of placenta.

Reference Books

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.

3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC403	**Genomics and Proteomics**	**L**	**T**	**P**	**C**
Version1.0	**Contact Hours -45**	2	1	1	4
Pre-requisites/Exposure	Basic genetics and protein biochemistry				
Co-requisites	--				

Course Objectives:

1. The course will provide an introduction to genomics.
2. The course will intricately describe various sequencing techniques
3. The course will offer outlines of state-of-the-art big data analysis approaches
4. The course will offer introduction to proteomics
5. The course will provide fundamental hands-on knowledge on structural modelling and visualization.

Course outcome:

1. Remembering: Recall the basic concepts and terminology related to genomics and proteomics, including genome sequencing, genome-wide screening, and genome editing.
2. Understanding: Explain the principles and techniques used in genome analysis tools like CHIP-SEQ, RNA-SEQ etc., and proteome anlaysis tools such as 2D-gel electrophoresis and mass spectrometry for proteomics research.
3. Applying: Apply knowledge of genomics and proteomics to interpret and analyze data from genome sequencing and proteomics experiments (MS-data).
4. Analyzing: Analyze and compare different methods of genome analysis and proteomics techniques for differential proteomics studies.
5. Creating: Design and implement experiments using genome analysis tools and proteomics techniques to investigate biological processes and functions at the molecular level.

Course Description:

The main aim of this module is to provide an understanding about the genomics and proteomics techniques and their applications in biological sciences. The subject deals with a rapidly evolving scientific are a that introduces students into genomes, proteomes, databases and nanobiotechnology that store various data about genes, proteins, genomes and proteomes. Students would learn about genomics, proteomics and nano biotechnology and offer basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications. Students would gain skills in comparative evolutionary, human genomics and functional genomics. The acquired knowledge during the course would be helpful to those students who want to work incorefacilitiesandcommercialbiologicalandmedicallaboratoriesaswellasintheirpostgr

aduate studies.

Course Content:

Genomics and Proteomics

Unit 1. Introduction **15Lecture**

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit2. Genome sequencing projects **5**

Lecture hours Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identificationandclassificationusingmolecularmarkers-16SrRNAtyping/sequencing, ESTs and SNPs.

Unit3. Proteomics **10Lecturehours**

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting;

Unit4. Quantitative Proteomics **5 lectures**

LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF;SAGE and Differential display proteomics, Protein-protein interactions. Yeast two hybrid system.

Unit V. Functional genomics and proteomics

1

0 Lecture hours Analysis of microarray data; Epigenomics, CHIP-seq, Protein and peptide microarray-based technology; PCR-directed protein *insitu* arrays; Structural proteomics: structure prediction and visualization

List of practical:

1. PCR amplification of 16SrDNA and analysis
2. Demonstration of sequence reads and analysis pipelines
3. SDS PAGE
4. Analysis of mass-spec data

5. Protein structural modelling and visualization

Experiential learning:

1. Attending on line small workshops on genome anlaysis
2. Small project works from avaikable genime project data
3. https://www.youtube.com/watch?v=qOW5e4BgEa4

Extra credit in offer:

NPTEL course:

Data Analysis for Biologists Prof. Biplab Bose, IITG

Structural Biology Prof. Saugata Hazra, IITR

Or a relevant one (up on due approval)

Suggested Books

1. Berg,J.M.,Tymoczko,J.L.andStryer,L.(2006).Biochemistry.VIEdition. W.HFreemanandCo.
2. Buchanan,B.,Gruissem,W.andJones,R.(2000)BiochemistryandMolecu larBiologyofPlants.AmericanSocietyofPlantBiologists.
3. Nelson,D.L.,Cox,M.M.(2004)LehningerPrinciplesof Biochemistry,4thEdition,WHFreemanandCompany,NewYork,USA.
4. Hopkins,W.G.andHuner,P.A.(2008)IntroductiontoPlantPhysiology.Jo hnWileyandSons.

Modes of Examination:

Assignment/Quiz/Project/Presentation/Written Exam Examination

Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

BIC404	**RESEARCH METHODOLOGY for BIOCHEMISTRY**	**L**	**T**	**P**	**C**
Version	**Contact Hours -**				
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology in industry and concept of basic and applied research.				
Co-requisites	--				

Course Objectives

1. To provide the students with understanding of research and its types along with identification of problem for conducting research.
2. It will also deal with the research methodology and work plan to be adopted for conducting research.
3. To study the scope of Good Laboratory Practice as an integral part of research and industrial laboratory.
4. To get introduced to various forms of quality management system (QMS) applied for biotechnological research as well as allied industries.

Course Outcomes

CO1. Remember: Recall and explain the fundamental principles of research methodologies in biochemistry.
CO2. Understand: Analyze and compare different research paradigms in biochemistry.
CO3. Apply: Design and implement appropriate study designs for biochemistry research projects.
CO4. Analyze: Evaluate the importance of Good Laboratory Practices (GLP) and work standards in biochemistry research.
CO5. Evaluate: Critically assess the validity and reliability of research findings in biochemistry.

Catalogue Description

This course is designed to introduce the concept of research methodology to the students and provide them with understanding of research and its types along with identification of problem for conducting research. The concept of GLP will be dealt at par with international guidelines that is followed in various industries. The course will also introduce various forms of quality management system (QMS) applied for biotechnological research as well as allied industries.

Course Content

RESEARCH METHODOLOGY

Unit I

Definitions and characteristics of research; Types of research; Main components of any research work. Problem identification, analyzing the problem and review of the literature

UNIT II

Research methodologies: Study population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; **Ethical considerations.**

UNIT: III

Work Plan; Fieldwork; Writing a research report. **Introduction to the WHO/TDR Handbook on GLP,** WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force (GHTF) Guidance docs, **Controlling the GLP** inspection process, Documentation, Audit, goals of Laboratory Quality Audit, **relevant ISO and Quality Council of India (QCI) Standards**

UNIT: IV

Good Automated Laboratory Practices, Principles of GALP, GALP Requirements, SOPs of GALP, Software Evaluation checklist, relevant ISO and QCI Standards, **Good Distribution Practices**, Introduction to GDP, Legal GDP requirements put worldwide, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), elevant CDSCO guidance and ISO standards

UNIT: V

Quality management systems, Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of Qualification, Validation master plan (VMP), Analytical Method Validation.

List of the Practical

1. **Patient application**
2. **Plagiarisms Checking**
3. **Ethical practice**
4. **Statistical analysis**
5. **Graphical Abstract**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quize tc	Regular evaluation	Atten dance	

Weightage (%)	10	5	30	5	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

BIC405	**Modern Techniques & Bioinstrumentation**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	UNDERSTANDING OF BASIC LEVEL OF BIOLOGY				
Co-requisites	A Bachelor's degree in any branch of Life Sciences / Technology				

Course Objectives

1. To familiarize students with various modern instrumentation techniques,
2. To increase students' understanding of principles behind different bio instruments
3. To build students' abilities to interpret data and to integrate results into decision making

Course Outcomes

On completion of this course, the students will be able to

1. Remembering- Students will be able to **explain** various fundamental components of laboratory instruments.
2. Understanding-Students will be able to **summarize** various tools and techniques of laboratory.
3. Applying-Students will be able to **understand** and interpret test results
4. Analysing-Students will be able to **outline** a research project that utilizes bioinstrumentations
5. Evaluating-Students will be able to **explore** the multidisciplinary areas that by the knowledge of bioinstrumentation

Catalog Description

By this course students will be able to learn basic concepts of physics and apply them to study the physicochemical properties of biomolecules. They will learn to investigate the light absorption properties of biomolecules through spectrophotometry, for qualitative and quantitative analysis of biomolecules. This course will enable them to understand mechanics of solids and liquids which will help them to understand the basic mechanisms of cell biology especially cell adhesion, migration and mechano-transduction.

Course Content

Modern Techniques & Bioinstrumentation (MIB)

Unit 1: Imaging and related techniques

Principles of microscopy; Light microscopy; Fluorescence microscopy; Electron Microscopy (a) Flow cytometry (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for

electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching. Radioisotopes Use in biological research, auto-radiography, pulse chase experiment.

Unit 2: pH and Centrifugation

pH meter: Principles and instrumentation, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation, application. Sonication, Freeze drying. Cell fractionation, sucrose density gradient, CsCl gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Spectrophotometry

Principle involved in Spectrophotometer; Basic principles of electromagnetic radiation, energy, wavelength, wave numbers and frequency. Review of electronic structure of molecules (Molecular Orbital theory), absorption and emission spectra. Beer-Lambert law, light absorption and its transmittance. Spectrophotometric techniques, Instrumentation: ultraviolet and visible spectrophotometry (single and double beam, double wavelength spectrophotometers), Infrared spectrometers - Luminometry and densitometry – principles and their applications - Mass Spectroscopy-principles of analysis, application in Biology. Characterization of proteins and nucleic acids; X-ray crystallography, NMR; Characterization of proteins and nucleic acids; Electrophoresis: PAGE, SDS-PAGE

Unit 4: Chromatography

Chromatographic techniques: Principle and applications – TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Column - thin layer –paper, affinity and gas chromatography - Gel filtration - Ion exchange and High-performance liquid chromatography techniques– Examples of application for each chromatographic system - Basic principles of electrophoresis. UV and visible spectrophotometry-principles, instrumentation and applications. Fluorescence spectroscopy, static & dynamic quenching, energy transfer, fluorescent probes in the study of protein, nucleic acids, Infra-red spectroscopy, light scattering in biology, circular dichroism.

Unit 5: Electrophoretic Techniques

Theory, Principle, Apparatus, Methods and Applications of Paper Electrophoresis, Poly Acrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis. Principle and Applications of: Iso-electric Focusing, Immuno Electrophoresis, Enzyme Linked Immunosorbant Assay (ELISA), Southern, Northern and Western Blotting

List of Practicals:

1. Efficacy testing of autoclave employing chemical and biological autoclave indicators.
2. Standardization of pH meter using standard buffers.
3. Studies on pH titration curves of amino acids/acetic acid and determination of pKa values

and Handerson-Hasselbach equation.

4. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC and Paper Chromatography.
5. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
6. Paper Electrophoresis of proteins.
7. Separation of Proteins/Nucleic acids by gel electrophoresis.
8. Density gradient centrifugation.

Textbooks:

1. Principles of Biochemistry (Lehninger) (5th edition), MM Cox and DL Nelson, CBS Publishers.
2. Molecular Biology by David Freifelder, ISBN:9780867200690, 0867200693 Publisher:Jones and Bartlett
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by David Freifelder, ISBN:9780716714446, 0716714442; Publisher: W. H. Freeman
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by Freilder, D. Freeman, San. Francisco, 1976
5. Biochemical Techniques: Theory and Practice by Robyt, John F.; White, Bernard J. Waveland Press, Inc., U.S.A. Published: 1990.

Reference:

1. Biochemistry (4th edition): D Voet and JE Voet, 2011 John Wiley and Sons.
2. Molecular Cell Biology, (6th edition) Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, and James Darnell. WH Freeman Publication

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

PDC401	Professional Development Course-V	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
Co-requisites	Completion of PDC-4 course				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course learning outcomes:

CO1. Remembering
Identify key concepts and principles of professional development.
CO 2. Understanding
Explain the importance of lifelong learning and continuous improvement in a professional context.
CO 3. Applying
Utilize effective communication strategies in professional interactions.
CO 4. Analyzing
Assess personal strengths and weaknesses to create a targeted development plan.
CO 5. Evaluating
Critique case studies of successful professional development initiatives.

Course Contents:
The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.

5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

1=weakly mapped 2= moderately mapped 3=strongly mapped

SEMESTER VIII

MIB406	Biostatistics and Biomathematics	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic concept of Mathematics and biology				
Co-requisites	--				

Course Objectives

1. To provide those students with apt the knowledge to mathematics and statistics
2. It will also provide in depth knowledge of the mathematical modeliing.
3. Elaborating the measures of central tendency, Correlation and
4. Explore the knowledge of the statistical inference and applications of biostatistics

Course Outcomes

Upon completion of this course, students will be able to:

1. Remember:
- Define and explain key concepts in biostatistics and biomathematics, such as central tendency, sampling techniques, statistical tests, vectors, calculus, and biomathematical modeling.

2. Understand:
- Select and conduct suitable statistical tests to analyze biostatistical data.

3. Apply:
- Utilize vectors and calculus in the context of biomathematics to solve real-world problems.

4. Analyze:
- Analyze the accuracy and precision of biomathematical models in predicting biological outcomes.

5. Create:
- Design and conduct biostatistical experiments and biomathematical simulations to address specific research questions.

Catalogue Description

The course of 'Biomathematics and Biostatistics' will help to understand the introductory level knowledge to statics in the field of biological science. This course is a beginning to the biostatistics, the application of different biostatistics methods to biological data analysis, different measures of central tendency, correlation and regression and some possible applications of biostatistics. Furthermore, the current research activities in the field of biostatistics would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Biostatistics and Biomathematics [MIB406]

Unit 1. Sampling and distribution (9 h): Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Standard Deviation and Correlation, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic introduction to Multivariate statistics, etc.

Unit 2. Central tendency, correlation, and regression (9 h)
Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions

Unit 3. Biomathematics (9 h)
Sets. Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc., increasing, decreasing and, periodicity of the functions. Sequences - finite sequences, recursion and difference equations, the Fibonacci sequence branching habit of trees and breeding habit of rabbits.Intuitive idea of algebraic relationships and convergence. Infinite Geometric Series. Series formulas, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

Unit 4. Calculus (9 h): Differentiation, Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations. Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Product of matrices upto order 3.

Unit 5. Vectors (9 h): Physical quantities like position and force as vectors, Attracting and repelling charges, Vector addition- Calculation of magnitude and direction of a vector, Unit vectors, Calculation of resultant force; Dot product and cross product, Polar coordinate system, Gradient of a scalar. Applications of calculus and vector algebra in biology. Nernst equation, Potential difference across a membrane, Flow of ions due to diffusion, Flow of ions due to electrostatic interactions. Diffusion equation Continuity equation, Diffusion equation. Mean-square position Mean-square displacement.

Lab courses:

1. Simple model for polymerization depolymerisation.
2. Modelling using ODE
3. Simplest model in population genetics/evolution and Wright-Fisher model.
4. Application of statistics SPSS/ PRISM: Test of normality, One Sample t test, One sample Wilcoxon test, independent samples t test, Mann Whitney U test, Paired samples t test, Wilcoxon signed rank test, One Way ANOVA, Kruskal Wallis H test, correlation and regression analysis.
5. PLOTTER/ ORIGIN: Statistical Graphics

Experiential learning:

1. Data analysis workshop
2. Problem (numerical) solving
3. Video lectures:
https://www.youtube.com/watch?v=VPZD_aij8H0&list=PLUl4u3cNGP60uVBMaoNERc6knT_MgPKS0&ab_channel=MITOpenCourseWare

Extra credit in offer:

NPTEL course:

.
Biostatistics and Design of experiments *Prof. Mukesh Doble* *IITM*

Or a relevant one (up on due approval)

Text Books:
1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA

Reference Books:
1. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
2. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley andSons Inc.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment (including lab)	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC407	CANCER BIOLOGY	L	T	P	C
Version 1.0	Contact Hours - 60	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of cell biology, immunology, genetics				
Co-requisites	--				

Course Objectives

- Students will **understand** the basic concept of malignant transformation in carcinogenesis, different forms of cancers and the risk factors contributing to it.
- Students will **appraise** the molecular basis of cancer considering the role of cellular components together with genetic and epigenetic factors in initiation and progression of cancer.
- Students will be able to **assess** how cancer cells sabotage the normal metabolomics of a healthy cell and these cellular components are used to generate and utilize energy in cells
- Students will be able to **evaluate** the contribution of GOF and LOF in epidemiology of different cancers and the therapeutic strategies to combat the effect.
- Students will be able to **apply** their theoretical knowledge to identify and characterize cancer cells and distinguish between malignant and healthy cells.

Course Outcomes

On completion of this course, the students will be able to

CO 1 **Remembering-Recall** malignant transformation of cells and identify different types of cancers along with risk factors contributing to it.

CO 2 **Understanding-classify** causes of molecular carcinogenesis process.

CO 3 **Applying-compare** between the metabolomics of normal vs. cancer cells.

CO 4 **Analysing -choose** the preferred chemotherapeutic/chemo preventive drug for different types of carcinogenesis based on the mode of action.

CO5 **Evaluate-Identify** features of cancer cells and **compare** and **contrast** tumor cells and healthy cells

Catalog Description

The core-course of 'Cancer Biology' will help to understand the classification, structure and function of different carcinogenic compounds affecting animals. This course provides a comprehensive approach to study molecular mechanism of carcinogenesis and subsequent progression of cancer in humans. It also encompasses the role of genetic and epigenetic factors, viruses and different physical and chemical carcinogens in induction of carcinogenesis. Furthermore, the application of therapeutics and gene delivery would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Cancer Biology

Unit I: Fundamentals of cancer biology
(12 Hrs)
Regulation of Cell cycle, Apoptosis, Mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, Modulation of cell cycle-in cancer, Programmed cell death and apoptosis,

Unit II: Clinical form of malignancy
(12 Hrs)
Different forms of cancers, Diet and cancer. Epidemiology of different cancer. Process of malignant transformation and cellular features of transformed cells
Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement membrane disruption, three step theory of invasion, Proteinases and tumour cell invasion.

Unit III: Mutations; Oncogenes and Tumor suppressor genes
(12 Hrs)
Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as

transcriptional activators. X-Ray radiation and chemical carcinogenesis Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes. Oncogenes / Proto Oncogenes activity. Growth factors related to transformations.

Unit IV: Cancer cell metabolism
(12 Hrs)
Metabolic reprogramming of cancer, role of oncometabolites and acidosis, anabolism promoting cell growth, metabolism of glutamine, fatty acids, nucleotides, signaling pathways regulating tumor cell metabolism, effects on bioenergetics and redox balance

Unit V: New molecules for cancer therapy
(12 Hrs)
Different forms of therapy, Chemotherapy, Radiation Therapy, Gene therapy, targeting metabolism for cancer therapy, Detection of Cancers, Microarray, Prediction of aggressiveness of Cancer, Advances in Cancer detection.

Practical application of cancer biology
Cell culture (normal vs cancer cells) (demo)
Observation of immunohistochemical slides
Case study of solid tumor
Epidemiological study of cancer

Reference book:

1. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics by Lauren Pecorino, 2016
2. The Biology of Cancer by Robert A. Weinberg,2006
3. Introduction to the Cellular and Molecular Biology of Cancer by Margaret A. Knowles,2005

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped 3=strongly mapped

MIB408	**Biomedical Nanotechnology**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge in Biology and Chemistry				
Co-requisites	--				

Course Objectives

This course provides an introduction to the principles and applications of nanotechnology in the field of biomedicine. It covers the fundamental concepts of nanomaterials, nanofabrication techniques, and their applications in drug delivery, diagnostics, tissue engineering, and biosensing. The course also explores the ethical and safety considerations associated with biomedical nanotechnology.

Course Outcomes

By the end of this course, students will be able to:

CO1. Remembering-Recall novel function resulted from the nanoscale structures using scientific and technological principles
CO2. Understanding-Gain knowledge of various nanoscale fabrication and characterization techniques
CO3. Applying-Apply the unique elements of nanostructure materials for biomedical applications
CO4. Analyzing-Assess the present and ever-developing state-of-art biomedical nanotechnology in the areas of tissue engineering, and stem cell research by considering the elements unique to nanostructure materials, nanostructures, nanofabrication techniques, and cell behavior
CO5. Evaluate-Gain knowledge of risk assessment, toxicity, societal and ethical implications of biomedical nanotechnology.

Catalogue Description

This course provides an overview of nanotechnology, fabrication, characterization and functions of nanoscale structures, and serves as an introduction to major areas in biomedical sectors influenced by developments in nanotechnology. Moreover, this course provides the platform to improve the students' oral and written communication skills.

Course Content

Unit 1: Introduction to Nanotechnology and Nanomaterials (10 h)

Definition and scale of nanotechnology, Historical overview and key milestones, Interdisciplinary nature and applications in biomedicine, Introduction to nanomaterials (metals, polymers, carbon-based, piezoelectric crystals, etc.)

Unit 2: Synthesis and Characterization of Nanomaterials (10h)
Fabrication methods (top-down and bottom-up approaches), Characterization techniques (microscopy, spectroscopy, etc.)

Unit 3: Applications of nanotechnology in medicine (10h)
Challenges in conventional drug delivery systems, Nanoparticles and nanocarriers for targeted drug delivery, Controlled release systems, Imaging techniques at the nanoscale (fluorescence, magnetic resonance, etc.)

Unit 4: Nanotechnology in Tissue Engineering and Regenerative Medicine (10h)
Biomaterials for tissue engineering, Scaffold design and fabrication techniques, Application of nanotechnology in organ regeneration, Integration of nanomaterials and microfluidics

Unit 5: Safety and Ethical Considerations in Biomedical Nanotechnology (10h)
Toxicity and risk assessment of nanomaterials, Regulatory frameworks and guidelines, Societal and ethical implications

List of practicals: (10h)
1. Synthesis of metallic nanoparticles (e.g., gold, silver) using chemical reduction methods or green synthesis approaches.
2. Characterization of nanoparticles using UV-Vis spectroscopy.
3. Investigation of nanoparticle-biomolecule interactions using fluorescence spectroscopy.
4. Case studies exploring real-world applications of nanobiotechnology and their implications for healthcare, environment, and society.

Text Books:
1. Malsch, N.H., “Biomedical Nanotechnology”, CRC Press. (2005).
2. Mirkin, C.A. and Niemeyer, C.M., “Nanobiotechnology II: More Concepts and Applications”, Wiley-VCH. (2007).
3. Kumar, C. S. S. R., Hormes, J. and Leuschner C., “Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact”, WILEY -VCH Verlag GmbH & Co. (2005).

Reference Books:
4. Lamprecht, A., “Nanotherapeutics: Drug Delivery Concepts in Nanoscience”, Pan Stanford Publishing Pte. Ltd. (2009).
5. Jain, K.K., “The Handbook of Nanomedicine”, Humana press. (2008).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MIB452	**Fundamentals of Nanobiotechnology**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge in Biology and Chemistry				
Co-requisites	--				

Course Objectives

This course offers an overview of nanotechnology's principles and uses within biomedicine. It delves into key topics such as nanomaterials, fabrication methods, and their roles in drug delivery, diagnostics, tissue engineering, and biosensing. Additionally, the course examines the ethical and safety implications inherent in biomedical nanotechnology.

Course Outcomes

By the end of this course, students will be able to:

CO1. Remembering-Understand the fundamentals of nanotechnology and biotechnology.

CO2. Understanding- Interpret data obtained from characterization experiments.

CO3. Analysing-toxicity and biocompatibility considerations associated with nanomaterials.

CO4. Applying-Explore the design and functionality of drug delivery systems utilizing nanocarriers, targeted delivery, and controlled release.

CO5. Evaluate -Investigate the ethical, social, and environmental implications of nanobiotechnology.

Catalogue Description

This course offers a comprehensive examination of nanotechnology, including its principles, fabrication methods, characterization techniques, and the diverse functionalities of nanoscale structures. It also serves as an introduction to key biomedical fields impacted by advancements in nanotechnology. Furthermore, the course aims to enhance students' abilities in both oral and written communication.

Course Content

Unit 1: Introduction to Nanobiotechnology

- Overview of nanotechnology and biotechnology.
- Introduction to nanomaterials and their properties.
- Applications of nanobiotechnology in healthcare, agriculture, and environmental remediation.

Unit 2: Nanomaterial Synthesis and Characterization

- Methods for the synthesis of nanoparticles (e.g., chemical reduction, sol-gel, template-assisted).
- Characterization techniques: TEM, SEM, AFM, XRD, DLS, and FTIR.

Unit 3: Interactions of Nanomaterials with Biological Systems

- Cellular uptake mechanisms of nanoparticles.
- Nanoparticle-biomolecule interactions.
- Toxicity and biocompatibility considerations.
- Lab session: Cellular uptake assays and toxicity testing.

Unit 4: Applications of Nanobiotechnology

- Drug delivery systems: Nanocarriers, targeted delivery, and controlled release.
- Biosensors and diagnostic assays: Nanoparticle-based detection platforms.
- Tissue engineering and regenerative medicine: Scaffold design and functionalization.
- Lab session: Design and fabrication of a nanobiotechnology-based application.

Unit 5: Emerging Trends and Future Directions

- Nanobiotechnology in personalized medicine and precision agriculture.
- Challenges and opportunities in commercializing nanobiotechnology products.
- Ethical, social, and environmental implications.
- Research project: Proposal and presentation on an emerging topic in nanobiotechnology.

List of practicals:

1. Synthesis of metallic nanoparticles (e.g., gold, silver) using chemical reduction methods or green synthesis approaches.
2. Characterization of nanoparticles using UV-Vis spectroscopy.
3. Investigation of nanoparticle-biomolecule interactions using fluorescence spectroscopy.
4. Case studies exploring real-world applications of nanobiotechnology and their implications for healthcare, environment, and society.

Text Books:

1. Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
2. Mirkin, C.A. and Niemeyer, C.M., "Nanobiotechnology II: More Concepts and Applications", Wiley-VCH. (2007).
3. Kumar, C. S. S. R., Hormes, J. and Leuschner C., "Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact", WILEY -VCH Verlag GmbH & Co. (2005).

Reference Books:

4. Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2009).
5. Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2008).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC453	**Drug Design and Development**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours -**				
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. Develop concepts of protein folding and modelling
2. Mechanistic perception of drug-receptor interaction
3. To develop concept of drug development from laboratory to application

Course Outcomes

CO1 Remembering-Identify different stages of drug development process.
CO2 Understanding-Explain the principles and techniques of drug design and development.
CO3 Analysing-Utilize computational tools and software for drug design.
CO4 Applying-Evaluate the efficacy and safety of potential drug candidates.
CO5 Evaluate-Assess strategies for optimizing drug design process and design a comprehensive drug development plan for a specific target.

Catalog Description

The course of '**Drug Design and Development'** would primarily aim identifying drug targets and candidate molecules. Also, the course would deal with details of gene expression regulation. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit I:

Introduction to Drug design, Lead compounds and Pro-drug Concept. Development of new drugs: Introduction, procedure followed in drug design, prodrugs and soft drugs, prodrug; introduction, prodrug formation of compounds containing various chemical groups, multiple prodrug formation, soft drugs; design of soft drugs.

Unit II:

SAR and QSAR Studies in drug discovery Structure-Activity Relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isosterism, bioisosterism, spatial considerations, biological properties of simple functional groups. Theories of drug activity, occupancy theory, rate theory, induced-fit theory. Quantitative structure-activity relationship (QSAR): history and development of QSAR, drug receptor interactions, the additivity of group contributions

Unit III

QSAR Approaches in drug designing and modern methods in discovery Hansch analysis- Advantages and drawbacks. Free Wilson analysis, Advantages and drawbacks. Introduction to molecular modelling using computers and docking, uses of molecular modelling manual use, further computer programming.

Unit IV:

Designing of Enzyme Inhibitors as drugs Structure-based drug design: Process of structure-based drug design, deactivation of certain drugs necessary for T cell functioning, determination of the active site with special reference to chymotryspin, design of inhibitors. Design of Enzyme Inhibitors, 9-alkylpurines, 9-mercaptopurines and allopurines, active site directed irreversible enzyme inhibition, suicide enzyme inactivators

Unit V:

Development of New drugs high throughput screening. Drug design software and its applications, industrial designs, geographical indications, trademarks, trade secrets. Patentable inventions. Patentable drugs. Role of patents in pharmaceutical industry. Patent writing for drug designed. Examples of new drugs developed.

List of the practical:

Quantitative structure-activity relationship study
Designing of enzyme inhibitors as drug
High throughput screening for drug
Patent writing for drug designed

Text Book:

1. S. S. Pandeya and J. R. Dimmock, An Introduction to Drug Design New Age International (P) Ltd. Publishers, 2007.
2. E. Wolf Burge`s Medicinal Chemistry and Drug Discovery Vol 1 (9 and 14), John Wiley and Sons, New York, 1997.
3. Alen-Gringauz, Introduction to Medicinal Chemistry, 1st edition, WileyVCH,1996.
4. D. Lednicer and L. A. Mitscher, The Organic Chemistry of Drug Synthesis, Vol. I to V, John Wiley, 2005.

Experiential learning:

1. Consulting recent articles on drug development
2. Videos on drug discovery pipelines: https://www.youtube.com/watch?v=s-SoJpQB4mA&ab_channel=OxfordChemistry

Extra credit in offer:

NPTEL course:

Computer Aided Drug Design By Prof. Mukesh Doble, IIT Madras
Or a relevant one (up on due approval)

Reference Book:

1. Alen-Gringauz, Introduction to Medicinal Chemistry, Wiley-VCH, 1997.
2. R.B. Silverman, Organic Chemistry of Drug design and Drug action, 3rdedition, Academic Press, 2014.
3. A. Leach, Molecular Modelling: Principles and applications, 2nd edition, Pearson India, 2001.
4. Norman Bailey, Statistical methods in Biology, 3rd edition, Cambridge University Press, 1995.
5. P. Krogsgaard-Larsen, U. Madsen, T. Liljefors A Textbook of Drug Design

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

BIC409	**Dissertation**	**L**	**T**	**P**	**C**
Version 1.0		0	0	12	12
Pre-requisites/Exposure	Concept of Microbiology and allied subjects at UG				
Co-requisites	--				

Course Objectives

1. This will enable students to design, evaluate and present scientific work

2. Students will learn to deduce evidence-based conclusions.

3. Skill of presentation and scientific content writing will be improved.

Course Outcomes

On completion of this course, the students will be able to

- **Remember**: Recall and define fundamental research concepts, methodologies, and ethical considerations relevant to their field of study.
- **Understand**: Summarize existing literature and articulate the significance of their research question within the broader academic context.
- **Apply**: Implement appropriate research methods and techniques to gather and analyze data effectively, demonstrating proficiency in using relevant tools and technologies.
- **Analyze**: Critically assess data and findings, identifying patterns, relationships, and discrepancies to derive meaningful conclusions related to the research question.
- **Evaluate**: Formulate well-reasoned arguments and critiques of their own work and that of others, considering various perspectives and methodologies within the discipline.

Catalogue Description

The core-course of 'dissertation' will enable the students to nurture their research interest by compiling basic knowledge obtained in three years of their education together with novel ideas from contemporary research. An idea about appropriate application of microbiological and biotechnological skill for industrial and research purpose can be developed. With the potential to design and evaluate scientific investigations the students will learn to comprehend conclusions based on experimental evidences. The entire literature review work and experimentation focuses on practical implementation of knowledge. Students will perceive the basic concepts of the subject via exercise and discussions with the mentor.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Components	**Report/Thesis submission**	**Presentation**
Weightage (%)	**50**	**50**

Examination Scheme:

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
Avg	3	3	3	1	3	3	3	3	3	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped