DEPARTMENT OF BIOCHEMISTRY

(DST-FIST Sponsored Department)

BHARATHIDASAN UNIVERSITY

(NAAC Re-accredited with Grade A^{+})

SCHOOL OF LIFE SCIENCES

BHARATHIDASAN UNIVERSITY

TIRUCHIRAPPALLI - 620 024

SYLLABI AND COURSE OF STUDY FOR

M.Sc. DEGREE PROGRAMME IN BIOCHEMISTRY

(Semester Pattern – Autonomous)

BASED ON CHOICE BASED CREDIT SYSTEM

Effective from 2025-2026 onwards

PROGRAMME OUTCOMES (PO)

PO1	• PG Graduands are Professionally Competent with characteristic **Knowledge-bank, Skill-set, Mind-set** and **Pragmatic Wisdom** in their chosen fields.
PO2	• PG Graduands demonstrate the desired sense of being **seasoned** and exhibit unequivocal **Spiritedness** with excellent qualities of productive contribution to **society** and **nation** in the arena of Science and Technology.
PO3	• PG Graduands are mentored such that they exert **Leadership Latitude** in their chosen fields with **commitment to novelty** and **distinction**.
PO4	• PG Graduates are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining **Cultural** and **Civilized** personality.
PO5	• PG Graduates are able to collate the information from different kinds of sources and gain a coherent understanding of the subject.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1	• The course aims at gaining an understanding of the processes of metabolic transformation at the molecular level and how these processes are studied.
PSO2	• It is important to study enzymes, the rate limiting molecules of all the chemical reactions and understanding enzymes could pave research ideas.
PSO3	• Students can make the Knowledge of the relationship between structure and function at organ and/or organism level, of important cell biological communication principles and processes, and how they are regulated.
PSO4	• Students are able to Characterize certain functionalities of biomolecules by using spectroscopic techniques.
PSO5	• Students will gain conceptual understanding of subject matter, scientific reasoning skills, laboratory manipulative skills.
PSO6	• The course aims to give participants a basic knowledge of mechanisms of signal transduction and the significance of signal transduction in physiology and pathophysiology.
PSO7	• Students can understand the capacity to evaluate and synthesize information from a wide range of sources in order to communicate ideas, concepts and construct arguments in both non-scientific and scientific language.

REGULATIONS

I. Name of the Program

Bharathidasan University is offering a two-year M.Sc. Degree Program in Biochemistry to be conducted in the Department of Biochemistry, School of Life Sciences, Bharathidasan University.

II. Eligibility for Admission to the Program

A pass in B.Sc. Degree (10 + 2 + 3 pattern) with Biochemistry / Biotechnology / Microbiology / Molecular Biology / Biology / Life Sciences / Botany / Zoology / Nutrition and Dietetics / Chemistry / Clinical Laboratory Technology or any relevant degree in biological sciences from any recognized university in India or abroad.

III. Duration of the Program

The Program is for a period of two years. Each year shall consist of two semesters, viz. Odd and Even semester. Odd semester shall be from June/July to October/November and Even semester shall be from November/December to April/May. There shall be not less than 90 working days which shall comprise 450 teaching hours for each semester (exclusive of the days for the conduct of university end-semester examinations).

IV. Course

Each Course is designed with lectures/tutorials/laboratory/seminar/ practical training/assignments/term paper or report writing etc., to meet effective teaching and learning requirements.

V. Semesters

In each semester, Courses are offered in 15 teaching weeks and the remaining 5 weeks are to be utilized for conduct of examinations and evaluation purposes. Each week shall have 30 working hours spread over 5/6 days a week.

VI. Credits

The term "Credit" refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. For instance, a six-hour course is assigned four to six credits, four/five-hour course is assigned three to five credits. However, in no instance the credits of a course can be greater than the hours allotted to it. The total minimum credits required for awarding M.Sc. Biochemistry is 95.

VII. Condonation

Students must have 75% of attendance in each semester to appear for the examinations. Students who have attendance between 65% and 74% shall apply for condonation in the prescribed form with the prescribed fee. Students who have attendance between 50% and 64% shall apply for condonation in prescribed form with the prescribed fee along with the Medical Certificate.

Students who have attendance below 50% are not eligible to appear for the examinations. They shall re-do the semester(s) after completion of the Program (i.e. after 2 years).

VIII. Examinations

1. There shall be examinations at the end of each semester, for odd semesters in the month of October/November; for even semesters in April/May.
2. A candidate who does not pass the examination in any course(s) may be permitted to appear in such failed course(s) in the subsequent examinations to be held in October/November or April/May. However, candidates who have arrears in practical's shall be permitted to appear for their arrears in practical examination only along with regular practical examination in the respective semester.
3. A candidate should get registered for the first semester examination. If registration is not possible owing to shortage of attendance beyond the condonation limit/regulation prescribed OR belatedly joining OR on medical grounds, the candidates are permitted to move to the next semester. Such candidates shall re-do the missed semester after completion of the course.
4. Viva-voce: Each candidate shall be required to appear for the Viva-voce examination in defense of the project during the last semester.

IX. Project

Each candidate shall be required to take up a project work in the fourth semester and submit it at the end of the final year. The candidate will be permitted to take up the project in recognized institutions in India and Abroad. The Head of the Department shall assign the Guide for those candidates who prefer to do their project work within the department. A copy of the project report will be submitted to the department through the Head of the Department on or before the date fixed by the department. The project will be evaluated by an internal and an external examiner nominated by the Head of the Department. The candidate concerned will have to defend his/her project through a viva-voce examination.

X. Question Paper Pattern

- Section A: 10 Questions x 2 Marks = 20 Marks (Two questions from each unit)
- Section B: 5 Questions x 5 Marks = 25 Marks (Internal Choice and one set of questions from each unit)
- Section C: 3 Questions x 10 Marks = 30 Marks (Answer any 3 out of 5 questions; one question from each unit)

XI. Evaluation

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points. Evaluation for each course shall be done by a Continuous Internal Assessment (CIA) by the course teacher concerned as well as by an end semester examination and will be consolidated at the end of the semester. The components for continuous internal assessment are:

Theory (Internal)	
Best 2 CIA out of 3	- 15 Marks
Seminar	- 05 Marks
Assignments	- 05 Marks
Total	25 Marks

Practical (Internal)	
Continuous performance	- 10 Marks
Model practical	- 05 Marks
Record	- 05 Marks
Viva	- 05 Marks
Total	25 Marks

Attendance need not be taken as a component for continuous assessment, although the students should secure a minimum of 75% attendance in each semester. In addition to the continuous evaluation component, the end semester examination, which will be a written-type examination of at least 3 hours duration, would also form an integral component of the evaluation. The ratio of marks allotted to continuous internal assessment and to the end semester examination is 25:75. The evaluation of laboratory components / Internship / Project, wherever applicable, will also be based on continuous internal assessment and end-semester practical examination with 25:75 ratio.

XII. Passing Minimum

A candidate shall be declared to have passed in each course if he/she secures not less than 40% marks in the University Examinations and 40% marks in the CIA and not less than 50% in the aggregate, including CIA and University Examinations marks.

Candidates who have secured the pass marks in the end-semester Examination (U.E.) and in the CIA, but failed to secure the aggregate minimum pass mark (U.E. + C.I.A. - 50%) are allowed to secure an aggregate minimum pass mark by appearing for the University Examination only.

Candidates who have failed in the Internal Assessment (CIA) are permitted to appear for their Internal Assessment marks in the subsequent semesters (2 chances will be given) by writing the CIA tests and assignments. A candidate shall be declared to have passed in the project work if he/she gets not less than 40% in each of the project report and viva-voce but not less than 50% in the aggregate of both the marks for project report and Viva-voce.

A candidate who gets less than 40% in the project must resubmit the project report. Such candidates need to defend the resubmitted project at the viva-voce within a month. A maximum of 2 chances will be given to the candidate.

XIII. Guidelines for Award of Moderation marks

Moderation of maximum 5 marks is given to each semester to cover all the theory subjects appeared by the students for the Regular and Supplementary Examinations. No moderation marks for the practical subjects. No moderation will be given to the failed subjects due to want of / less internal marks (got minimum pass in the external but failed due to low internal marks).

Moderation marks will be given only to the subject that requires passing minimum marks in University examination (external only) as specified in the curriculum and not for the improvement of grades obtained. While allotting moderation marks, the subject(s) require less moderation marks (ascending order- 1, 2, 3, 4, and 5) will be given priority.

If the external marks obtained are same in two subjects (less than passing minimum) among the subjects in a semester, for allotting moderation marks the subject(s) having more internal marks will be given priority irrespective of the subjects want of moderation marks.

Again, the internal marks are same in both the subjects, the allocation of moderation marks goes as per the subject order listed in the curriculum of the respective semester/degree programme. During the allocation of marks, if any subjects need moderation marks more than the balance available in the semester, moderation marks will not be given. Any balance moderation marks available in a semester will not be carried over to next semester.

XIV. Guidelines for Revaluation Procedures and final marks fixation

Revaluation of the answer papers will be done by the subject experts from other Institutions/Department faculty as per Bharathidasan University norms.

XV. Ranking: University Rank Examination

1. The University Rank Examination shall be conducted for the topper (First Ranker) of the university department along with all the colleges (topper having passed their examinations in the first appearance within the prescribed duration of the program) including autonomous / non-autonomous streams and they are required to write an examination. Absence from an examination shall not be taken as an attempt.
2. The question papers of the examinations comprise objective type questions covering the core courses of Biochemistry stream.
3. The top scorers in this University Rank Examination would be declared as University Rank Holders, irrespective of their grades in their respective University end semester examinations.

XVI. Grading System

1. Grading

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added. The marks thus obtained, will then be graded as per the scheme provided in Table 1. From the second semester onwards the total performance within a semester and the continuous performance starting from the first semester are indicated by Semester Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA), respectively. These two are calculated by the following formulae:

$$\text{GPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i} \qquad \text{WAM (Weighted Average Marks)} = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$$

where 'Ci' is the Credit earned for the Course i; 'Gi' is the Grade Point obtained by the student for the Course i . 'M' is the Marks obtained for the course i and 'n' is the number of Courses **passed** in that semester.

CGPA = Average GPA of all the Courses starting from the first semester to the current semester.

2. Classification of Final Results

a) The classification of final results shall be based in the CGPA, as indicated in Table 2.

b) For the purpose of Classification of Final Results, the candidates who earn the CGPA 9.00 and above shall be declared to have qualified for the Degree as "Outstanding". Similarly, the candidates who earn the CGPA between 8.00 and 8.99, 7.00 and 7.99, 6.00 and 6.99, and 5.00 and 5.99 shall be declared to have qualified for their Degree in the respective program as "Excellent", "Very Good", "Good", and "Above Average" respectively.

c) Absence from an examination shall not be taken as an attempt.

Table 1: Grading of the Courses

Marks Range	Grade Point	Corresponding Grade
90 and above	10	O
80 and above but below 90	9	A+
70 and above but below 80	8	A
60 and above but below 70	7	B+
50 and above but below 60	6	B
Below 50	N.A	R.A

Table 2: Final Result

CGPA	Corresponding Grade	Classification of Final Results
9.00 and above	O	Outstanding
8.00 to 8.99	A+	Excellent
7.00 to 7.99	A	Very Good
6.00 to 6.99	B+	Good
5.00 to 5.99	B	Above Average
below 5.00	R.A.	Re-Appear

Credit based weighted Mark System is to be adopted for individual semesters and cumulative semesters in the column 'Marks Secured' (for 100)

DEPARTMENT OF BIOCHEMISTRY,
BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI-24
M.Sc. Biochemistry Course Structure (2025-2026 onwards)

S.No	Semester	Category	Course Code	Course Title	Hrs/ week	Credit
1	I	Core 1	25BC101CR	Biomolecules	6	5
2		Core 2	25BC102CR	Enzymes	6	5
3		Core 3	25BC103CR	Biochemical Techniques	6	5
4		Core 4	25BC104CR	Laboratory Course-I	6	5
5		Value added course	*25BC101VAC	Artificial Intelligence in Pharma and Biotech Industries	3	0
6		@ Elective	25BC101DCE	Cell Biology	3	3
			25BC102DCE	Bio-Entrepreneurship		
			25BC103DCE	Developmental Biology		
			25BC104DCE	Genetics		
			25BC105DCE	General Microbiology		
				TOTAL	**30hrs/ Week**	**23**

7	II	Core 5	25BC201CR	Intermediary Metabolism	5	5
8		Core 6	25BC202CR	Molecular Biology	5	5
9		Core 7	25BC203CR	Biochemistry of Signal Transduction	5	5
10		Core 8	25BC204CR	Laboratory Course-II	6	5
11		Value added Course	*25BC201VAC	Data Science in Healthcare	3	0
12		@ Elective	25BC201DCE	Human Physiology	3	3
			25BC202DCE	Bioinformatics		
			25BC203DCE	Molecular Endocrinology		
			25BC204DCE	Ecology and Environmental Biology		
			25BC205DCE	Research Methodology		
13		Non-Major Elective	#	Non-Major Elective 1	3	2
14		$$MOOC (NPTEL/Swayam)		Online Course	$	$
		**Internship / Industrial Activity during summer vacation.				
TOTAL					**30hrs/ Week**	**25**

15	III	Core 9	25BC301CR	Immunology	5	5
16		Core 10	25BC302CR	Genetic Engineering	5	5
17		Core 11	25BC303CR	Clinical Biochemistry	5	5
18		Core 12	25BC304CR	Laboratory Course-III	6	5
19		Value Added Course	* 25BC301VAC	Artificial Intelligence in Digital Publishing	3	0
20		@ Elective	25BC301DCE	Chromatin and Epigenetics	3	3
			25BC302DCE	Genomics and Proteomics		
			25BC303DCE	Reproductive Biology		
			25BC304DCE	Concept in Neurochemistry		
			25BC305DCE	Nutritional Biochemistry		
21		Non-Major Elective	#	Non-Major Elective 2	3	2
22		$$MOOC (NPTEL/Swayam)	-	Online Course	$	$
23		Internship/Industrial Activity	25BC301IN	Internship/ Industrial Activity	**	2
				TOTAL	**30hrs/ Week**	**27**

24	IV	Core 13	25BC401CR	Proposal writing Research based project Project Dissertation Project Viva-Voce	30	20
				TOTAL	**30hrs/ Week**	**20**
					TOTAL CREDITS	**95**

***No credits will be awarded for Value Added Course.**

@ Students will be offered one elective course based on their choice in each semester.

 # Students have to choose Non-Major Elective papers offered by other departments.

$ Online Course should be a minimum of 8 weeks duration with not less than 2 credits.

$$ Online courses are extra credit courses and the credits will not be included in the total credits.

****Summer Internship – Internship/Industrial activity during the summer vacation after first year (Internship will be evaluated and the marks will be included in 3rd semester mark statement).**

****Internship duration should be a minimum of 2 Weeks with10 working days.**

Courses offered under Choice Based Credit system in

M.Sc., BIOCHEMISTRY

Programme Code - 2PSBIC

CORE COURSES (Compulsory 20 Credits for each semester)

S.No	Course Code	Course Title	Hrs/week	Credit	Semester
1	25BC101CR	Biomolecules	6	5	I
2	25BC102CR	Enzymes	6	5	
3	25BC103CR	Biochemical Technique	6	5	
4	25BC104CR	Laboratory Course-I	6	5	
5	25BC201CR	Intermediary Metabolism	5	5	II
6	25BC202CR	Molecular Biology	5	5	
7	25BC203CR	Biochemistry of Signal Transduction	5	5	
8	25BC204CR	Laboratory Course-II	6	5	
9	25BC301CR	Immunology	5	5	III
10	25BC302CR	Genetic Engineering	5	5	
11	25BC303CR	Clinical Biochemistry	5	5	
12	25BC304CR	Laboratory Course-III	6	5	
13	25BC401CR	Proposal Writing Research based project Project Dissertation Project Viva-Voce	30	20	IV

Discipline Centric Electives (DCE)

S.No	Course Code	Course Title	Hrs/week	Credit	Semester
1	25BC101DCE	Cell Biology	3	3	I
2	25BC102DCE	Bio-entrepreneurship	3	3	
3	25BC103DCE	Developmental Biology	3	3	
4	25BC104DCE	Genetics	3	3	
5	25BC105DCE	General Microbiology	3	3	
6	25BC201DCE	Human Physiology	3	3	II
7	25BC202DCE	Bioinformatics	3	3	
8	25BC203DCE	Molecular Endocrinology	3	3	
9	25BC204DCE	Ecology and Environmental Biology	3	3	
10	25BC205DCE	Research Methodology	3	3	
11	25BC301DCE	Chromatin and Epigenetics	3	3	III
12	25BC302DCE	Genomics and Proteomics	3	3	
13	25BC303DCE	Reproductive Biology	3	3	
14	25BC304DCE	Concept in Neurochemistry	3	3	
15	25BC305DCE	Nutritional Biochemistry	3	3	

Value Added Courses

S.No	Course Code	Course Title	Hrs/week	Semester
1	25BC001VAC	Artificial Intelligence in Pharma and Biotech Industries	3	I
2	25BC002VAC	Data Science in Healthcare	3	II
3	25BC003VAC	Artificial Intelligence in Digital Publishing	3	III

Non-Major Electives (NME): These courses are open to students of other Departments except Biochemistry

S.No	Course Code	Course Title	Hrs/week	Credit	Semester
1	25BC001NME	Artificial Intelligence in Health Care	3	2	ODD
2	25BC002NME	Intellectual Property Rights	3	2	EVEN

SEMESTER I

CATEGORY	CODE	SUBJECTS	HOURS	CREDITS
Core 1	**25BC101CR**	**Biomolecules**	**6**	**5**
Core 2	**25BC102CR**	**Enzymes**	**6**	**5**
Core 3	**25BC103CR**	**Biochemical Technique**	**6**	**5**
Core 4	**25BC104CR**	**Laboratory Courses-I**	**6**	**5**
Value Added Course	***25BC101VAC**	**Artificial Intelligence in Pharma and Biotechnology**	**3**	**0**
Elective	**25BC101DCE to 25BC105DCE**	**Elective 1**	**3**	**3**
Total credits for Semester I			**30**	**23**

COURSE NAME - BIOMOLECULES						
Course Code 25BC101CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		5	1	-	5	

Pre-requisite	Knowledge on basic concepts in Biochemistry

Course Objectives
• To understand the structure and functions of important biological macromolecules.
• Students gain a comprehensive understanding of the chemical basis of life and the crucial roles that biomolecules play in all living organisms

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	The students will be able to understand the source, chemical structure, properties, function and uses of various polysaccharides.	K2
CO2	The students will be able to understand amino acid structures, their physical and chemical properties, and primary, secondary, tertiary and quaternary structure of proteins.	K2,K3
CO3	The students will understand the structure of nucleic acids and its chemical synthesis.	K4,K5
CO4	The students will understand the biological importance of vitamins and minerals in the biological system.	K4
CO5	Upon successful completion of this course the students would be able to understand the major components of biomolecules and their functions.	K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

BIOMOLECULES - 25BC101CR	
UNIT - I **HOMO AND HETEROGLYCANS**	Polysaccharides - Occurrence, structure, properties and functions of homoglycans - starch, glycogen, cellulose, dextrin, inulin, chitin, xylans and galactans. Occurrence, structure, properties and functions of heteroglycans - hyaluronic acid, keratan sulphate and chondroitin sulphate. Bacterial cell wall polysaccharides, Blood group substances, Sialic acid. Glycoproteins and their biological functions. Lectin structure and functions.
UNIT - II **PROTEINS**	Classification, structure and properties of amino acids, Essential and non-essential amino acids. Non protein amino acids. Proteins - Classification based on solubility, shape, composition and function. Properties of proteins. Denaturation and renaturation of proteins. Structure of peptide bonds. Chemical synthesis of polypeptides. Protein structure - Primary, secondary, tertiary and quaternary structures of protein. Forces stabilizing the secondary, tertiary and quaternary structures of proteins. Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (hemoglobin, myoglobin), lipoproteins, metalloproteins, glycoprotein and nucleoproteins.
UNIT - III **LIPIDS**	Definition and classification of lipids. Fatty acids - classification, nomenclature, structure and properties. Triacylglycerols. Classification, structure and function of prostaglandins, thromboxanes and leukotrienes. Chemical properties and functions of phospholipids and their structures - lecithin, cephalins, phosphatidylserine, phosphatidylinositol, plasmalogens. Glycolipids (cerebrosides and gangliosides), Isoprenoids and sterols (cholesterol and zymosterol), steroids (steroid hormones), bile acids and bile salts. Types and functions of plasma lipoproteins.

UNIT - IV **NUCLEIC ACIDS**	Structure of purines and pyrimidines. Components of nucleic acids - nucleosides, nucleotides, and polynucleotides. Occurrence and isolation of nucleic acids. Properties of DNA: buoyant density, viscosity, hypochromicity, denaturation and renaturation– the cot curve. Chemical synthesis of oligonucleotides. DNA: structure of different types (A, B and Z DNA), biological role, polymorphism. Structure and role of different types of RNA.
UNIT - V **VITAMINS AND PORPHYRINS**	Structure and biochemical properties of water soluble and fat soluble vitamins and their coenzyme activity. Macro minerals (Ca, P, Mg, Na, K, Cl) and micro minerals/trace elements (Co, I, Fe, Mn, Zn, and F) - their sources, daily requirements, functions and deficiency diseases symptoms. Porphyrins the porphyrin ring system, chlorophyll, hemoglobin, myoglobin and cytochrome.
UNIT VI **CURRENT CONTOUR**	Recent developments in the design of biomolecule based nanostructures in clinical research. The impact of AI on the design and application of biomolecule-based nanostructures in clinical research and enhancing the precision and efficiency of therapeutic interventions, and effective medical treatments.
Total Lecture Hours – 75	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	S	M	S	S
CO3	S	M	S	S	M
CO4	S	S	M	S	S
CO5	S	S	S	M	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. L. Stryer. 2023. Biochemistry, 10th edition. W.H.Freeman & Company, New York
2. Murray R. K. et al. Harpers Illustrated Biochemistry, 2023, 32nd edition. Lange Medical Books/McGraw-Hill.
3. L. Lehninger, Nelson & Cox. 2021. Principles of Biochemistry, 8th edition, CBS, India.
4. Zubay, Geoffrey L,. Principles of Biochemistry, 2020, 5th edition. Medtech.
5. Horton, R., Moranm, LA., Scrimgeour, G, MarcPerry and David Rawn. 2013. Principles of Biochemistry, 4th edition.
6. Richard Harvey, Denise Ferrier. 2011. Lippincott's Illustrated Reviews Williams & wilkins, 5th edition.

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COURSE NAME - ENZYMES						
Course Code 25BC102CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		5	1	-	5	

Pre-requisite	Basic Knowledge on Enzymes

Course Objectives
• Students will obtain basic knowledge about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions.
• Students can understand to compare and contrast the historical uses of enzyme technology with current applications in a diverse range of industries.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	The student could able to analyze the structure/function relationships in bio catalyzed reactions	K1
CO2	Students are able to research a contemporary application of enzyme technology or metabolic engineering and present the results in a well-structured oral presentation.	K3
CO3	The student could able to understand the significance of enzyme kinetics.	K2, K3
CO4	Describe the Mechanism of enzyme action, Therapeutic, diagnostic and Industrial Applications of Enzymes.	K4
CO5	At the end of the course students will be explored to understand the use of enzymes in medicine, food, organic synthesis, genetics and other areas that favor a wide reach for them.	K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

ENZYMES - 25BC102CR	
UNIT - I **INTRODUCTION TO ENZYMES AND BIOENERGETICS**	Definitions (catalytic power, specificity, reactivity, regulation, transformation of different forms of energy, Holoenzyme, Apoenzyme, coenzymes and cofactors). Enzyme Nomenclature and IUB system of enzyme classification. Active site- Fisher and Koshland models. Formation of enzyme substrate complex evidence. Basic concepts of bioenergetics: The collision theory, activation energy and transition state theory. Measurement and expression of enzyme activity – enzyme assays, Investigation of subcellular compartmentation of enzymes and marker enzymes. Enzyme units.
UNIT - II **ENZYME KINETICS**	Definitions (catalytic power, specificity, reactivity, regulation, transformation of different forms of energy, Holoenzyme, Apoenzyme, coenzymes and cofactors). Enzyme Nomenclature and IUB system of enzyme classification. Active site- Fisher and Koshland models. Formation of enzyme substrate complex evidence. Basic concepts of bioenergetics: The collision theory, activation energy and transition state theory. Measurement and expression of enzyme activity – enzyme assays, Investigation of subcellular compartmentation of enzymes and marker enzymes. Enzyme units.
UNIT - III **ENZYME INHIBITION AND MECHANISM OF ENZYME ACTION**	Reversible and Irreversible inhibition - Competitive, Non-competitive, Uncompetitive and mixed inhibition. Substrate inhibition and Feedback inhibition. Determination of inhibitor constant. Therapeutic, diagnostic and industrial applications of enzyme inhibitors. Mechanism of enzyme action: Factors

	contributing to the catalytic efficiency - proximity and orientation, covalent catalysis, acid-base catalysis, metal ion catalysis, strain and distortion theory. Mechanism of action of Lysozyme, Carboxypeptidase, Chymotrypsin and Ribonuclease.
UNIT - IV **INTRODUCTION TO CO-ENZYMES AND ALLOSTERIC ENZYMES**	Structure and functions – Pyridine and flavin nucleotides, coenzyme A, Pyridoxal phosphate and thiamine pyrophosphate, tetrahydrofolate and B12coenzymes. Allosteric Interactions: Enzyme regulation, allosteric enzymes. Allosteric kinetics (MWC and KNF models), symmetry and sequential models. Hill's equation and Hill's coefficient. Enzyme repression and covalent modification of enzymes. Zymogen activation. Isozymes.
UNIT - V **MULTIENZYME SYSTEM AND IMMOBILIZED ENZYMES**	Multifunctional enzymes. Multi-enzyme complexes (Pyruvate dehydrogenase complex, fatty acid synthase and Na - K ATPase), Oligomeric enzymes and Metalloenzymes. Modern concepts of evolution of catalysts: Catalytic RNA (Ribozymes), abzymes. Immobilized enzymes and their industrial applications. Chemical modification and site-directed mutagenesis of enzymes. Industrial applications of enzymes - food and pharmaceutical enzymes. Biosensors.
UNIT VI **CURRENT CONTOUR**	Recent advancement in enzyme technology and its applications. Influence of COVID-19 infection on enzyme levels. These advancements underscore the transformative potential of AI in enzyme technology, paving the way for more efficient, sustainable, and innovative applications in various sectors.
Total Lecture Hours – 75	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	S	M	S	S
CO3	S	M	S	S	M
CO4	S	S	M	S	S
CO5	S	S	S	M	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. ENZYMES: Catalysis, Kinetics and Mechanisms by Narayan S. Punekar, 2nd edition, 2025
2. Molecular and Cellular Enzymology, by Jeannine Yon-Kahn , G. Hervé, 1st edition, 2010
3. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2nd edition, 2008 Trevor Palmer and Philip Bonner
4. Biochemistry, 10th edition, by Lubert Stryer, New York: W H Freeman & Co. 2023, ISBN-10: 0-7167-3051-0.
5. Principles of Biochemistry, 2021. A.L. Lehninger, Nelson & Cox (CBS, India) 8th edition.
6. Enzymes in Food Technology. CRC Press, 2002. Whitehurst RJ.
7. Biochemistry, 2017, Donald Voet and Judith Voet, John Wiley and sons. ISBN - 047119350, Global edition.
8. Text Book of Biochemistry with clinical correlations, 7th edition, 2010 – Thomas M. Devlin.
9. Text of Biochemistry, 4th edition, 2017 – West & Todd, MacMillian Publications
10. Principles of Biochemistry, by G. L. Zubay, 4th edition1998, Wm. C. Brown
11. Biochemistry, 4th edition Christopher K.Mathews and K.E.VanHolde (2000) (Benjamin and cumming).
12. Enzymes, Dixon and Webb 3rd ed. Longmans, 1987.
13. Industrial Enzymes and their applications. Uhlig H. John Wiley, 1998.
14. Fundamentals of enzymology 3rd edition,1999 by Nicholas C. Price and Lewis Stevens.

COURSE NAME - BIOCHEMICAL TECHNIQUES						
Course Code 25BC103CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		5	1	-	5	

Pre-requisite	Knowledge on basics in Analytical Biochemistry

Course Objectives
• This course will introduce some of the experimental techniques used in biochemistry and molecular biology.
• Students are able to learn methods for purifying proteins, expressing recombinant proteins in bacterial cells, and analyzing biological molecules by electrophoresis, Western blotting, and enzyme activity assays. To provide insights in the techniques used in biochemical analysis.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To be able to communicate and discuss General principles of biochemical investigation	K2
CO2	Familiarity with working principles, tools and techniques of analytical techniques	K3
CO3	Describe the principles of electrophoresis and realize its applications	K4
CO4	Students can understand the knowledge for the separation of proteins/peptides by selecting appropriate separation techniques.	K5
CO5	Students are able to characterize certain functionalities of biomolecules by using spectroscopic techniques.	K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

BIOCHEMICAL TECHNIQUES - 25BC103CR	
UNIT - I **UNITS & MEASUREMENT OF SOLUTES IN SOLUTION**	Normality, Molarity, molality and milliosmole. Ionic strength. pH, pOH, Henderson-Hasselbalch equation, buffers, pH of body fluids. Measurement of pH by indicators, Zwitterions. pH dependent ionization of amino acids and proteins. Colloids and their application, Viscosity, surface tension and Donnan membrane equilibrium. Principles of electrochemical techniques – measurement of pH by glass electrode and hydrogen electrode. Oxygen electrode – principles, operation of a Clarke electrode and its applications.
UNIT - II **CELL FRACTIONATION TECHNIQUES**	Cell lysis, differential and density gradient centrifugation, Salting in, Salting out, Dialysis, Ultrafiltration. Ultra Centrifugation - preparative and analytical, Svedberg's constant, Sedimentation velocity and Sedimentation equilibrium, Schlieren optics
UNIT - III **CHROMATOGRAPHIC TECHNIQUES**	Principles and Applications of Paper, Column, TLC, HPTLC, Adsorption, Ion exchanges, Gel filtration, Affinity, GLC, Chromatofocusing, HPLC, FPLC.
UNIT - IV **ELECTROPHORETIC TECHNIQUES**	Polyacrylamide gel electrophoresis, SDS-PAGE, 2D – PAGE, Isoelectric focusing, Visualizing protein bands – CBB & Silver staining. Agarose gel Electrophoresis, pulse field electrophoresis, high voltage electrophoresis, Capillary Electrophoresis, Isotachophoresis, RFLP, FISH. Blotting techniques and its applications – Western, Northern & Southern.
UNIT - V **SPECTROSCOPIC**	Spectroscopic technique: Colorimetry, spectrophotometry – UV-VIS, Principle – Beer & Lambert's law, Extinction coefficient. Principle and application - AAS, Fluorimetry. Basic

AND RADIO ISOTOPE TECHNIQUES	principle and application of mass spectra, NMR, ESR, ESI-MS, HRMS, MALDI-TOF, CD, MRI, CT scans. Biochips (DNA chips, Protein chips and Sensor chips).Vibration Spectra – IR and Raman – Principles and Applications. X-ray crystallography – protein crystals, Bragg's law. Radio isotope technique: Radioactive decay constant, half- life of an isotope, Detection and measurement of radio activity, Geiger Muller counters, scintillation counting, auto radiography and RIA, Application of isotopes in biological studies.
UNIT VI **CURRENT CONTOUR**	Application of analytical techniques in diagnostics. Ex: qRT-PCR, and its application with reference to COVID-19 infection. The impact of AI driven PET and CT radiomics in Non-small cell lung cancer, progress in management, prospects and challenges.
Total Lecture Hours – 75	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	S
CO3	S	S	S	M	S
CO4	S	S	S	S	M
CO5	M	S	S	M	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 2020.
2. Wilson and Walker. A biologist's guide to principles and techniques of practical biochemistry. 8th edition. Cambridge University Press 2018.
3. Boyer, R. Modern Experimental Biochemistry. 3rd ed. Addison Weslery Longman, 2002.
4. Simpson CFA & Whittaker, M. Electrophoretic techniques.
5. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 2012.
6. Friefelder and Friefelder. Physical Biochemistry – Applications to Biochemistry and Molecular Biology. WH Freeman & Co. 1995.
7. Pavia et al. Introduction to Spectroscopy. 5th edition. Brooks/Cole Pub Co., 2015.

COURSE NAME - LABORATORY COURSE - I						
Course Code 25BC104CR	Course Type Practical	L	T	P	C	Syllabus version 2025-2026
		-	1	5	5	

Pre-requisite	Basic knowledge of Enzymes and Analytical Chemistry

Course Objectives
• The objective of the course is to provide hands-on training of basic experiments related to biomolecules, enzymes and bio-analytical techniques using different techniques.
• The course focuses on the estimation of various enzyme kinetics, subcellular fractionation, and separation techniques. Students will learn to quantify sugars, amino acids, proteins, lipids, vitamins, and nucleic acids using appropriate chemical and biological methods.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students will develop the habit of being cautious, safe and will learn to follow basic laboratory rules.	K1
CO2	Students will be able to design an experiment and learn to troubleshoot	K2
CO3	The course helps to understand the principles of instrumentation and promote working ability.	K3
CO4	Students will have intense working knowledge on basic scientific equipment and to analyze the data.	K4
CO5	Laboratory studies promote inquiry, fostering critical thinking while enhancing conceptual understanding, scientific reasoning, and practical skills.	K6,K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

LABORATORY COURSE I - 25BC104CR	
Experiments	1.Estimation of a sugar, amino acid, protein, lipids, vitamin, nucleotide / nucleic acids by appropriate chemical and biological methods. 2.Kinetic characterization of any one enzyme. 3.Subcellular fractionation of functional mitochondria by differential centrifugation and identification using marker enzymes. 4.Separation of amino acids/lipids by thin layer chromatography/Column chromatography.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	M
CO5	M	M	S	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Instrumental Methods of Chemical Analysis Bk.Sharma, Goel publications, Meerut, 33 edition, 2023, by Krishna Prakashan Media (P) Ltd.
2. Principles and Techniques of Practical Biochemistry- Keith Wilson, John Walker, 8th edition, 2018, Cambridge University Press
3. Manual Molecular Cloning: A Laboratory Manual, by Michael R. Green, Joseph Sambrook, 4th edition, 2012, Publisher, Cold Spring Harbor Laboratory Press
4. Manuals in Biochemistry – Dr. J. Jayaraman, New Age International Pub, 2nd edition, 2011.
5. Laboratory manual in Biochemistry T.N.Pattabiraman. 4th edition, 2015, All India publishers.
6. Lab Manual in General Microbiology - N Kannan, Palaniappa Brothers, 2000.
7. Lab Manual in Microbiology - Dr. P Gunasekaran, New Age International Pub, 2000

COURSE NAME - ARTIFICIAL INTELLIGENCE IN PHARMA AND BIOTECH INDUSTRIES						
Course Code	**Course Type**	**L**	**T**	**P**	**C**	**Syllabus version**
25BC101VAC	**VAC**	**2**	**1**	**-**	**0**	**2025-2026**

Pre-requisite	**Basic Knowledge on Artificial Intelligence**

Course Objectives
• A core objective is to develop AI systems that can analyze information, identify patterns, and make predictions or decisions to solve complex problems.
• Students are able to learn AI software and tools in the pharmaceutical and biotechnology industry, aimed to accelerate drug discovery, personalize medicine, optimize manufacturing and improve regulatory compliance.

COs	**COURSE OUTCOMES**	**KNOWLEDGE LEVEL**
CO1	To study the concept of Artificial Intelligence and problem solving.	**K1**
CO2	To figure out advanced problem solving patterns and knowledge representation.	**K3**
CO3	To explore the relationship between digital biomarkers and drug discovery.	**K3**
CO4	Students will be able to design new molecules with desired properties, optimizing their structure and interactions with targets.	**K4**
CO5	AI tools and software are transforming the pharmaceutical and biotechnology industries by accelerating drug discovery, optimizing clinical trials and enhancing manufacturing processes.	**K5**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

ARTIFICIAL INTELLIGENCE IN PHARMA AND BIOTECH INDUSTRIES - 25BC101VAC	
UNIT - I **ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING (ML)**	General Intelligence, General Problem solver, Philosophy of AI: Chinese room argument, strong AI and weak AI – C-3PO Vs Apple Siri. Predictive AI and generative AI. The rise of ML: Checkers program. Deep learning and artificial neural networks.
UNIT - II **COMMON AI SYSTEMS AND DATA**	Robotics, language processing, Internet, Generative systems-DIAL-E2, AI Chatbot. Learn from data: Supervised, unsupervised & reinforcement learning, massive dataset, data models. Identify patterns of data: Classify data, cluster data & reinforcement learning. ML algorithms, fitting algorithms, building artificial neural networks, accuracy.
UNIT - III **APPLYING AI TO DRUG DISCOVERY & DEVELOPMENT**	Pharma 4.0, 5 A's: Automated, Assisted, Analytical, Accelerated and Augmented intelligence. Target identification, drug discovery: de novo and repurposing approaches, preclinical studies and clinical studies. Tools for AI driven drug discovery. Impact of AI on Pharma 4.0
UNIT - IV **AI IN BIOTECHNOLOGY**	Disease prediction, diagnosis, personalized medicine, gene coding identification and editing and creating 3D protein structure. Developing predictive models, image recognition and biomarker prediction.
UNIT - V **AI SOFTWARE AND TOOLS IN PHARMA AND BIOTECHNOLOGY**	International Business Machine (IBM), E-VAI, QSAR, ADMET, PubChem, ChemBank, DrugBank, ChemDB, MYCIN, DENDRAL, PUFF, REINVENT, RDKit, CRISPR libraries, Biogen, InSilicio Medicine, DeepChem, Atomwise, Cradle, iBioSim.

UNIT VI **CURRENT CONTOUR**	Recent developments and applications of AI in Pharma and Biotech Industries.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	S
CO2	S	S	M	S	M
CO3	S	M	S	M	S
CO4	S	M	S	S	M
CO5	M	S	M	M	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Ashenden, S. K. (2021). ERA of Artificial Intelligence, Machine Learning, and data science in the pharmaceutical industry. Academic Press.
2. Philip, A., Shahiwala, A., Rashid, M., & Faiyazuddin, M. (2023). A Handbook of Artificial Intelligence in Drug Delivery. Academic Press, an imprint of Elsevier.
3. Artificial Intelligence in Pharma: From Drug Discovery to Patient Care by Yseop
4. Artificial Intelligence: Emerging Applications in Biotechnology and Pharma David Sahner, David C Spellmeyer. Biotechnology Entrepreneurship, 399-417, 2020
5. Daniel D. Lee AI Pharma: Artificial Intelligence in Drug Discovery and Development (Code and Compassion)
6. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again by Eric Topol https://pmc.ncbi.nlm.nih.gov/articles/PMC7577280/

COURSE NAME - CELL BIOLOGY						
Course Code 25BC101DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Biology

Course Objectives
• The Cell Biology course will enable you to consider the most exciting current problems in the field. This course will give you a unique opportunity to study the mechanisms that define and regulate the function of cells and organisms.
• As this is a research-focused master's course, one will take an interactive approach to learning, rather than taking traditional lectures, through seminars, small group tutorials and research placements.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students will demonstrate their mastery of cell biology concepts	K2
CO2	Learn the most significant functions of cell organelles at the molecular level.	K3
CO3	Acquire knowledge on internal organization of cell	K2
CO4	Understand the concepts of cell cycle, Regulation of CDK checkpoints. Apoptosis and Cancer.	K5
CO5	Understand the concept of Stem cell Morphology Differentiation, Origin and Types of Stem cells.	K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

CELL BIOLOGY - 25BC101DCE	
UNIT - I **THE CELL**	History of the Cell, Cell theory, Protoplasm and Organismal theory, Broad classification of cell types History of the Cell, Cell theory, Protoplasm and Organismal theory, Broad classification of cell types–Bacteria, Archea (Prokaryotes) and Eukaryotes, Cells and Genomes: Universal features of cells, Diversity of Genomes and the Tree of life. Cell Membranes: Basic properties of Cell Membranes – The lipid Bilayer: Composition and Structural Organisation, Membrane proteins: Structure and basic functions, Membrane transport of small molecules and the electrical properties of Membranes, Endocytosis and Exocytosis. The plant Cell wall.
UNIT - II **CELL ORGANELLES**	Organelles bounded by Double membrane Envelopes [Nucleus and Mitochondria], Organelles bound by single membrane [Peroxisome, ER, GA, Lysosomes], Ribosomes, Dictyosomes, Microbodies, Peroxisome, Plastids, Chloroplast, Chromoplast and Leucoplast. Vacuoles and Centrosome.
UNIT - III **INTERNAL ORGANIZATION OF THE CELL**	The Cytoskeleton: Components of Cytoskeleton, Structure and basic functions of Microtubules, Microfilaments, Intermediate filaments. Cell Communication: Cell- Cell Junctions, Tight Junction, Gap Junction, Cell – Matrix Anchoring junctions: Desmosomes, Adhering Junctions. Cell-Cell Adhesion proteins: Cadherins, Catenins, Scaffold Proteins, Connexins, Integrins, Selectins. Plasmodesmata in Plants. The extracellular Matrix of Animals, Collagens, Elastins, Fibronectin, Laminin.

UNIT - IV **CELL CYCLE**	Overview of Cell cycle: Mitosis and Meiosis, Stages of Mitosis, Meiosis and Fertilization, Fertilization and Inheritance, Crossing over and Linkage. Model organisms and methods to study the cell cycle. Regulation of CDK activity and role of check points. Apoptosis and Cancer
UNIT - V **STEM CELLS**	Overview/Concepts: History and Scientific Background, Introduction to Concepts in Stem Cell Biology-Potency, Plasticity, Self Renewal and Expansion, Properties, Stem Cells. Classification and Sources. Embryonic Stem cells, Stem cell Morphology Differentiation, Origin and Types of Stem cells. Stem cells and Tissue Renewal.
UNIT VI **CURRENT CONTOUR**	Microscopy: Light microscopy, fluorescent microscopy, confocal microscopy, Phase contrast microscopy, electron microscopy. SEM, TEM. Freeze fracture technique, FACS, Tunnel assay, comet assay, clonogenic assay and cell toxicity assays. Cellular Imaging and AI.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	M
CO4	S	S	M	S	M
CO5	S	S	S	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Stephen R. Bolsover, Andrea Townsend-Nicholson, Greg Fitz Harris, Elizabeth A. Shephard, Jeremy S. Hyams, and Sandip Patel. Cell Biology – A short Course. 4th Edition, Wiley-Blackwell Publication, 2022
2. Stem Cells- Scientific Facts and Fiction (Elsevier) By Christine Mummery, Sir Ian Wilmut, Anja van de Stople, Bernard A J Roelen. 3rd edition, 2021
3. Geoffrey M. Cooper, Kenneth M. Adams. "The Cell: A Molecular Approach", 9th Edition, Oxford University Press, 2022
4. George Plopper, David Sharp, Eric Sikorski. Lewin's Cells –3rd Edition, Jones & Bartlett Student Edition, 2013.
5. Lodish, Harvey et al., "Molecular Cell Biology", 9th Edition, W.H.Freeman & Co Ltd, 2021
6. Sadava, D.E. "Cell Biology: Organelle Structure and Function", CBS (1 January 2009)
7. Alberts, Bruce et al., "Essential Cell Biology", 6th Edition, Norton & Company, 2023.
8. Bruce Alberts et al., Molecular Biology of the Cell. 7th Edition, 2022
9. Becker, W.M. et al., "The World of the Cell", 10th Edition, Pearson Education, 2021

COURSE NAME - BIO-ENTREPRENEURSHIP						
Course Code 25BC102DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Bioscience in Business

Course Objectives
• To teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.
• Illustrate the basics of bio-business in various emerging biological field
• Build critical thinking capability and design methodologies for entrepreneur
• Create the ability for planning, commencing, executing and managing business

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centers and various agencies	K2
CO2	The knowledge pertaining to management should also help students to be able to build up a strong Network within the industry.	K3
CO3	Evaluate and develop critical thinking leading to Innovative skills related to business.	K4
CO4	Develop the protocol to approach funding agencies both government and non-government	K5
CO5	Through practical training, mentorship, and networking opportunities, EDPs enable participants with the skills to navigate the complexities of starting and managing a business.	K6,K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

BIO-ENTREPRENEURSHIP - 25BC102DCE	
UNIT - I **INTRODUCTION TO BIO BUSINESS**	Introduction to Bio-business, Fundamentals of Biotech for bio-Business, Contemporary Vs antique Bio-business, Wealth Creation in Bio-business. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make in India), strategic dimensions of patenting & commercialization strategies.
UNIT - II **BIOSCIENCES IN BUSINESS**	Healthcare, Biomedical sciences, Industrial Life Sciences, Biotechnology, Agriculture based business, Food Industry; Where Things Stand: A Quick Survey of Regional and Global Strengths and Capabilities. Business related to Environment Management, Bioremediation, Bioleaching and waste management.
UNIT - III **BIO MARKETS - BUSINESS STRATEGY AND MARKETING**	Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio-business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.
UNIT - IV **PROTECTING THE INTELLECTUAL PROPERTY**	Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO,

	WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.
UNIT - V **PATENTING: BASICS OF PATENTS**	Types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and noncommercial incentives.
UNIT VI **CURRENT CONTOUR**	Business plan preparation including statutory and legal requirements, Business feasibility study, and financial management issues of procurement of capital and management

	of costs, Collaborations & partnership, Information technology.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	M	M	S	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. James F. Jordan, Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press, 2021
2. Ganguli, P. . Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: McGraw Hill Education; 1st edition, 2017
3. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, Government of India, 2016
4. David J. Adams , John C. Sparrow . Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences., Scion Publishing Ltd, Bloxham , 2008.

COURSE NAME - DEVELOPMENTAL BIOLOGY						
Course Code 25BC103DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Biology

Course Objectives
• Understand the molecular and cellular mechanisms of development and learn about basic embryology

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To understand the basic concepts and theories related to developmental biology	K2
CO2	Understand reproductive organs, gametogenesis and fertilization.	K3
CO3	Understand the concept of cell differentiation and gene action in development	K4
CO4	Understand the cellular and molecular mechanism of embryogenesis in Plants and Animals.	K5
CO5	Students can understand Morphogenesis and organogenesis in plants.	K4,K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

DEVELOPMENTAL BIOLOGY - 25BC103DCE	
UNIT - I **INTRODUCTION TO EVOLUTION**	Emergence of evolutionary thoughts: Lamarks; Darwin – concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis, Origin of cells and unicellular evolution; Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.
UNIT - II **CONCEPTS OF DEVELOPMENT**	Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
UNIT - III **FERTILISATION IN ANIMALS AND PLANTS**	Gametogenesis, Fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilisation in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.
UNIT - IV **ANIMAL DEVELOPMENT**	Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, organogenesis – vulva formation in Caenorhabditis Elegans; eye lense induction, limb

	development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.
UNIT - V **PLANT DEVELOPMENT**	Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; lead development and phyllotaxy; transition to flowering, floral development in Arabidopsis and Antirrhinum.
UNIT VI **CURRENT CONTOUR**	Recent advances in Developmental Biology. Short talk and detailed discussion of original research articles in class.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	S	M	M	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Developmental Biology Hardcover –13th Edition, by Michael Barresi, Scott Gilbert, 2023
2. Developmental Biology, by Michael J.F. Barresi, Scott F. Gilbert 20th edition, 2020
3. Developmental Biology (Looseleaf), 10th Edition, Scott F. Gilbert, Sinauer Associates, Inc., 2013.
4. Principles of Development. 3rd edition, by L. Wolpert, 2006, Oxford University press, USA
5. Developmental Biology, 6th edition by Scott Gilbert, 2000, Sunderland (MA): Sinauer Associates.

COURSE NAME - GENETICS						
Course Code 25BC104DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic idea of Genetics

Course Objectives
• The course focuses on the estimation of various enzyme kinetics, subcellular fractionation, and separation techniques. Students will learn to quantify sugars, amino acids, proteins, lipids, vitamins, and nucleic acids using appropriate chemical and biological methods.
• The course also aims to develop critical thinking and research skills through the analysis of genetic data and the evaluation of genetic research.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes.	K2
CO2	Transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes.	K3
CO3	To identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored.	K2,K3
CO4	To describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA.	K4
CO5	To describe applications and techniques of modern genetic technology, as well as select the correct techniques to solve practical genetic problems.	K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

GENETICS - 25BC104DCE	
UNIT - I **INTRODUCTION TO GENETICS**	Brief history/basic concepts of genetics, Cell division and chromosomes. Mendelian genetics/monohybrid, dihybrid cross. Mendelian genetics/trihybrid cross, probability. Modification of Mendelian ratios/incomplete and codominance. Modification of Mendelian ratios/incomplete and codominance. Structure of Gene - Interaction of Gene - Commentary Factors, Supplementary Factors, Inhibitory and Lethal Factors - Atavism.(https://www.slideshare.net/vanessaceline/intorduction-to-genetics)
UNIT - II **CHROMOSOME ABNORMALITIES**	Diploid chromosomes number- Sex differentiation and sex determination. The X chromosomes, Barr bodies, the Lyon hypothesis. Aneuploidy and polyploidy: Gene deletion, duplication, inversions and translocation. Sex Linkage in Drosopohila and Man, Sex Influenced and Sex Limited Genes - Non-Disjunction and Gynandromorphs - Cytoplasmic Inheritance - Maternal Effect On Limnaea (Shell Coiling), Male Sterility (Rode's Experiment).CO2 sensitivity In Drosophila, Kappa particles in Paramecium, Milk Factor in Mice. (Blended mode of teaching).
UNIT - III **BLOOD GROUPS AND CROSSING OVER**	Blood Groups and their Inheritance in Human - Linkage and Crossing Over:- Drosophila - Morgans' Experiments - Complete and Incomplete Linkage, Linkage Groups, Crossing Over types, Mechanisms - Cytological Evidence for Crossing Over, Mapping of Chromosomes - Interference and Coincidence.
UNIT - IV **FUNCTION OF GENETIC MATERIAL**	Fine Structure of the Gene - Cistron, Recon, Muton - Mutation - Molecular Basis of Mutation, Types of Mutation, Mutagens, Mutable and Mutator Genes. Chromosomal Aberrations - Numerical and Structural Examples from Human.

UNIT - V **APPLIED GENETICS**	Animal Breeding - Heterosis, Inbreeding, Out Breeding, Out Crossing, Hybrid Vigour. Population Genetics, Evolutionary genetics, Hardy Weinberg Law - Gene Frequency, Factors Affecting Gene Frequency, Eugenics, Euphenics and Euthenics, Bioethics. (www.goldiesroom.org/...)
UNIT VI **CURRENT CONTOUR**	Genetic Principles and their application in medical practice; Case studies (Interacting with patients, learning family history and drawing pedigree chart); Introduction to Exome Sequencing, Syndromes and disorders: definition and their genetic basis - Cystic fibrosis and Tay Sach's Syndrome; Phenylketonuria and Galactosemia; Ethical issues with clinical genetics.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	M	M	S	S
CO3	S	M	S	S	M
CO4	S	S	S	S	S
CO5	M	S	M	M	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Essential genetics and genomics, by Jones & Bartlett Learning, 7th edition , 2020, LLC, an Ascend Learning Company.
2. Genetics analysis and principles by Brooker R.J and McGraw Hill. 7th edition, 2021
3. Molecular Genetics - By Andrew Andres, Pawel Parafianowicz et. al 3rd edition, 2021
4. Concepts of Molecular Genetics, by santiago R, 2023, AMERICAN ACADEMIC PUBLISHER
5. Essential genetics : a genomics perspective, by Hartl, Daniel. 6th edition, 2014

COURSE NAME – GENERAL MICROBIOLOGY						
Course Code 25BC105DCE	**Course Type** Elective	**L**	**T**	**P**	**C**	**Syllabus version** 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Microbiology

Course Objectives
• The student will be able to identify common infectious agents and the diseases that they cause.
• The student will be able to evaluate methods used to identify infectious agents in the clinical microbiology lab.
• The student will be able to recall microbial physiology including metabolism and regulation.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students will gain knowledge about the different cell organelles of microorganisms and their detailed functions.	K1
CO2	Students are able to know the composition and functions of cell appendages and inclusions.	K2
CO3	Students will gain knowledge about Microbial Diversity.	K3
CO4	Students will also study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.	K4
CO5	Students can also understand the Environmental and biological factors that influence microbial diversity.	K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

GENERAL MICROBIOLOGY - 25BC105DCE	
UNIT - I **CLASSIFICATION OF MICROORGANISM**	History of bacterial classification. Haeckel's three kingdoms concept, Whittaker's five kingdom concept, three domain concept of Carl Woese; Basis of microbial classification, molecular approaches in microbial classification, concept of microbial species; Principle and classification of bacteria on the basis of Bergey's manual of Determinative bacteriology; Cyanobacteria and Prochloron.
UNIT - II **MORPHOLOGY AND FINE STRUCTURE OF BACTERIA**	Morphological types – size, shape and arrangements; cell walls of archaea, Gram negative, Gram positive eubacteria, eukaryotes; L forms – cell wall synthesis, antigenic properties, cell membranes – structure, composition and properties. Reserve materials, inorganic and organic inclusions.
UNIT - III **STRUCTURE AND FUNCTION OF CELL**	Capsule types, composition and function; flagella, fimbrae, pili, cilia, gas vesicles, chromosomes, carboxysomes, magnetosomes, phycobillisomes, nucleoid, plasmids (types of plasmids and function); Bacterial spores: Regulation of spore formation.
UNIT - IV **MICROBIAL TECHNIQUES**	Aerobic, anaerobic, shaking, static cultures, nutritional types, culture media, culture methods pure culture techniques, Growth curve, generation time, synchronous, batch and continuous culture; Measurement of growth and factors affecting growth, Sterilization and disinfection- heat, UV radiation, ionizing radiation, filtration. Chemical disinfectants.
UNIT - V **MICROBIAL DIVERSITY AND EXTREMOPHILES**	Microbial diversity, distribution ecological niche, abundance and density. Extremophiles – Psychrophiles, acidophiles, alkaliphiles, thermophiles, barophiles etc., non-culturable bacteria (Metagenomics). Methanogens, Methanotrophs and Methylotrophs.

UNIT VI **CURRENT CONTOUR**	Design a mechanism that would allow a bacterium to protect its nitrogenase from oxygen. Analyze the symbiotic relationship that some N2-fixing bacteria have with plants. Identify what the bacteria contribute and what the plant contributes. Describe the process of methanogenesis in terms of electron transport and energy generation. The interactions of microorganisms among themselves and with their environment are determined by their metabolic abilities (e.g. quorum sensing, oxygen consumption, nitrogen transformations).
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	S	M
CO4	S	M	S	S	M
CO5	M	M	S	S	L
S-Strong; M-Medium; L-Low					

Recommended References:

1.Microbiology by Lansing M Prescot, Donald A klein, John P Harley, McGraw Hill, 12th edition, 2022

2.Ananthanarayan and Paniker's Textbook of Microbiology, 13th Edition Paperback – 2024

3.General Microbiology and Microbial Physiology- by Dr. Parthiban Karuppiah, Dr.Sivamanikandan Palanivelu, 2024,

4.Microbiology: Principles and Explorations by Jacquelyn Black, 10th edition, 2017

5.General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis Microbiology by Michael J Pelczar, 5th edition, 2016

6.General Microbiology by Power & Daginawala, Himalaya Publishing House, 1st E 2017

SEMESTER II

CATEGORY	CODE	SUBJECTS	HOURS	CREDITS
Core 5	25BC201CR	Intermediary Metabolism	5	5
Core 6	25BC202CR	Molecular Biology	5	5
Core 7	25BC203CR	Biochemistry of Signal Transduction	5	5
Core 8	25BC204CR	Laboratory Course-II	6	5
Value Added Course	*25BC201VAC	Data Science in Healthcare	3	0
Elective	25BC201DCE to 25BC205DCE	Elective II	3	3
Non Major Elective	#	Non-Major Elective 1	3	2
**Internship/ Industrial Activity during summer vacation				
		Total credits for Semester II	30	25
# - Students have to choose Non-Major Elective papers offered by other departments				

COURSE NAME - INTERMEDIARY METABOLISM						
Course Code 25BC201CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		4	1	-	5	

Pre-requisite	Knowledge on basic concepts in Metabolism and its regulation

Course Objectives
• To learn the metabolism and integration of biomolecules that takes place in the human system
• Integrate the various aspects of metabolism & their regulatory pathways
• Students can understand the fundamental energetic of biochemical processes
• To elaborate the relation between biochemical defects and metabolic disorders.
• To follow the organization of signaling pathways

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To learn the metabolism and integration of biomolecules that takes place in the human system.	K2
CO2	Integrate the various aspects of metabolism & their regulatory pathways	K1
CO3	Students can understand the fundamental energetics of biochemical processes	K2
CO4	To understand the relation between biochemical defects and metabolic disorders.	K3,K4
CO5	Overall, gaining an understanding of the processes of metabolic transformation at the molecular level and how these processes are studied	K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

INTERMEDIARY METABOLISM - 25BC201CR	
UNIT - I **BIOENERGETICS**	Overview of major classes of biomolecules, forces stabilizing biomolecules. General scheme of metabolism, historical and experimental details in derivation of a metabolic pathway, catabolic, anabolic and amphibolic pathways. Thermodynamics and metabolism: Cell bioenergetics, laws of thermodynamics, standard free energy, enthalpy, entropy. Exergonic and endergonic reactions. Definition of open, closed and isolated systems – Oxidative phosphorylation. Electron transport chain. Standard free energy change of a chemical reaction, redox potentials, ATP and high energy phosphate compounds. (Blended Mode of teaching)
UNIT - II **CARBOHYDRATE METABOLISM**	Glycolysis and gluconeogenesis – pathway, key enzymes and co-ordinate regulation. The citric acid cycle and its regulation. The pentose phosphate pathway. Metabolism of glycogen and regulation. Key junctions in metabolism– glucose-6-phosphate, pyruvate and acetyl CoA. Blood glucose homeostasis– role of tissues and hormones.(chalk and talk)
UNIT - III **AMINO ACID METABOLISM**	Biosynthesis and degradation of amino acids and their regulation. Transamination and deamination, ammonia formation, the urea cycle and regulation of Urogenesis.
UNIT - IV **LIPID METABOLISM**	Lipogenesis: biosynthesis of fatty acid, triglycerides, phospholipids, and cholesterol. Regulation of triacylglycerol, phospholipids and cholesterol biosynthesis. Oxidation of lipids. Role of carnitine cycle in the regulation of β -oxidation. Ketogenesis and its control. Lipoprotein metabolism - exogenous and endogenous pathways.

UNIT - V **NUCLEIC ACID METABOLISM**	Biosynthesis and catabolism of purines and pyrimidines and their regulation.
UNIT VI **CURRENT CONTOUR**	Current aspects on metabolism: metabolic changes after covid-19 infections. AI is used to screen for enzyme inhibitors, metabolic modulators, or biological targets related to metabolic pathways.
Total Lecture Hours – 60	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	S	S	M	S	S
CO3	S	M	S	S	M
CO4	S	S	M	S	M
CO5	M	S	M	M	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Biochemistry – L. Stryer, 10th edition, 2023. W.H.Freeman & Co.
2. Biochemistry - Lippincott Williams & Wilki - Illustrated reviews 9th edition, 2025
3. Lehninger's Principles of Biochemistry-D. L. Nelson and M. M. Cox. 8th edition, 2021.
4. Harpers Biochemistry- R. K. Murray et al. 32nd edition, 2022 McGraw Hill education (Pvt Ltd.)
5. Principles of Biochemistry- G. L. Zubay. 5th edition, 2020, Medtech, publisher.
6. Principles of Biochemistry – R. Horton et al. Pearson education India, 5th ed., 2013.

COURSE NAME – MOLECULAR BIOLOGY						
Course Code 25BC202CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		4	1	-	5	

Pre-requisite	Knowledge on basic concepts in Molecular Biology

Course Objectives
• This course is about genes - their structure and function - therefore, students will study the mechanics of replication, repair, transcription, and translation in bacteria, archaea and eukaryotes.
• A central goal is to understand gene regulation at all levels, and the structure-function relationships of nucleic acids and proteins.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	The course gives deep insight into the molecular mechanisms behind the existence of life.	K1
CO2	Students will understand, structure and organization of genomes and its functions in lower to higher forms of life.	K2
CO3	Students will learn will about the regulation of gene expression	K3
CO4	Which enables the students to pursue career in health care and clinical research	K4
CO5	Course covers the fundamental molecular causes behind the several non- communicable disease and communicable diseases.	K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

MOLECULAR BIOLOGY - 25BC202CR	
UNIT - I **CENTRAL DOGMA OF LIFE**	History of 20th & 21st century molecular biology, Genomics & Post-Genomics. DNA as the genetic material, supercoiling, hybridization. Hierarchy of Chromatin Organization, Central Dogma, Unique sequence DNA, Repetitive DNA – SINEs, LINEs, Satellite, Minisatellite and Microsatellite DNAs, C-Value Paradox. *E.coli* chromosome and plasmids, Mitochondrial and Chloroplast Genomes. Concept of genes. Structure of Protein-coding genes in prokaryotes and eukaryotes. structures of DNA/RNA components, the different forms of nucleic acids (A, B, Z) and the types of amino acids that mediate backbone and sequence-specific binding.
UNIT - II **DNA REPLICATION, REPAIR AND MUTATION**	DNA in prokaryotes and eukaryotes: Mode of replication; experimental findings of Meselson &Stahl. Enzymes involved in replication, events on the replication fork and termination, mechanism of replication. Inhibitors of DNA replication and DNA repair mechanisms (Direct repair, excision repair, mismatch repair, recombination repair, SOS response, Eukaryotic repair system).Type of damages and mutation – point mutation and frameshift mutation. Suppressor Gene mutation and chromosomal aberration.
UNIT - III **TRANSCRIPTION**	Organization of transcriptional units – prokaryotes and eukaryotes. RNA polymerases – structure and functions. Promoters, transcription factors, transcription complex assembly and mechanism of transcription- Operon model. Transcriptional regulation –hormonal (steroid hormone receptors), phosphorylation (STAT proteins). Molecular

	biology of HIV [and other retroviruses], influenza virus, and how current genomics projects (e.g., comparative and functional, and other '-omics') are altering our understanding of molecular biology. Activation of transcriptional elongation by HIV tat protein. Post-transcriptional processing. Alternative splicing. Catalytic RNA (ribozymes), antisense RNA. Inhibitors of transcription.
UNIT - IV **TRANSLATION**	The genetic code – specificity, redundancy and wobble hypothesis. Mitochondrial and chloroplast genetic codons. Components of protein synthesis– mRNA, rRNA and tRNA. Mechanism of protein synthesis. Regulation of protein synthesis - constitutive and narrow domain regulation. Inhibition of protein synthesis. Co- and post-translational modifications. Protein targeting- the signal sequence hypothesis, targeting proteins to membranes, nucleus and intracellular organelles. Protein degradation - ubiquitin pathway. Protein folding - models, molecular chaperones.
UNIT - V **GENE EXPRESSION AND REGULATION**	Levels of gene expression. Principles of gene regulation. Upregulation, downregulation, induction and repression. Comparison of gene regulation strategies in prokaryotes and eukaryotes. Genetic and epigenetic gene regulation by DNA methylation. Methylation and gene regulation in mammals and plants. Epigenetic gene regulation by DNA methylation in mammals - role of imprinting and X-chromosome inactivation
UNIT VI **CURRENT CONTOUR**	Role of antibiotics and other inhibitors of Prokaryotic and eukaryotic replication/transcription/translation.

	AI-driven models decode dynamic gene expression patterns, making it possible to identify disease biomarkers and understand gene regulation.
Total Lecture Hours – 60	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	S
CO3	S	M	S	M	S
CO4	S	S	S	S	M
CO5	M	S	S	M	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Molecular Biology of the Gene, 8th edition, James D Watson, 2024, Cold Spring Harbor Laboratory.
2. Molecular Biology of The Cell, 7th edition, Bruce Alberts, 2022. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter, Garland edition.
3. Molecular Cell Biology, 9th edition, Harvey Lodish, Arnold Berk, Paul Matsudaira, chris A. Kaiser, Monty Krieger, Mathew P Scott, Lawrence Zipursky, James Darnell, W.H Freeman & Co. 2021.
4. Cell and Molecular Biology Concepts & Experiments, 9th edition, 2020. Gerald Karp, wiley Publications.
5. Becker's World of The Cell, 8th edition, 2017. Jerrf Hardin, Gregory Bertoni, Lewis Kleinsmith, Pearson Publications.
6. Cell Biology and Histology, 6th edition, 2010. Gartner et al., Lippincott William and Wilkins Publishers.
7. Genes VIII, Benjamin Lewin, Pearson Prentice Hall, 8th edition, 2004.
8. Cell Biology and Molecular Biology, 8th edition, EDP De Robertis and EMF De Robertis, Lippincott Williams and Wilkins, 2017.

COURSE NAME - BIOCHEMISTRY OF SIGNAL TRANSDUCTION						
Course Code 25BC203CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		4	1	-	5	

Pre-requisite	Knowledge on basic concepts in Signal Transduction

Course Objectives
• The objective of this course is to examine in detail the biochemical basis of the transmission of molecular signals from a cell's exterior to its interior and how this can bring about changes in cellular behavior and gene expression.
• The course emphasises the biochemical concepts underlying signal transduction and the types of experimental analysis that are employed to study signaling pathways.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students should be able to recognize emerging patterns of pathway organization and give examples.	K1
CO2	They should be able to identify similarity and differences between pathways and apply their knowledge to novel problems.	K2
CO3	Students are expected to be able to identify and describe the biochemical mechanisms of how pathways are turned on and off including allosteric mechanisms.	K3
CO4	Students should be able to describe mechanisms of how the cell achieves specificity in signaling pathways.	K4
CO5	They should appreciate that pathways are interconnected and form networks. A basic understanding of how network regulation is studied is expected.	K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

BIOCHEMISTRY OF SIGNAL TRANSDUCTION - 25BC203CR	
UNIT - I **REGULATION OF TRANSCRIPTION**	Regulation of transcription in prokaryotes - positive and negative control, repressor and inducer, concept of operon, lac and trp operons, regulons. Regulation in eukaryotes- gene families, regulatory strategies in eukaryotes, gene alteration, regulation of synthesis of primary transcripts, hormonal control, transcription factors, transcription factors: targets of signaling pathways. DNA binding motifs in pro and eukaryotes - helix turn helix, zinc fingers, leucine zippers/ b zip, helix loop helix motifs. Regulation at the level of translation in prokaryotes and eukaryotes
UNIT - II **CELL SURFACE RECEPTORS AND SIGNALLING**	Signal transduction – definition, signals, ligands and receptors. Endocrine, paracrine and autocrine signaling. Receptors and signaling pathways- cell signaling, cell surface receptors. G Protein coupled receptors- structure, mechanism of signal transmission, regulatory GTPases, heterotrimeric G proteins and effector molecules of G Proteins. Receptor tyrosine kinases - Role of phosphotyrosine in SH2 domain binding, Signal transmission via Ras proteins and MAP kinase pathways. Signaling molecules- cAMP, cGMP, metabolic pathways for the formation of inositol triphosphate from phosphatidyl inositol diphosphate, Ca2+, DAG and NO as signaling molecules, ryanodine and other Ca2+ receptors, phosphor-regulation of inositol and the calcium channel activation. Ser/Thr-specific protein kinases and phosphatases.
UNIT - III	Sensory Transduction : Nerve impulse transmission – Nerve cells, synapses, reflex arc structure, Resting membrane potential, Nernst equation, action potential, voltage gated ion-

SIGNALLING IN NERVE IMPULSE TRANSMISSION, VISION AND MUSCLE CONTRACTION	channels, impulse transmission, neurotransmitters, neurotransmitter receptors. Rod and cone cells in the retina, biochemical changes in the visual cycle, photochemical reaction and regulation of rhodopsin. Chemistry of muscle contraction – actin and myosin filaments, theories involved in muscle contraction, mechanism of muscle contraction, energy sources for muscle contraction.
UNIT - IV **NUCLEAR RECEPTOR AND SIGNALING**	Signaling by nuclear receptors- ligands, structure and functions of nuclear receptors, nuclear functions for hormones/metabolites - orphan receptors; cytoplasmic functions and crosstalk with signaling molecules, signaling pathway of the steroid hormone receptors. Cytokine receptors- structure and activation of cytokine receptors, Jak-Stat pathway, Janus kinases, Stat proteins.
UNIT - V **CELL CYCLE AND ITS REGULATION**	Regulation of the cell cycle- Overview of the cell cycle, cell cycle control mechanisms, Cyclin-dependent protein kinases (CDKs), regulation of cell cycle by proteolysis, G1/S Phase transition, G2/M Phase transition, cell cycle control of DNA replication, DNA damage checkpoints. Cancer, types of cancer, factors causing cancer-physical, chemical and biological agents. Errors in function of signal proteins and tumorigenesis. Oncogenes, proto-oncogenes and tumour suppressor genes. Tumour suppressor protein p53 and its role in tumour suppression. Tumour suppressor APC and Wnt/ β-Catenin signaling.
UNIT VI **CURRENT CONTOUR**	Discuss the latest advances on identification of signaling pathways in pre-clinical and clinical research. Ex: *In-silico* approach.
Total Lecture Hours – 60	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	M	M	S	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Molecular Cell Biology, 9th edition, Harvey Lodish. New York: W. H. Freeman; 2021.
2. Molecular Biology of the Cell, 7th edition, Bruce Alberts. New York: Garland Science; 2021
3. Biochemistry of Signal Transduction and Regulation. 5thEdition. Gerhard Krauss, 2014 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
4. Molecular biology- David Freifelder, 2nd edition, Narosa Publishing House Pvt. (Ltd), 2012
5. Principles of cell and molecular biology- Lewis Kleinsmith, Pearson, 2nd edition, illustrated, HarperCollins, 1997.
6. https://pmc.ncbi.nlm.nih.gov/articles/PMC7520847/
7. https://www.nature.com/articles/s41392-023-01442-3 (2023)
8. https://www.sciencedirect.com/science/article/pii/S1936523322001693
9. https://academic.oup.com/narcancer/article/2/3/zcaa025/5911781 (2020)

COURSE NAME – LABORATORY COURSE II						
Course Code 25BC204CR	Course Type Practical	L	T	P	C	Syllabus version 2025-2026
		-	1	5	5	

Pre-requisite	Basic knowledge of Molecular Techniques

Course Objectives
• To provide hands on training in the techniques used in industries and research
• To apply the principles studied

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To impart the basic knowledge about safety measures and good laboratory practices. To develop understanding of the basics of sterilization techniques.	K3
CO2	To develop the skills to analyze different methods of preparations of solutions. To impart the knowledge of handling sophisticated laboratory equipments and instruments	K4
CO3	Students should be able to recognize emerging patterns of pathway organization and give examples	K3
CO4	Familiarized with annotation of DNA sequences for efficient design, tracking, and management of cloning experiments in the laboratory.	K4,K5
CO5	A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research.	K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

LABORATORY COURSE II – 25BC204CR	
EXPERIMENTS	1. NCBI database 2. BLAST and FASTA analysis 3. Multiple sequence alignment 4. Primer Design. Online tools 5. Principle and operations of lab equipment: Autoclave, Laminar Airflow, Incubator, Shaking incubator, PCR, Electrophoresis and Western blot 6. Isolation of Genomic DNA 7. Amplification of Gene by PCR 8. Isolation of Plasmid DNA 9. Preparation of insert DNA and expression vector 10. DNA ligation and Transformation 11. Over expression of Recombinant Protein 12. Purification of recombinant protein by Affinity chromatography 13. Protein separation by SDS-PAGE Electrophoresis

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	M
CO2	S	S	S	S	S
CO3	M	S	S	M	M
CO4	M	S	S	L	M
CO5	S	M	S	S	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Amit D. Sonagra; Sagar J. Dholariya. Electrophoresis, published in the journal Europe PMC in 2022
2. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, 4th edition, 2012).
3. Re & quot;Gel Electrophoresis – An Overview. " ScienceDirect Topics,
4. Elsevier, https://www.sciencedirect.com/topics/neuroscience/gel-electrophoresis.
5. Hanahan, Douglas. "Studies on Transformation of Escherichia coli with Plasmids." Journal of Molecular Biology, vol. 166, no. 4, 1983, pp. 557–580. http s://doi.org/10.1016/S00222836(83)80284.

COURSE NAME – DATA SCIENCE IN HEALTHCARE						
Course Code 25BC201VAC	Course Type VAC	L	T	P	C	Syllabus version 2025-2026
		2	1	-	-	

Pre-requisite	Knowledge on basic concepts in Clinical Documentation

Course Objectives
• The objective of this course is to examine data science in the healthcare system, and the interdisciplinary field combined statistics, machine learning, analysis and interprets complex medical data.
• The aim of the course is to understand how data science principles are applied to analyze health data, predict diseases, personalize medicine, and enhance the healthcare system.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To understand the fundamentals of probability and statistics, allowing us to analyze and predict the results in various mathematical scenarios.	K2
CO2	Students will be able to understand data science to improve the patients outcome to make it more effective.	K3
CO3	Understanding the concepts of Large Language Models (LLMs) as powerful AI models.	K4
CO4	Students will understand that effective clinical documentation is crucial for patients safety, accurate billing, and regulatory compliance.	K4,K5
CO5	The course also covers Healthcare analytics tools and softwares to analyze data aggregation.	K5,K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

DATA SCIENCE IN HEALTHCARE - 25BC201VAC	
UNIT - I **MATHEMATICAL CONCEPTS**	Sampling and probability, Algebra, Calculus, Optimization and combinatorial explosion, Bayes theorem, Statistics, linear algebra, Calculus and regression, Probability & statistics inference, data visualization, data structures, & database management.
UNIT - II **DATA SCIENCE AND HEALTHCARE**	Data Science Vs Statistics, Automation of data analysis and algorithms. Data Science life cycle, Data collection: Probability sampling, Non-Probability sampling. Computational tools, Structuring Data, Data Analysis, Data Cleaning, Data Visualization, Inference and statistical analysis, Prediction in data science.
UNIT - III **HEALTHCARE AND GENERATIVE AI**	Generative AI, generative AI models and its application, LLMs and their architecture.
UNIT - IV **CLINICAL DOCUMENTATION IN HEALTHCARE**	Electronic health records, Patient Identification and Demographics, Medical History, Progress Notes, Medication records, Discharge summary, Insurance and billing.
UNIT - V **HEALTHCARE ANALYTICS TOOLS**	Data Handling and Processing: pandas, numpy, openpyxl, SQLAlchemy. Data Visualization: matplotlib, seaborn, plotly. Clinical Analytics Tools: Electronic Health Records, Clinical Decision Support Systems and Predictive Analytics Tools. Healthcare specific libraries.
UNIT VI **CURRENT CONTOUR**	Recent trends in clinical documentation using artificial intelligence.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	S	S	M	S	S
CO3	S	M	S	S	M
CO4	S	S	M	S	M
CO5	M	S	M	M	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Dr Reema Thareja. 2022. Data Science and Machine Learning using Python Paperback s standard Edition, McGraw Hill Publisher
2. Sunila Gollapudi, S. 2016. Practical Machine Learning. Packt Publishing Ltd.
3. Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA
4. Toby Segaran. 2007. Programming Collective Intelligence (First ed.). O'Reilly.
5. Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine - a Complete Overview. Springer.
6. Peter Harrington. 2012. Machine Learning in Action. Manning Publications Co., Greenwich, CT, USA.
7. Selected seminal and contemporary readings from peer-reviewed literature such as Proceedings of Machine Learning in Healthcare, Artificial Intelligence in Medicine, IEEE Transactions on Biomedical and Health Informatics, and other relevant venues.

COURSE NAME - HUMAN PHYSIOLOGY						
Course Code 25BC201DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concept in Human Physiology

Course Objectives
• Physiology may be defined as the study of the functions of living organisms.
• It addresses how organs and systems within the human body perform their functions at the molecular and cellular level, and the impact of these functions on the entire human body.
• This course is designed to provide students with an understanding of the function & regulation of the human body and physiological integration of the organ systems to maintain homeostasis.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Acquire knowledge on internal and external organization of body fluids	K1
CO2	Have an enhanced knowledge and appreciation of mammalian physiology.	K1,K2
CO3	Understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems.	K4
CO4	Understand the concepts of Digestion and absorption of small intestine and large intestine.	K3,K5
CO5	Be able to perform, analyze and report on experiments and observations in physiology	K4,K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

HUMAN PHYSIOLOGY - 25BC201DCE	
UNIT - I **CIRCULATORY AND RESPIRATORY SYSTEM**	Characteristics of Life, Tissues/Organ Systems. Extracellular fluid, Intracellular fluid: Lymph & Blood. Osmolarity of the body fluids, ionic composition, electrolytes, body buffers. Circulation: Structure and functions of Heart and blood vessels, cardiac cycles, cardiac factors controlling blood pressure, atherosclerosis, myocardial infarction electrocardiogram. Respiration: Anatomy and physiology of respiration, pulmonary surfactant, Gas Exchange & Transport: exchange of gases between lung and blood and between blood and tissues. Role of lung in acid-base balance
UNIT - II **SKELETAL, MUSCULAR SYSTEM AND RETINAL PHYSIOLOGY**	Physiology of bone, ligaments and tendons. Role of minerals in bone strength. Osteoporosis, rickets. Types and functions of muscles and muscle proteins. Mechanism of muscle contraction. Retinal physiology: Anatomy and Function of Retina, Rhodopsin - Retinal Visual Cycle. The Sense of Hearing, Tympanic Membrane and the Acicular System, Chemical Senses -Taste and Smell.
UNIT - III **NERVOUS SYSTEM**	Physiology: Nervous Tissue & Organization. Structure of neurons, axon and dendrites. Sensory Physiology; Peripheral Nervous System, Central nervous system. Membrane Potentials, Impulse Communication and Nerve Impulse Conduction; Resting potential and action potential, Synaptic transmission. Brain - chemical composition, metabolism, metabolic adaptation, neurotransmitters and cAMP.

	Biochemical aspects of learning and memory. Enkephalins and endorphins.
UNIT - IV **DIGESTIVE SYSTEM**	Digestive system: Anatomy of the digestive system, Salivary, Gastric and Biliary Secretions- composition and functions. Pancreatic secretions. Ingestion of food, Gastrointestinal hormones, movements in Gastro intestinal tract, Digestion and absorption of carbohydrates, lipids and proteins in small intestine and large intestine.
UNIT - V **EXCRETORY AND ENDOCRINE SYSTEM**	Excretory system: Structure and functions of kidney. Urine - composition and formation. Renal regulation of acid-base balance. Role of kidney in excretion. Determinants of the GFR, Renal Blood Flow, Physiologic Control of Glomerular Filtration and Renal Blood Flow. Endocrinology: Basics of hormones, Endocrine glands, hormones produced by endocrine glands. Physiology of hormones. Mechanism of hormonal action. Hormonal disorders.
UNIT VI **CURRENT CONTOUR**	Describe how the body works in health and how it responds and adapts to the challenges of everyday life, recognition and identification of principle tissue structure. And discuss AI applications.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Guyton And Hall - Textbook Of Medical Physiology, 14th edition 2022
2. Human Physiology for Medical Students, by N Geetha, 2nd edition, 2022, Jaypee Brothers Medical Publishers.
3. Guyton & Hall medical physiology 11th edition. Hardcover – 2017
4. McArdle, Katch & Katch, edition, Exercise Physiology: Nutrition, Energy, and Human Performance, seven edition, Lippincott Williams & Wilkins, 7th edition, 2010.
5. Widmaier, Raff, & Strang: Vander's Human Physiology: The Mechanisms of Body Function, 12th edition, McGraw Hill, 2008.
6. Textbook in Medical Physiology and Pathophysiology: Essentials and clinical problems, Copenhagen Medical Publishers 1999 – 2000 Access at: http://www.mfi.ku.dk/PPaulev/content.htm.

COURSE NAME – BIOINFORMATICS						
Course Code 25BC202DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Bioinformatics

Course Objectives
• The purpose of studying this paper is to apply computational facility in different fields of life sciences, physical and chemical sciences.
• After completion, students could learn drug designing through computer based modification programs using synthetic or natural sources.
• Most important application of Bioinformatics is in the field of drug discovery where it reduces more than 60% of the time, money and labor

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To introduce the basic concepts of Bioinformatics and its significance in Biological data analysis.	K2,K4
CO2	Explain about the methods to characterise and manage the different types of Biological data.	K3
CO3	Introduction to the basics of sequence alignment and analysis	K3
CO4	Introduction to identify the protein structure visualization tools. Genome databases- Prokaryotic Genome Database with comparison with Human genomes like HGP, GENE CLUSTER, DNA Microarray, SWISS-2DPAGE.	K5
CO5	Develop relevant skills in math, statistics and biology that enable success in the field of bioinformatics. Develop analytical skills that will allow them to identify important problems in bioinformatics and to identify solutions	K6,K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

BIOINFORMATICS - 25BC202DCE	
UNIT - I **BIOINFORMATICS**	An overview, Definition & History; Bioinformatics databases & tools on the Internet- NCBI, EBI, PIR, Swiss-Prot, GenBank; pattern & motif searches- BLOCKS, PRINTS, PFAM
UNIT - II **PROTEINS AMINO ACIDS**	Levels of protein structure – Ramachandran Map. Protein Secondary structure prediction - Chou Fasman rules, Gamier-Osguthorpe-Robson (GOR) methods; Predicting 3D structure – homology modeling, threading - fold recognition and ab initio methods - Rosetta – CASP.
UNIT - III **BIOLOGICAL SEQUENCE ANALYSIS**	Pairwise sequence comparison – Sequence queries against biological databases – BLAST and FASTA - Multiple sequence alignments –Phylogenetic alignment. Algorithms and Matrices: Scoring matrices- PAM and BLOSUM; dynamic programming, Algorithms, Needleman and Wunsch, Smith-Waterman;
UNIT - IV **PROTEIN STRUCTURE'S TOOLS**	RasMol, HEX, Argus Lab Swiss PDB Viewer - Structure – Classification, alignment and analysis – SCOP, CATH, FSSP, UNIX.
UNIT - V **FUNCTIONAL GENOMICS (METABOLISM AND REGULATION) IN BIOCHEMISTRY**	Sequencing genomes– Genome databases on the web, Prokaryotic Genome Database with comparison with Human genome, HGP, GENECLUSTER, DNA Microarray, SWISS-2DPAGE Database, TIGR,WIT, CYTOSCAPE and DRUG DISCOVERY.
UNIT VI **CURRENT CONTOUR**	Using Bioinformatics tool to predict protein models in disease related pathways
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	S
CO4	S	S	M	S	M
CO5	M	M	S	M	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Bioinformatics: A Practical Guide to Next Generation Sequencing Data Analysis -J by Hamid D. Ismail, 1st edition, 2023. Publisher - Boca Raton : CRC Press
2. Methods and Applications: Genomics, Proteomics and Drug Discovery – by Namita Mendiratta, Parag Rastogi , S.C.Rastogi , 5th edition, 2022
3. Bioinformatics-Sequence and Genome Analysis- David W.Mount, Cold Spring Harbor Laboratory Press (2004).
4. Introduction to Bioinformatics, Attwood, T.K. and D.J. Parry-Smith, Pearson Education Ltd., New Delhi (2004).
5. Bioinformatics – Westhead, D.R., Paris J.H. And R.M. Twyman, Instant Notes: Viva Books Private Ltd, New Delhi (2003).
6. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, New Delhi (2003).
7. Bioinformatics- Sequence, structure and databanks, Higgins D. and W. Taylor (Eds), Oxford University Press, New Delhi (2000).
9. Introduction to computational Biology, Michael, S. Waterman, Chapman & Hall.

COURSE NAME – MOLECULAR ENDOCRINOLOGY						
Course Code 25BC203DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Endocrine disorders

Course Objectives
• Study the molecular mechanisms of hormone and growth factors action.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students will be able to identify the organs involved in endocrine system, hormones	K1
CO2	Students will able to understand key human endocrine disorders	K2
CO3	Students will understand know the major hormones that are produced by these organs and will know the physiological effect of these	K4
CO4	The students know the clinical evaluation of endocrine system	K7
CO5	Endocrine disorders are diverse conditions that affect hormone production, leading to a wide range of symptoms and health complications	K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

MOLECULAR ENDOCRINOLOGY - 25BC203DCE	
UNIT - I **BASICS OF ENDOCRINE SYSTEM**	Definition and scope of Endocrinology- Historical and anatomical aspects of mammalian endocrine system. Definition of a hormone- chemical nature of mammalian hormones- types of hormone receptors- secondary messenger system general mechanism of peptide and non- peptide hormones action. Feed-back regulation of Endocrine System.
UNIT - II **ENDOCRINES OF HYPOTHALAMUS AND THYROID GLAND**	The Endocrines of Hypothalamus - Hypo-Physiotropic hormones- Neurovascular hypothesis. Pituitary gland hormones- chemistry and biochemical functions. Pineal gland hormones- chemistry- biochemical functions- mechanism of action. Thyroid gland hormones- chemistry- biochemical functions- mechanism of action. Parathyroid glands- biochemical functions
UNIT - III **HORMONES OF ADRENAL AND PANCREAS**	Adrenal gland: Hormones of adrenal gland- chemistry- mechanism of action biochemical functions. Pancreas- Insulin/glucagon: chemistry- biochemical functions- mechanism of action. Somatostatin. Hormones involved in calcium metabolism- chemistry- mechanism of action. Neuro-hormones- the brain- Renin-Angiotensin System, Urotensin-neuropeptides.
UNIT - IV **HORMONES OF FEMALE AND MALE REPRODUCTIVE SYSTEM**	Hormones of female and male reproductive system: Ovarian steroid hormones chemistry- biosynthesis and transport; Synthesis, chemistry and metabolism of androgens- dynamics of steroid hormone production and metabolism mechanisms of action of sex steroid hormones. Testicular and ovarian determining genes – Mullerian-inhibiting substance genes- molecular basis of male and female contraception

UNIT - V **ENDOCRINOPATHIES**	Endocrinopathies: Hypo-physeal, Thyroid, parathyroid, adrenal and pancreas. Disorders of pituitary hormone axis- thyrotoxicosis- hypothyroidism- Hashimoto's thyroiditis- metabolic bone diseases- Cushing's syndrome- Addison's diseases. Diabetes mellitus- androgen deficiency syndromes- Testicular neoplasm: Klinefelter's syndrome and Turner's syndrome. Clinical evaluation of endocrine functions-overview.
UNIT VI **CURRENT CONTOUR**	Discussion on recent research in key human endocrine disorders
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	M
CO2	S	S	M	S	S
CO3	S	M	S	S	M
CO4	S	S	M	S	S
CO5	M	M	S	S	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. A. L. Lehninger, Nelson & Cox. 2021. Principles of Biochemistry, 8th edition, CBS, India
2. Endocrinology: Mac E. Hadely. 5th edition, Pearson Education, 2000.
3. Henry M. Kronenberg, Shlomo Melmed, Kenneth S. Polonsky, P. Reed Larsen. William Textbook of Endocrinology, 13th edition. Saunders Elsevier 2016
4. Bolander, F. F. Molecular Endocrinology, 3rd. Academic Press, 2004. Chromatin Kensal E. van Holde · 2012 ,
5. Chromatin (Springer Series in Molecular and Cell Biology) Paperback – 2011

COURSE NAME – ECOLOGY AND ENVIRONMENTAL BIOLOGY						
Course Code 25BC204DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic idea of Ecology also environmental Biology

Course Objectives
• To study the physical and biological characters of the environment and the interrelationship between biotic and abiotic components of nature as well as relationship among the individuals of the biotic components
• The core objectives of an Ecology and Environmental Biology course include understanding fundamental ecological principles, appreciating biodiversity and its conservation, and developing skills in research and environmental management.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Develop an appreciation of the modern scope of scientific inquiry in the field of Ecology.	K2
CO2	Become familiar with the variety of ways that organisms interact with both the physical and the biological environment.	K3
CO3	Develop an understanding of the differences in the structure and function of different types of ecosystems	K1
CO4	They will learn about the intricate relationships between living organisms and their environment, including biotic and abiotic factors.	K3
CO5	Students will understand the effects of human activities on ecosystems, such as pollution, habitat loss, and climate change	K2,K3
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

ECOLOGY AND ENVIRONMENTAL BIOLOGY - 25BC204DCE	
UNIT - I **INTRODUCTION TO ENVIRONMENT AND ECOLOGY**	The Environment: definition, types of environment and their importance: physical environment; biotic environment; social environment; biotic and abiotic interactions. Ecology: scope of ecology; historical background; ecology in India; terminology of ecology; basic concepts of ecology.
UNIT - II **ENVIRONMENTAL COMPLEX**	Environmental complex, Environmental and ecological factors-Direct and indirect factors; four categories of ecological factors-climatic, topographic, edaphic and biotic factors; interaction of ecological factors. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
UNIT - III **POPULATION ECOLOGY**	Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
UNIT - IV **COMMUNITY ECOLOGY**	Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Habitat and Niche:Concept of habitat and niche, types of niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement
UNIT - V **ECOLOGICAL SUCCESSION**	Ecological succession types, mechanisms, changes involved in succession, concept of climax. Ecosystem Ecology: Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, and P); primary production and decomposition; structure and function of some Indian

	ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
UNIT VI **CURRENT CONTOUR**	Environmental pollution-Types, global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves)
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	S
CO3	M	S	M	S	M
CO4	S	M	M	M	S
CO5	S	M	M	S	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. A Text Book of Environmental Pollution, Dr Thangavelu Arumugam, 3rd edition, 2024
2. Ecology and Environmental Biology, T.K.Saha, Books and Allied (P) Ltd, Kolkata 2011.
3. Modern concepts of Ecology, H.D.Kumar, 8thed, Vikas Publishing House Pvt Ltd, 2008.
4. Fundamentals of Environment Biology, Dr. Biswarup Mukherjee, Silverline publications, 2008.
5. A Text Book of Environmental Science, V. Thakur, 2012.
6. A Textbook of Environmental Science, Prabhat Patnaik, 2011.
7. Textbook of Ecology, S.K. Dubey, 2012.

COURSE NAME – RESEARCH METHODOLOGY						
Course Code 25BC205DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Research

Course Objectives
• The course emphasizes various statistical methods and its significance.
• The students are expected to understand the concepts and solve relevant problems pertaining to each topic.
• To provide sufficient background to be able to interpret statistical results in research

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students will able to describe various application of biostatistics, bioinformatics in Research	K2
CO2	Will able to distinguish different types of data and sampling techniques	K3
CO3	To compare different population sample using ANOVA	K3
CO4	Will able to compute and interpret the result of correlation and regression analysis	K5
CO5	To compare different population sample using ANOVA	K6

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation

RESEARCH METHODOLOGY - 25BC205DCE	
UNIT - I **RESEARCH METHODOLOGY**	Introduction: meaning of research; objectives of research; types of research; research approaches; significances of research; Components of a research, research methods; importance of knowing how research is done; Computer application in scientific research: Finding scientific articles. Defining the research problem; What is the research problem? Selecting the problem; Techniques involved in defining the problem; Research design; Need for research Design; different types of research designs; basic principles of experimental designs. year books, & monographs, journals, conference proceedings, abstracting & indexing journals, index & References cards, internet, magazines.
UNIT - II **DATA COLLECTION**	Primary and secondary Data collection. Sampling: Sampling and Population, Techniques sampling selection, Characteristics of a good sample, Sampling errors and how to reduce them. Techniques of Data Collection: Data schedule, Observation, Opinionnaire, Questionnaire, Interview schedules, Bibliometrics, Webometrics. Report writing; Preparation of manuscript- plan of the report, review of literature & its use in designing a research work, designing of methodology, interpretation of data & thesis layout. Scientific writing. Characteristic of scientific writing, essential features of an abstract, presentation of data, writing of results & discussions. Bibliography, oral presentation; precautions for writing research reports; conclusions.
UNIT - III	Tabulation, organization and graphical representation of quantitative data. Measures of central tendencies: Mean

DESCRIPTIVE STATISTICS	Median and Mode. Measures of variability: Range. Q.D; S.D; A.D; and Coefficient of Variation Measures of Relative Position: Percentiles, Percentile Ranks, Standards Scores, Stanine Scores, T- Scores Normal Probability Distribution, properties of normal curve, applications of normal curve, Hypothesis testing: What is Hypothesis? Basic concepts concerning testing of hypothesis; procedure for hypothesis testing; Probability; Markov models and Hidden Markov Models; Probability distribution; Binomial; Poisson; Normal distribution and Multiple testing Methods ANOVA; Test of significance-t-test; F-test.
UNIT - IV **BIOINFORMATICS**	Origin and overview of bioinformatics. Applications of bioinformatics. Research in bioinformatics, Biological Databases: Literature databases, Sequence databases, Structure databases, Structural classification databases, Metabolic pathways database, Pattern and Motif searches: PROSITE, BLOCKS, PRINTS, PFAM. Sequence alignment: Pairwise sequence alignment - Local and Global alignments. Dotplot -Dynamic programming methods. Scoring or Substitution matrices - Database searching -FASTA and BLAST searches - Multiple sequence alignment. ClustalW. T-Coffee .Tools for Drug discovery / drug design.
UNIT - V **GENOMICS AND PROTEOMICS**	Genome features of Prokaryote and Eukaryote. - Genome projects: HGP, E.coli, A.thaliana and Human-Genomic variations (SNP). Genome expression (Microarray). Comparative Genomics: MUMMER,Etc. Proteomics: Protein sequence and structure characterization - Proteomics tools in Expasy server. Primary Structure

	Prediction by Computing there pi, Secondary structure prediction: GOR and Chou Fasman – Tertiary structure prediction: Homology modeling. Ab initio Modelling, Protein Structure and Function Determination, Protein structure visualization tools: RasMol and Swiss PDB Viewer, online Analyzing Tools.
UNIT VI **CURRENT CONTOUR**	Describing Data, The Normal Distribution, Sampling Distributions, Confidence Intervals, Hypothesis Testing, Proportions, Linear Regression, Survival Analysis.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	S	S	M	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Statistical Methods, by - Gupta, S.P, 49th edition, 2023, Sultan Chand & Son Publishers.
2. Research Methodology and Applied Statistics - by D N SANSANWAL, paperback 2020
3. Tests, Measurements and Research Methods in Behavioural Sciences . Singh, A.K. Bharati bhawan, 2015
4. Biostatistical Analysis, 5thEdition- Zar, J.H, Pearson Education, 2010.
5. Statistical Methods . Y.P. Aggarwal. 2012
6. Kothari. C.R. Research Methodology – Methods and Techniques, New Age International(P)Ltd, 2004
7. Research Methodology. Methods & Techniques : Kothari, C.R. 2nd edition, 2004
8. Methods of Statistical Analysis . P.S. Grewal -14th edition, 2007

SEMESTER III

CATEGORY	CODE	SUBJECTS	HOURS	CREDITS
Core 9	25BC301CR	Immunology	5	5
Core 10	25BC302CR	Genetic Engineering	5	5
Core 11	25BC303CR	Clinical Biochemistry	5	5
Core 12	25BC304CR	Laboratory Course-III	6	5
Value Added Course	25BC301VAC	Artificial Intelligence in Digital Publishing	3	0
Elective	25BC301DCE to 25BC305DCE	Elective III	3	3
Non Major Elective	#	Non-Major Elective II	3	2
Internship	25BC301IN	Internship/ Industrial Activity	**	2
		Total credits for Semester III	30	27

- Students have to choose Non-Major Elective papers offered by other departments

** Evaluation of Summer internship will be done and marks will be included in 3rd semester

COURSE NAME - IMMUNOLOGY						
Course Code 25BC301CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		4	1	-	5	

Pre-requisite	Knowledge on basic concepts in Immune System

Course Objectives
• Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity
• Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses
• Define the basic mechanisms that regulate immune responses and maintain tolerance
• To demonstrate the molecular basis of complex, cellular processes involved in inflammation and immunity, in states of health and disease
• Describe basic and state-of-the-art experimental methods and technologies

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity.	K1
CO2	Define the basic mechanisms that regulate immune responses and maintain tolerance.	K2
CO3	Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses. Understand the molecular basis of complex, cellular processes involved in inflammation and immunity, in states of health and disease.	K3
CO4	Describe basic and state-of-the-art experimental methods and technologies. Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease.	K4
CO5	Apply understanding of basic and state-of-the-art experimental methods and technologies in the design of research plans to test specific hypotheses	K6,K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

IMMUNOLOGY - 25BC301CR	
UNIT - I **INTRODUCTION TO IMMUNOLOGY**	Central and peripheral lymphoid organs – Thymus, bone marrow, spleen, lymph nodes and other peripheral lymphoid tissues – MALT, GALT and CALT. Cells of the immune system- lymphocytes, mononuclear phagocytes – dendritic cells, granulocytes, NK cells and mast cells. Immunoglobulins – structure, classification and functions. Idiotype network hypothesis. Antigen, types of antigen, antigen Vs immunogens, Haptens. Factors influencing immunogenicity. Isotypes, allotypes and idiotypes. (Blended mode of teaching)
UNIT - II **COMPLEMENT PATHWAYS**	Complement system: components of complement activation and its biological consequences – classical, alternative and lectin pathways. Clonal selection theory. Organization and expression of immunoglobulin genes, generation of antibody diversity. Class switching. Overview of B cell &T cell, types of immune response, T – cell, B- cell receptors, Antigen recognition – processing and presentation to T- cells. Interaction of T and B cells. Effector mechanisms – macrophage activation. Cell mediated cytotoxicity, Cytokines types, regulation of immune response : immune tolerance and immunosuppression.*(Chalk and talk)*
UNIT - III **MAJOR HISTOCOM-PATIBILITY COMPLEX**	Major Histocompatibility complex (MHC): MHC genes and products. Polymorphism of MHC genes, role of MHC antigen in immune response, MHC antigens in transplantation. Transplantation types, allograft rejection mechanism. Immune response to infectious diseases – Viral, bacterial and Protozoal. AIDS and other immunodeficiency disorders. Autoimmunity:

	Mechanism of induction of organ specific and systemic autoimmune diseases. Hypersensitivity – types. Immune response to cancer, immunotherapy.
UNIT - IV **VACCINES**	Immunization practices – active and passive immunization. Vaccines – killed, attenuated – toxoids. Recombinant vector vaccines – DNA vaccines, synthetic peptide vaccines – anti idiotype vaccines. Humanized antibodies and plantibodies. Production of polyclonal and monoclonal antibodies. Principles, techniques and application. Genetically engineered antibodies. Abzymes.
UNIT - V **IMMUNO-TECHNIQUES**	Immunotechniques: Agglutination and precipitation technique. Immuno – electrophoresis, RIA, immunoblotting, Avidin – biotin mediated immunoassay. Immunohistochemistry – immunofluorescence, immunoferritin technique. Fluorescent immunoassay, fluorescence activated cell sorting (FACS). Cytokines assay: ELISA and ELISPOT. Lymphocytes transformation test (LTT); Lymphoblastoid cell lines. Experimental animal models: inbred strains, SCID mice, nude mice, knockout mice fully cloned animals. (www.biologydiscussion.com/biochemistry/immunochemical...)
UNIT VI **CURRENT CONTOUR**	Recent studies on Auto-immune disorders, Hypersensitivity. Dynamics of the immune response. The immune response in health and disease. Immunity against covid-19 infections. Use of A I in diagnosis.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	M
CO2	S	S	M	S	S
CO3	S	M	S	S	M
CO4	S	S	M	S	S
CO5	S	S	S	M	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Sharon Stranford; Judy Owen; Patricia Jones; Jenni Punt, Kuby's Immunology, 8th edition, 2022
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Essential Immunology, 13th edition. | : John Wiley & Sons, Inc., 2017.
3. Janis Kuby - (2006), Immunology, 6th edition, W.H. Freeman & Co. (Ltd).
4. Kenneth M. Murphy, Paul Travers, Mark Walport - (2022), Janeway's Immunobiology, 10th edition, Garland Science.
5. Abul K. Abbas, Andrew H. Lichtman, Jordan S. Pober- (2021), Cellular and molecular immunology, 10th edition, B. Saunders Company
6. Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt - (2017),Roitt's Essential Immunology, 13th edition, Wiley-Blackwell.
7. 5. Donald Mackay Weir &Stewart John - (2008), Immunology, 8th edition, Churchill Livingston.
8. Geoffrey L. Zubay - (1998), Biochemistry,4th edition, W.M.C. Brown publishers.

COURSE NAME - GENETIC ENGINEERING						
Course Code 25BC302CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		4	1	-	5	

Pre-requisite	Knowledge on basic concepts in Genetic Engineering

Course Objectives
• This course enables the students to gain knowledge on main aspects of implementation and transmission of a genetic material at molecular and cellular levels.
• The methods of change of a genetic material and construction of transgenic organisms with the given properties.
• To understand the function of creative use of modern tools and techniques for manipulation and analysis of genomic sequences

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	The course covers the fundamentals of genome, gene cloning and gene transfer techniques	K1
CO2	Students will understand the general plant tissues culture technique along gene therapy strategies.	K2
CO3	Students will understand the basic molecular techniques and techniques involved in the field of forensics	K2,K3
CO4	understand the function of creative use of modern tools and techniques for manipulation and analysis of genomic sequences	K4
CO5	outcomes of these genetic modifications include increased food production, reliability, and yields; enhanced taste and nutritional value; and .	K5,K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

GENETIC ENGINEERING - 25BC302CR	
UNIT - I **INTRODUCTION TO GENE CLONING**	Restriction and modification enzymes. Cloning vectors: Characteristics, Natural & artificial plasmids as vectors - advantages and disadvantages. Vectors used for cloning in *E.coli*., yeast, higher plants (Ti plasmid derivatives, caulimovirus) and animal cells (constructs of SV 40 and retroviruses). Characteristics of expression vectors. Construction of DNA libraries - genomic and cDNA libraries. Screening of recombinants. *(Blended of teaching)*
UNIT - II **TRANSGENICS**	Transposons and transposable elements: Transgenic animals - Gene transfer methods in animals. Recombinant selection and screening. Totipotency, haploids, growth of animal cell lines. Competent cells preparation, electroporation, microinjection and particle bombardment method, and selection of transformants. Transgenic plants - Use of *Agrobacterium tumefaciens* for genetic engineering in plants. Plant cell cultures for the production of important compounds. Plant tissue culture – Micropropagation, protoplast isolation, somatic hybrids. Identification of transformed cells into callus and regeneration of transgenic plants.
UNIT - III **MOLECULAR TECHNIQUES**	Polymerase chain reaction – principle, types and applications. Sanger's and Maxam-Gilbert's method for DNA sequencing, Next-Generation Sequencing. DNA Fingerprinting - RAPD, RACE (Rapid Amplification of cDNA Ends), RFLP and AFLP analysis and its application in forensic science, pedigree analysis, biodiversity, genetic counselling and germplasm maintenance. DNA foot printing. DNA Barcoding, RNA sequencing, Chromosome walking, chromosome jumping.

	Mutagenicity test – Ames test. Markers linked to drug and disease resistant genes. Antisense technology and its application. Microarray technology: genomic and cDNA arrays.
UNIT - IV **GENE THERAPY**	*Ex vivo*, *In vivo*, *In situ* gene therapy Strategies of gene therapy: Gene augmentation – ADA deficiency, CFTR, Antisense therapy, Ribozymes, Protein Aptamers, Intrabodies. Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells. Testing and generation of embryonic stem cells, Testing for adult stem cells and differentiation, Potential use of stem cells – Cell based therapies.
UNIT - V **GENOME PROJECT AND BIOETHICS**	Human genome projects, gene bank. Genetically modified organisms (GMOs) in developed and developing countries. Genetically modified foods – benefits and risks. Bioethics: Laws and regulations in biotechnology, patent laws, and Intellectual property rights (IPR). Biosafety, types of biosafety, advantage and disadvantage. Ethics in cloning and stem cell research.
UNIT VI **CURRENT CONTOUR**	Discuss recent techniques in genetic engineering that help understand diseases and treat the same . Transcriptomics, Metabolomics, Proteomics.
Total Lecture Hours – 60	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	M	M	M	S
CO4	S	S	S	S	M
CO5	M	M	S	M	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Molecular biotechnology- Principles and Applications of recombinant DNA, Bernard R. Glick , Cheryl L. Patten , 6th edition, ASM Press, 2022
2. Molecular Cloning: A Laboratory manual, Michael R. Green , Joseph Sambrook. 4th edition, Cold Spring Harbor Laboratory Press New York, 2012
3. DNA Cloning: a Practical Approach, DM Glover and BD Hames, 2nd edition, IRL Press
4. Handbook of Molecular and Cellular methods in Biology and Medicine. Ara Kirakosyan , Leland J. Cseke , Margaret V. Westfall , Peter B. Kaufman ,3rd edition, CRC Press Inc, 2013
5. DNA Science. A first Course in Recombinant Technology, David A. Mickloss and Greg A. Freyer, 2nd edition, Cold Spring Harbor Laboratory Press,U.S.,2003
6. Molecular Biotechnology (2n, Edition) SB Primrose, Blackwell Scientific Publications, UK., 1994
7. Milestones in Biotechnology : Classic papers on Genetic Engineering. Julian Davies and William S. Reznikoff, Butterworth-Heinemann, Boston, 1992
8. Route Maps in Gene Technology, MR Walker and R Rapley, 1st edition, Blackwell Science, Ltd, Oxford, 1997
9. Principles of Gene Manipulation and genomics, Sandy B. Primrose, Richard Twyman 7th edition, Blackwell publication,2006

COURSE NAME - CLINICAL BIOCHEMISTRY						
Course Code 25BC303CR	Course Type Core	L	T	P	C	Syllabus version 2025-2026
		4	1	-	5	

Pre-requisite	Knowledge on basic concepts in Clinical Biochemistry

Course Objectives
• The course aims to provide an advanced understanding of the biochemical mechanisms and pathophysiological processes responsible for common biochemical disorders.
• The course provides an overview of normal and abnormal metabolic functions, the impact of disorders on metabolic processes, an overall picture about the molecular basis of diseases and novel strategies to prevent the diseases.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	The students will understand the basic concepts and principles of Clinical Biochemistry, detail on the various biological specimens including the process of collection, preservation and storage	K2
CO2	The students will understand the aetiology, types, clinical manifestations and treatment of various metabolic disorders of carbohydrate, protein and lipids	K2,K3
CO3	The students will understand the pathophysiological processes responsible for common inherited disorders	K3
CO4	The students are able to understand the Hepatobiliary system and find the differential diagnosis tests for bilirubin metabolism.	K4
CO5	The course covers the fundamentals disorder, therapeutic, metabolic disorders in humans.	K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

CLINICAL BIOCHEMISTRY - 25BC303CR	
UNIT - I **BIOCHEMICAL LABORATORY - ROUTINE ANALYSIS IN URINE AND BLOOD**	Introduction to Biochemical laboratory: Roles of biochemical laboratory, Mechanization and automation in clinical biochemistry. Quality control in clinical laboratories - Total laboratory uncertainty, accuracy and precision. Selection and optimization of laboratory methods. Clinical evaluation of laboratory methods. Biochemical analysis in blood and urine. Analysis of proteins - Plasma protein spectrum during inflammation, paraproteins. Blood gases. Electrolytes and acid – base balance. Regulation of electrolyte content of body fluids and maintenance of pH reabsorption of electrolytes. Acidosis & Alkaloids and their determination in clinical laboratory
UNIT - II **DISORDERS OF CARBOHYDRATE METABOLISM**	Glucose level in normal blood, renal threshold, hyper and hypoglycemia and glycosuria - qualitative tests for sugars in urine - intravenous and other types of glucose tolerance tests - fructose levels in blood, lab diagnosis of early and latent diabetes mellitus - diabetic coma, secondary degenerative changes associated with diabetes mellitus. Glycogen storage disorders, Pentosuria, and galactosemia
UNIT - III **DISORDERS OF PROTEIN AND PROTEIN METABOLISM**	Agammaglobulinemia, Alpha – fetoprotein, Amyloidosis. Cryoglobulinemia. Hypo and hyper immune gamma – globulinemia. Abnormalities in Nitrogen Metabolism – uremia and factors affecting nitrogen balance, porphyrias and porphyrinuria. Disorders of lipids: Plasma lipoproteins, cholesterol, triglycerides & phospholipids in health and disease.

	Hyperlipidemia, hyperlipoproteinemia, ketone bodies, fatty liver. Major Cardiovascular diseases – Atherosclerosis – risk factors, pathogenesis. Laboratory diagnosis of acute myocardial infarction. Inborn error of metabolism: Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch – Nyhan syndrome, Histidinemia, Gaucher's disease, Tay – Sachs and Niemann – Pick disease.
UNIT - IV **DISORDERS OF LIVER AND KIDNEY**	Hepatobiliary system - Hepatobiliary function tests - lab findings and differential diagnosis of jaundice - metabolism of bilirubin - cirrhosis, hepatic coma, hepatitis, gallstones, cholecystitis and tumours. Diagnostic Enzymes – Enzymes in health and diseases. Excretory system - Renal function tests - Biochemical changes and laboratory findings in acute and chronic renal failure - clearance of tests - urinary calculi, renal hypertension - principles of peritoneal and hemodialysis.
UNIT - V **DISORDERS OF ENDOCRINE SYSTEM**	Blood and coagulation - disturbances of blood clotting mechanisms - systematic analysis of hemorrhagic disorders - coagulation and prothrombin time, determination - hemoglobin- anaemia - abnormal hemoglobin and their identification. Endocrine system: Laboratory diagnosis and investigations related to disorders of thyroid, pituitary, adrenal cortex, adrenal medulla, testes, ovaries - plasma and urinary assays of hormones related to various endocrine disorders.
UNIT VI **CURRENT CONTOUR**	Seminar talks on recent research topics in diabetes and cardiovascular diseases.
Total Lecture Hours – 60	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	M
CO4	S	S	M	S	S
CO5	S	S	S	M	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. DM. Vasudevan, Sreekumari S, Kannan Vaidyanathan - Textbook of Medical Biochemistry for medical students, 10th edition, (2022), JAYPEE BROTHERS

2. Michael Lieberman, Allan D. Marks – (2023). Basic Medical Biochemistry: A Clinical Approach, 6th edition, Lippincott Williams & Wilkins

3. Nanda Maheshwari – (2022). Clinical biochemistry, 3rd edition, JAYPEE.

4. By William J. Marshall, S. K. (2014). Clinical Biochemistry: Metabolic and Clinical Aspects, 3rd edition, Paperback

4. Rodney F. Boyer - (2010). Biochemistry Laboratory: Modern Theory and Techniques, 2nd edition, Pearson Prentice Hall.

5. Undurti N. Das - (2011). Molecular Basis of Health and Disease, 1st edition, Springer.

6. MN Chatterjea, Ranashinde – (2012). Textbook of Medical Biochemistry, 8th edition, JAYPEE.

COURSE NAME – LABORATORY COURSE III						
Course Code 25BC304CR	Course Type Practical	L	T	P	C	Syllabus version 2025-2026
		-	1	5	5	

Pre-requisite	Knowledge on basic concepts in Research

Course Objectives
• This course is intended as an introduction to cell culture basics, covering topics such as getting familiar with the requirements of a laboratory dedicated to cell culture experiments, laboratory safety, aseptic technique, and microbial contamination of cell cultures, as well as providing basic methods for passaging, freezing, and thawing cultured cells.
• The objective of this course is to provide students with a comprehensive understanding of and practical skills in key protein and immunological laboratory techniques.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Understand cell culture requirements, media, and equipment; identify and troubleshoot common issues; explore applications and future prospects.	K1,K2
CO2	Maintain viable, contamination-free animal cell cultures and initiate plant micropropagation with awareness of species-specific needs.	K3
CO3	Prepare/evaluate media, cryopreserve/recover cells, and assess cell health.	K4
CO4	Extract, separate, and characterize proteins (e.g., SDS-PAGE); perform and interpret DOT-ELISA, ELISA, and rocket immunoelectrophoresis for antigen/antibody analysis.	K5
CO5	Collect, analyze, and interpret blood and urine samples for normal and pathological constituents using relevant laboratory tests.	K6,K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

LABORATORY COURSE - 25BC304CR	
EXPERIMENTS RELATED TO **CELL CULTURE**	1. Biology of cultured cells 2. Principle and operations of lab Equipment: Biosafety cabinet, CO2 Incubator, Real time PCR 3. Aseptic techniques, and safety protocols 4. Cell line repository 5. Preparation of Media 6. Plating of cells 7. Determination of Contamination 8. Adherent Subculture 9. Counting cells using a hemocytometer 10. Cryopreservation and Storage 11. Analysis of cell viability 12. Extraction of total RNA and cDNA synthesis 13. Reverse transcriptase Polymerase chain reaction 14. Extraction of protein 15. Separation of protein by SDS PAGE Electrophoresis 16. Identification and validation of protein by western blot analysis
EXPERIMENTS RELATED TO **IMMUNOLOGY**	17. Immunoprecipitation 18. DOT ELISA (ENZYME LINKED IMMUNO SORBENT ASSAY) 19. Rocket immunoelectrophoresis 20. Estimation of Antigen by ELISA
EXPERIMENTS RELATED TO **CLINICAL BIOCHEMISTRY**	21. Collection of blood and urine, Types of preservative and anticoagulants 22. Blood grouping, hemoglobin content, PCV, TC/DC count and ESR

	23. Qualitative tests of urine. Abnormal constituents- sugar, protein (albumin), ketone bodies, bile pigments and bile salts. 24. Quantitative estimation in blood a. Glucose, b. Protein, c. Cholesterol, d. Calcium, e. Urea, f. Iron, g. Bilirubin, h. Uric acid, i. Creatinine . 25. Quantitative estimations in urine: a. Urea , b. Uric acid, c. Creatine. 26. Liver Function Test by Enzymes: ALT,AST, GGT,AP.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	M	S
CO4	S	S	M	S	S
CO5	S	M	S	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Henry's Clinical Diagnosis and Management by Laboratory Methods, 2021, South Asia Edition - EBook 24th edition, Elsevier India,
2. Fundamental Techniques in Cell Culture, Laboratory HandBook, 3rd edition, 2019, The European Collection of Authenticated Cell Cultures (ECACC)
3. J. Clausen, Immunochemical Techniques for the Identification and Estimation of Macromolecules, 2025, Elsevier,
4. Doyle A., Griffiths J. B., Cell and Tissue Culture: Laboratory Procedures in Biotechnology. John Wiley & Sons Publications. 1999.
5. Butler M., Animal Cell Culture and Technology. Garland Science publications. 2004
6. Advancing Scientific Discovery with Cell Culture Lab Essentials - 2024

COURSE NAME - ARTIFICIAL INTELLIGENCE IN DIGITAL PUBLISHING						
Course Code 25BC301VAC	Course Type VAC	L	T	P	C	Syllabus version 2025-2026
		2	1	-	0	

Pre-requisite	Knowledge on basic idea of Research

Course Objectives
• The aim of the study is to gain knowledge about the role of AI in biological research.
• This course delivers new knowledge about publishing models and digital publishing tools in research.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To gain knowledge about the strategies and models of publishing through AI.	K1
CO2	Students will get an overview about the application of AI in the publishing industry.	K2
CO3	To learn about the impact of AI in research	K3
CO4	Integrating AI into existing education system	K4
CO5	To gain knowledge about different tools of AI operated for digital publishing.	K1
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

ARTIFICIAL INTELLIGENCE IN DIGITAL PUBLISHING - 25BC301VAC	
UNIT - I **PUBLISHING MODELS**	Creating, publishing, and distributing digital content such as e-books, audiobooks, and digital magazines. Traditional Publishing, Self-Publishing, Hybrid Publishing, Subscription-based Publishing, Freemium Publishing.
UNIT - II **AI IN PUBLISHING INDUSTRY**	Content creation, Creative writing, Manuscript preparation, grammar and style checking, editing and proof reading, Personalization, distribution and marketing, data management, content protection, social media automation.
UNIT - III **AI IN SCHOLARLY PUBLISHING**	AI Impact on Research: Designing research methodologies, experimental design and data analysis. Data Visualization and Analysis, formatting manuscript, graphical representation, plagiarism and Peer Review process.
UNIT - IV **AI IN EDUTECH**	Personalized learning, intelligent tutoring systems, automated grading, and predictive analytics. Adaptive Learning Platforms, Automated Assessment and Feedback, Virtual Learning Environments, Gamification, Predictive Analytics, Virtual Learning Assistants. Integrating AI into existing educational systems
UNIT - V **AI TOOLS FOR DIGITAL PUBLISHING**	Content Creation: AI Writing Assistants, Content Enrichment. Editing and Proofreading: Grammar and Style Checker, AI-powered Editing. Design and Visuals: AI-powered Design Tools, Image Recognition. Accessibility tools: Text-to-Speech and Speech-to-Text, Automated Language Translation.
UNIT VI **CURRENT CONTOUR**	Recent trends and innovations (robotic surgery, digital twins, AI in drug discovery)
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	M	S	M	S	S
CO3	S	M	M	M	M
CO4	M	S	S	S	S
CO5	S	S	L	S	L
S-Strong; M-Medium; L-Low					

Recommended References:

1. Artificial Intelligence and Machine Learning Fundamentals: Develop real-world applications powered by the latest AI advances, 1st Edition, Kindle Edition, 2018
2. Thomas L.Floyd and R.P.Jain, "Digital Fundamentals",11th Edition, Pearson Education, 2015
3. Morris Mano, "Digital Design", 6th, Edition, Pearson Education, 2018
4. Rajkamal, "Digital Systems: Principles and Design", 1st Edition, Pearson Education, 2007.
5. Anne Fischer Lent, "The Ultimate Desktop Publishing", Addison – Wesley Publishing company-1995
6. David A. Lauer, Stephen Pentak, "Design Basics", 6th Edition, Wadsworth, 2005
7. Harold Henke, "Electronic Books and e-Publishing: A Practical Guide for Authors", 1st edition, Springer, 2001

https://www.epublishing.com/news/2024/dec/05/ai-publishing/

COURSE NAME – CHROMATIN AND EPIGENETICS						
Course Code 25BC301DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Epigenetics

Course Objectives
• This course is designed to familiarize the students with basic and more advanced concepts of an emerging and rapidly evolving field of epigenetics
• To address fundamental questions in Epigenetics and Genetics Regulation

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	On Successful Completion of this course the students will have a sound knowledge about the Epigenetic contribution in cellular functions.	K1
CO2	Students can understand the function of DNA packaging within the cell and use examples to illustrate how packaging is achieved in various organisms.	K2
CO3	Students can describe in detail the protein components of the nucleosome and key modifications to nucleosome components, and understand the interactions between the DNA double helix and the nucleosome	K3
CO4	Students can understand the various chromatin states within the interphase nucleus – their degrees of compaction and the hierarchy of chromatin assembly	K4
CO5	The students would also learn the critical analysis, thinking of research papers and problem solving skills	K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

CHROMATIN AND EPIGENETICS - 25BC301DCE	
UNIT - I **CHROMATIN STRUCTURE**	DNA and Histones, Structure of Histones, , Histone-DNA Interactions, Nucleosomes, organization of Nucleosomes, Chromatin, Chromosomal architecture. Histone variants, Non-histone proteins.
UNIT - II **EPIGENETICS**	Genetics Vs Epigenetics, Regulation of gene expression and cell fate, Regulation from zygote to multipotent cells. Epigenetics of Tissue development, Homeostasis and regeneration. Epigenetic process of chromatin modification by transcriptional regulation, Hetero chromatin and Euchromatin.
UNIT - III **EPIGENETIC MODIFICATIONS**	Chromatin remodeling by DNA binding proteins, SWI/SNF family repositioning nucleosomes. Chromatin modifications by spontaneous conformational change, covalent modifications, Epigenetic modifications: DNA methylation and Post translational modification of Histones
UNIT - IV **EPIGENETIC CONTROL OF CHROMATIN**	Locus specific control: NURD, SIN3A, methyl transferase and kinase complexes. Coordination among Chromatin modifying complexes. Epigenetic control of Cell specific gene expression, Mitotic cell cycle, Gene imprinting, Cellular differentiation. Reversibility of Epigenetic modifications: Reprogramming epigenome by somatic cell nuclear transfer, cell fusion and by cell extracts.
UNIT - V **EPIGENETICS AND DISEASES**	Predisposition to disease, Imprinting based disorders, Epigenetics of Memory, neurodegeneration and mental health, Kidney, Diabetes and cardiovascular disorders.
UNIT VI **CURRENT CONTOUR**	Recent advances in chromatin and Epigenetics in AI
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	S	S	M	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Fundamentals of Epigenetics By Gurbachan S. Miglani, 2023, Publisher, Krishan Makhijani
2. Epigenetics. Lyle Armstrong. Ist edition, 2014, Publication, New york,
3. Epigenetic Advancements in Cancer By Manoj K, Mishra, Ist edition 2016
4. Epigenetic Biomarkers and Diagnostics By Jose luis garcia -Mica Haley, Ist edition, 2016,
5. Chromatin Structure and Function by Alan P. Wolffe. Academic Press. 3rdEdition 2012.
6. Chromatin Kensal E. van Holde · 2012 ,
7. Chromatin (Springer Series in Molecular and Cell Biology) Paperback – 2011

COURSE NAME - GENOMICS AND PROTEOMICS						
Course Code 25BC302DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Genomics

Course Objectives
• The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics	K2
CO2	Understand the Transcriptomics and metabolomics and their applications in various applied areas of biology.	K3
CO3	Knowledge about Overview of protein chips and functional proteomics; clinical and biomedical applications of proteomics.	K4
CO4	Analyze genetic data to identify genes associated with specific traits or diseases. - Evaluate the effectiveness of different gene therapy techniques in treating genetic disorders	K6,K7
CO5	Design experiments to map genes and analyze genetic markers in a research setting. - Develop a gene therapy strategy for a specific genetic disorder.	K4,K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

GENOMICS AND PROTEOMICS - 25BC302DCE	
UNIT - I **BASICS OF GENOMICS AND PROTEOMICS**	Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.
UNIT - II **GENOME MAPPING**	Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping
UNIT - III **GENOME SEQUENCING PROJECTS**	Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.
UNIT - IV **COMPARATIVE GENOMICS**	Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.
UNIT - V **PROTEOMICS**	Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases
UNIT VI **CURRENT CONTOUR**	Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes

	in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	M
CO4	S	S	M	S	M
CO5	S	M	M	S	L
S-Strong; M-Medium; L-Low					

Recommended References:

1. Genomics, Proteomics and biotechnology by RC Sibti, Manishi Mukesh, Aastha sobti, 1st edition, 2022, Publisher CR Press.
2. Gene Cloning and Manipulation, by Christopher Howe, Cambridge University Press Paperback , 2nd edition, 2007
3. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006).
4. Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
5. Liebler, D. C. (2014). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
6. Campbell, A. M., &Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.

COURSE NAME - REPRODUCTIVE BIOLOGY						
Course Code 25BC303DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in human reproductive biology

Course Objectives
• Study the molecular mechanisms of human reproduction.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	The scope of Human Reproduction covers the clinical science and medical aspects of reproduction.	K1
CO2	Reproductive biology research can contribute to a better understanding of how reproductive hormones affect various physiological processes, such as bone health, metabolism, and cardiovascular function.	K2,K3
CO3	Reproductive biology research can contribute to a better understanding of how reproductive hormones affect various physiological processes, such as bone health, metabolism, and cardiovascular function.	K4
CO4	Understanding the impact of endocrine dysfunction on fertility can lead to better management of conditions like infertility and related metabolic or cardiovascular problems.	K5,K6
CO5	Research can uncover key regulatory mechanisms of sperm function, highlighting the importance of factors like testicular cooling in male fertility.	K7
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

REPRODUCTIVE BIOLOGY - 25BC303DCE	
UNIT - I **SPERMATOGENESIS**	Theory Sex determination and differentiation: Mechanism of Sex determination, differentiation of gonad and the genital tract. Stem cell renewal in testis, Spermatogenesis: structural and molecular events, experimental approaches to study spermatogenesis; Seminiferous epithelial cycle; Sertoli cell: structure and function.
UNIT - II **STEROIDOGENESIS**	Leydig cell: generation of Leydig cell, steroidogenesis; Leydig and Sertoli cell proliferation during foetal and postnatal development; Regulation of testicular functions. Epididymal maturation of spermatozoa; Capacitation, Signal transduction pathway in acrosome reaction.
UNIT - III **MALE STERILITY**	Male sterility: azoospermia, oligozoospermia, asthenozoospermia, varicocele; Genetic basis for male infertility, Mutational analysis in genes for hormones, receptor and gamete development. Follicular development and selection; Role of extra-and intra-gonadal factors in folliculogenesis; Oocyte maturation and its regulation
UNIT - IV **FEMALE REPRODUCTIVE SYSTEM**	Ovulation: factors involved in follicular rupture; Luteinization and luteolysis; Follicular atresia. Regulation of reproductive cycle in female: menstrual cycle in human, estrous cycle in rat, estrous behaviour in cycling animals; Female reproductive disorder: amenorrhea, polycystic ovary
UNIT - V **FERTILIZATION AND CONTRACEPTION**	Fertilization: A comparative account on pre-fertilization events in oviparous animals (echinoderms-amphibians-mammals), activation of egg, candidate molecules involved in fertilization; Contraception leading to prevention of polyspermy: surgical, hormonal and immunocontraception

UNIT VI **CURRENT CONTOUR**	Seminar talks on recent research topics in male infertility
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	S	S	M	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. The Physiology of Female Reproduction, 2024, Vol 1 and 2, Ernst Knobil and Jimmy D. Neil, (ed), Raven Press.
2. Cell and Molecular Biology of Testis, (ed), Claude Desjardins and Larry L. Ewing Oxford University Press, USA- 2023
3. The ovary, Peter C.K. Leung and Eli Y. Adashi, (3rd), Elsevier (Academic Press), 2018.
4. Male Reproductive Function, Christina Wang, Kluwer Academic Publishers- 2021
5. The ovary, Solly Zuckerman Zuckerman, Barbara J. Weir, T. G. Baker. 2nd edition, 1977, Academic Press.

COURSE NAME - CONCEPTS IN NEUROCHEMISTRY						
Course Code 25BC304DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic concepts in Neuroscience

Course Objectives
• To introduce basic concepts about the organization, structure, and function of the human central nervous system; To enable students to apply these fundamental principles toward understanding nervous system function and dysfunction and toward clinical problem-solving in relation to disorders that affect the nervous system, with emphasis on the central nervous system.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To have in depth insight in basic brain structure and function reaching from the molecular to systems level	K2
CO2	To understand how neural systems contribute to sensory experiences, thoughts, emotions, behavior	K3
CO3	Neuroscience is a stand-alone course but it is expected that students have a basic understanding of human anatomy and physiology and the basic vocabulary of the anatomical sciences	K2,K3
CO4	The study of neurochemistry involves examining the chemical processes and substances within the nervous system	K4,K5
CO5	To apply and adopt experimental methods to gain new knowledge and overview of nervous system development and degenerative disorders	K5,K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

CONCEPTS IN NEUROCHEMISTRY - 25BC304DCE	
UNIT - I **CNS OVERVIEW**	Introduction to the Brain; Overview of brain systems and general principles of their functional organization: From cortical maps and subcortical loops to the micro-structure of brain circuits and their interconnections. CNS Organization; CNS Topography; Neuroembryology. VASCULATURE: Metabolism, Cerebral blood flow, CSF; Blood Supply; Stroke.
UNIT - II **CELL BIOLOGY OF NEURONS AND GLIA**	Nucleus and gene expression and regulation, Protein synthesis &translational control (including RNAi), Protein sorting &trafficking (signal peptides, Golgi, secretory and endocytic pathways), Cytoskeleton & transport (cytoskeleton, actin, microtubules, intermediate filaments, dendritic and axonal localization/transport, motors and adaptor), Signaling Pathways. Mitochondria, energy homeostasis and free radicals/energy metabolism in the neuron, Overview of glial cell biology &myelination (types of glia, morphology and function, myelination in CNS and PNS).*(Blended mode of teaching)*
UNIT - III **ELECTRICAL PROPERTIES OF NEURONS**	Overview of membrane structure & membrane transport, membrane potential, Ion channels and Ion Channel activity (electrochemical gradient), Action potentials, Propagation of action potentials along axons, Modulating action potential, Electrophysiological techniques for studying action potentials and ion channels
UNIT - IV **SYNAPTIC TRANSMISSION**	Overview of synaptic communication/structure of the synapse, Neural Signaling:- Neurotransmitters; Action potentials:- Resting potential; Excitatory; Inhibitory; Threshold; Depolarization; Hyperpolarization; Synapse: Formation;

	Synaptic communication; Neural circuits, synaptic plasticity: LTP/LTD, Spike Time dependent plasticity. Mechanism of neurotransmitter release, postsynaptic response: electronic properties of dendrites, basic integration, Ionotropic (v) metabotropic receptors, Neurochemical transmission: Glutamate, GABA, Glycine, Acetylcholine (Synthesis, storage, release and inactivation), Dopamine, Norepinephrine, epinephrine, serotonin, histamine, Neuropeptides &atypical neurotransmitters, Electrical synapses (gap junctions).
UNIT - V **DEVELOPMENT AND PLASTICITY**	Overview of nervous system development/ comparative embryology, Neural induction, Regionalization, Neurogenesis &migration, Mechanisms of axon guidance &target cell recognition, Synapse formation &elimination, Neuronal Death.*(Chalk and talk)*
UNIT VI **CURRENT CONTOUR**	Trends: Early genetic screening, AI-based developmental milestone tracking, and neuroprotective therapies
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	S	S	S	M
CO4	S	M	SM	S	M
CO5	M	S	S	M	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. J. W. Baynes, M. H. Dominiczak, Medical Biochemistry, 6th edition., Elsevier Mosby, Philadelphia, New York, Toronto, 2022.
2. Neurochemistry in Clinical Practice – Pradeep C. Bollu (Springer, 2022)
3. G. Siegel, R.W. Albess, S. Brady, D. Price, Basic Neurochemistry, 8th Edition, Amsterdam. Tokio, 2012.
4. Siegel, George and R. Wayne Albers, Scott Brady and Donald Price Basic Neurochemistry, 8th edition: Molecular, Cellular and Medical Aspects Academic Press - 2012
5. George J Siegel, MD, Editor-in-Chief, Bernard W Agranoff, MD, R Wayne Albers, PhD, Stephen K Fisher, PhD, and Michael D Uhler, PhD. Basic Neurochemistry, 6th edition Philadelphia: Lippincott-Raven; 1999.
6. Dale purves , George j. Augustine, David fitzpatrick , William c. Hall, Anthony-samuel lamantia , James o. Mcnamara , S. Mark williams. Neuroscienc ethird edition Publishers Sunderland, Massachusetts U.S.A, 2004.
7. Haines, Duane Neuroanatomy - An Atlas of Structures, Sections and Systems, 5th edition Lippincott Williams and Wilkins/2000.
8. Neuroanatomy An Illustrated Colour Text 6th Edition by Alan Crossman, David Neary, Ben Crossman - 2019
9. Haines, Neuroanatomy: An Atlas of Structures, Sections and Systems, 10th ed. Ed. Lippincott William and Wilkins, 2019
10. Blumenfeld, Neuroanatomy Through Clinical Cases (Paperback), Sinauer Associates; 2nd edition (2010).
11. Afifi and Bergman, Functional Neuroanatomy, Text and Atlas, McGrawHill, 2nd Edition, 2005.

COURSE NAME – NUTRITIONAL BIOCHEMISTRY						
Course Code 25BC305DCE	Course Type Elective	L	T	P	C	Syllabus version 2025-2026
		2	1	-	3	

Pre-requisite	Knowledge on basic idea of Nutrition

Course Objectives
• To review the biological system of energy metabolism
• To understand the research techniques used in basic biochemistry and nutritional biochemistry research
• To study the chemical/biochemical properties and metabolic pathways of carbohydrates, lipids, and proteins

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Capable of describing biochemical pathways relevant in nutrient metabolism	K2
CO2	Capable of describing biochemical techniques that are relevant for the investigation of the Nutrient metabolism.	K3
CO3	To introduce the latest concept of dietary management.	K3
CO4	Describes the metabolic functions and deficiency of micro & macro nutrients	K4
CO5	To evaluate and criticize the experimental approaches and scientific information presented in the research articles related to nutritional biochemistry	K5,K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

NUTRITIONAL BIOCHEMISTRY - 25BC305DCE	
UNIT - I **SOURCES, FOOD COMPOSITION, PROPERTIES AND STORAGE OF COMMON FOODS**	Functions of food in relation to health- classification of foods based on nutrients. Food preservation reasons for preserving foods, methods of preservation – an understanding of the principles involved, food additive in processed food and their effects. Food groups to provide nutritive requirement for normal health- body building foods, energy foods and protective foods.
UNIT - II **BASICS FOR COMPUTING NUTRIENT REQUIREMENTS**	Latest concepts in dietary recommendations, RDA – ICMR and WHO: their uses and limitations. Definition of unit of energy – cal, RQ, SDA and NPU. Energy metabolism: Basal and resting metabolism – influencing factors, Methods to determine energy requirements and expenditure. The sources and functions of essential nutrients – proteins (high biological and low biological value), carbohydrates and fats. Sources and functions of dietary fibre, Pro and Prebiotics**.**
UNIT - III **MICRO AND MACRO MINERAL NUTRIENTS**	Distribution sources, metabolic functions and deficiency manifestations – Calcium, Phosphorus, Sodium, Potassium, Iron, Copper, Selenium and Zinc. Fat and water soluble vitamins – Occurrence, properties and function – Hyber and Hypovitaminosis. Role of Vitamin as Antioxidant
UNIT - IV **NUTRITION THROUGHOUT LIFE CYCLE**	Special needs of Infants, children, adolescents, pregnant and lactating women, convalescents and old persons
UNIT - V **PRINCIPLES OF DIET THERAPY**	Diet during stressed conditions- laborers. Patients-therapeutic diets for anemia, malnutrition, obesity, diabetes mellitus and allergy.

UNIT VI **CURRENT CONTOUR**	Uncover the vital information about the role diet plays in the establishment, development, and prognosis of physical diseases such as cancer, diabetes, heart disease, and stroke
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	M
CO2	S	S	M	S	S
CO3	S	M	S	S	M
CO4	S	S	M	S	S
CO5	M	M	S	S	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. L. Stryer. 10th edit 2023. Biochemistry,ion. W.H.Freeman Company, New York
2. L. Lehninger, Nelson & Cox, Principles of Biochemistry, 8th edition, 2021, CBS, India.
3. Horton, R., Moranm, LA., Scrimgeour, G, MarcPerry and David Rawn. 2006. Principles of Biochemistry, 4th edition.
4. Murray R. K. et al. Harpers Illustrated Biochemistry, 2009, 28th edition. Lange Medical Books/McGraw-Hill.
5. Zubay, 2005. Principles of Biochemistry, 4th edition. Prentice hall.
6. Richard Harvey, Denise Ferrier. 2005. Lippincott. Outlines of Biochemistry, 5th edition.

SEMESTER IV

CATEGORY	CODE	SUBJECTS	HOURS	CREDITS
Core 13	25BC401CR	Proposal Writing Research based project Project Dissertation Project Viva-Voce	30	20
		Total credits for Semester IV	30	20

Non-Major Electives (NME): These courses are open to students of other Departments except Biochemistry

CATEGORY	CODE	SUBJECTS	HOURS	CREDIT
Non-Major Elective Odd semester	25BC001NME	Artificial Intelligence in Health Care	3	2
Non-Major Elective Even semester	25BC002NME	Intellectual Property Rights	3	2

COURSE NAME – ARTIFICIAL INTELLIGENCE IN HEALTHCARE						
Course Code	**Course Type**	**L**	**T**	**P**	**C**	**Syllabus version**
25BC001NME	**NME**	**2**	**1**	**-**	**2**	**2025-2026**

Pre-requisite	Knowledge on basic idea of Clinical Documentation

Course Objectives
• The objective of this course is to examine data science in the healthcare system, and the interdisciplinary field combined statistics, machine learning, analysis and interprets complex medical data.
• The aim of the course is to understand how data science principles are applied to analyze health data, predict diseases, personalize medicine, and enhance the healthcare system.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	To understand the fundamentals and Introduction to Artificial Intelligence (AI) in Healthcare	**K2**
CO2	Students will be able to understand data science and concepts of Large Language Models (LLMs) as powerful AI models. to make it more effective.	**K3**
CO3	Students will understand that effective clinical documentation is crucial for patients safety, accurate billing, and regulatory compliance.	**K4**

CO4	Students will understand that effective clinical documentation is crucial for patients safety, accurate billing, and regulatory compliance.	**K5**
CO5	The course also covers crucial for ensuring patient safety and effectiveness while fostering innovation.	**K5,K6**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

ARTIFICIAL INTELLIGENCE IN HEALTHCARE - 25BC001NME	
UNIT - I **INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI) IN HEALTHCARE**	Introduction to AI: Definition, history, evolution, and applications of AI. Difference between AI in Machine learning (ML) and Deep learning (DL), human and machine intelligence Applications of AI in biology and healthcare.
UNIT - II **DATA SCIENCE AND HEALTHCARE**	Clinical Data Sets: Data sources and types, Standards in data acquisition and management; Opportunities and challenges in data handling. Data Processing and visualization, Machine learning in Healthcare. Basics of Machine Learning (ML) Learning Paradigms: Supervised Learning (Classification & regression); Unsupervised Learning (Clustering); Reinforcement Learning. The ML Pipeline: Feature extraction, selection, and dimensionality reduction; Model building, validation, and evaluation metrics.
UNIT - III **CLINICAL DOCUMENTATION IN HEALTHCARE**	Electronic health records, Patient Identification and Demographics, Medical History, Progress Notes, Medication records, Discharge summary, Insurance and billing.
UNIT - IV	Data Handling and Processing: pandas, numpy, openpyxl, SQLAlchemy. Data Visualization: matplotlib, seaborn, plotly.

HEALTHCARE ANALYTICS TOOLS	Clinical Analytics Tools: Electronic Health Records, Clinical Decision Support Systems and Predictive Analytics Tools. Healthcare specific libraries.
UNIT - V **ETHICS GOVERNANCE OF AI**	Ethical issues, data protection, privacy, anonymity, biases. Regulations and governance frameworks for software as medical device.
UNIT VI **CURRENT CONTOUR**	Recent trends in clinical documentation using artificial intelligence.
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	S
CO3	M	M	M	M	S
CO4	S	S	S	S	M
CO5	M	S	S	M	M
S-Strong; M-Medium; L-Low					

Recommended References:

1. Alloghani, Mohamed, Thron, Christopher, Subair, Saad, Artificial Intelligence for Data Science in Theory and Practice, 2022, Cham Springer International Publishing
2. AI AND APPLICATION SECURITY: SECURING MACHINE LEARNING AND INTELLIGENT APPS, 2025, International Publications.
3. Dr Reema Thareja. 2022. Data Science and Machine Learning using Python Paperback s standard Edition, McGraw Hill Publisher

4. Gallier and Jocelyn Quaintance, 2020, Fundamentals of Optimization Theory with Applications to Machine Learning
5. Sunila Gollapudi, S. 2016. Practical Machine Learning. Packt Publishing Ltd.
6. Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA
7. Toby Segaran. 2007. Programming Collective Intelligence (First ed.). O'Reilly.
8. Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine - a Complete Overview. Springer.
9. Peter Harrington. 2012. Machine Learning in Action. Manning Publications Co., Greenwich, CT, USA.
10. Selected seminal and contemporary readings from peer-reviewed literature such as Proceedings of Machine Learning in Healthcare, Artificial Intelligence in Medicine, IEEE Transactions on Biomedical and Health Informatics, and other relevant venues.

COURSE NAME – INTELLECTUAL PROPERTY RIGHTS						
Course Code 25BC002NME	Course Type NME	L	T	P	C	Syllabus version 2025-2026
		2	1	-	2	

Pre-requisite	Knowledge on basic concepts in Intellectual Property Rights

Course Objectives
• To introduce the fundamental concepts of Intellectual Property Rights (IPR) and emphasize their importance in the development and management of innovative projects across industries.
• To provide comprehensive knowledge on various forms of IPR, including patents, copyrights, trademarks, designs, geographical indications (GI), plant varieties, and layout design protections, along with their registration procedures in India and abroad.
• To create awareness about the latest trends in IPR and the initiatives taken by the Government to promote and strengthen the IPR ecosystem.

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Students will understand the fundamentals of Intellectual Property Rights (IPR), including patents and copyrights, and their application in academic and research contexts.	K2
CO2	They will learn to utilize patent databases to perform state-of-the-art searches and assess the novelty of their innovative ideas.	K3
CO3	The course will help students refine their research output by leveraging insights gained from existing patent literature.	K3,K4
CO4	Students will be introduced to Intellectual Property as a potential career path, including opportunities as R&D IP Counsel, Patent Examiner, and IP Consultant.	K5
CO5	The course will also create awareness about roles such as certified Patent/Trademark Agent and encourage entrepreneurial ventures based on IP assets.	K5,K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

INTELLECTUAL PROPERTY RIGHTS - 25BC002NME	
UNIT - I **OVERVIEW OF INTELLECTUAL PROPERTY**	Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India: Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.
UNIT - II **PATENTS**	Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board.
UNIT - III **COPYRIGHTS**	Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.
UNIT - IV **TRADEMARKS**	Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks,

	certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.
UNIT - V **OTHER FORMS OF IP**	Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection. Geographical Indication (GI): meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection. Layout Design Protection : meaning – Procedure for registration, effect of registration and term of protection.
UNIT VI **CURRENT CONTOUR**	India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies
Total Lecture Hours – 30	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	M	S	M
CO3	S	M	S	S	S
CO4	S	S	S	M	S
CO5	M	S	M	S	S
S-Strong; M-Medium; L-Low					

Recommended References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
4. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
5. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf
6. A Handbook of Copyright law (copyright.gov.in/Documents/handbook.html)
7. WIPO Intellectual Property Handbook, WIPO publication 489(E) (http://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf
8. Journal of Intellectual Property Rights (JIPR): NISCAIR
9. Cell for IPR Promotion and Management (http://cipam.gov.in/)
10. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
11. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)