M. Sc. BIOCHEMISTRY

Course Structure with Syllabus

Programme Code : 2PSBIC

2023-2025

SENGAMALA THAYAAR EDUCATIONAL TRUST
WOMEN'S COLLEGE (AUTONOMOUS)
(Affiliated to Bharathidasan University, Tiruchirappalli)
(Accredited by NAAC & An ISO 9001:2015 Certified Institution)
Sundarakkottai, Mannargudi–614 016,
Thiruvarur (Dt.),Tamil Nadu, India.

SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE

(AUTONOMOUS)

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SUNDARAKKOTTAI, MANNARGUDI–614016.

TAMILNADU, INDIA.

M.Sc., BIOCHEMISTRY

CHOICE BASED CREDIT SYSTEM–

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS–LOCF)

(For the candidates admitted in the academic year 2023–2024)

CHOICE BASED CREDIT SYSTEM

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning. Our College hasmoved to CBCS and implemented the grading system.

OUTCOME-BASED EDUCATION (OBE)
LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected of graduates of a programme of study. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The expected learning outcomes are used as reference points that would help to formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn will help in curriculum planning and development, and in the design, delivery and review of academic programmes. They provide general guidance for articulating the essential learnings associated with programmes of study and courses with in a programme, maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility and provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

Some important aspects of the Outcome Based Education

Course: is defined as a theory, practical or theory cum practical subject studied in a semester.

Course Outcomes (COs): are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.

Programme: is defined as the specialization or discipline of a Degree.

Programme Outcomes (POs): Programme outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs are what the students should be able to do at the time of graduation with reference to a specific discipline.

Some important terminologies repeatedly used in LOCF.

Core Courses (CC): A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course. These are the courses which provide basic understanding of their main discipline. In order to maintain a requisite standard certain core courses must be included in an academic program. This helps in providing a universal recognition to the said academic program.

Discipline Specific Elective Courses (DSE): Elective course may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective (DSE). These courses offer the flexibility of selection of options from a pool of courses. These are considered specialized or advanced to that particular programme and provide extensive exposure in the area chosen; these are also more applied in nature.

Generic Elective Courses: An elective course chosen generally from an **unrelated discipline/subject,** with an intention to seek exposure is called a Generic Elective. Generic Elective courses are designed for the students of other disciplines. Thus, as per the CBCS policy, the students pursuing particular disciplines would have to optGeneric Elective courses offered by other disciplines, as per the basket of courses offered by the college. The scope of the Generic Elective (GE) Courses is positively related to the diversity of disciplines in which programmes are being offered by the college.

Non Major Elective (NME): A student shall choose at least two Non-major Elective Courses (NME) from outside his/her department.

Skill Enhancement Courses (SECs): These courses focus on developing skills or proficiencies in the student, and aim at providing hands-on training. Skill enhancement courses can be opted by the students of any other discipline, but are highly suitable for students pursuing their academic programme. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge**.**

Field Study/Industrial Visit/Case Study: It has to be completed during the third semester of the degree programme. Credit for this course will be entered in the third semester's marks statement.

Internship: Students must complete internship during summer holidays after the second semester. They have to submit a report of internship training with the necessary documents and have to appear for a viva-voce examination during fourth semester. Credit for internship will be entered in the third semester's mark statement.

Extra Credit Courses: In order to facilitate the students, gaining knowledge/skills by attending online courses MOOC, credits are awarded as extra credits, the extra credit are at three semesters after verifying the course completion certificates. According to the guidelines of UGC, the students are encouraged to avail this option of enriching their knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals such as SWAYAM, NPTEL etc.

Postgraduate Programme:

Programme Pattern: The Post Graduate degree programme consists of **FIVE** vital components. They are as follows:

Part –A	:	Core Course (Theory, Practical) Core Industry Module, Core Project
Part-B (i)	:	Elective courses
Part-B (ii)	:	Non Major Elective, Skill Enhancement course, Professional Competency course
Part-B (iii)	:	Internship
Part –C	:	Extension activity

EXAMINATION

Continuous Internal Assessment (CIA):

PG - Distribution of CIA Marks

Passing Minimum: 50 %

Assignments – 3 = 30%
Tests- = 50%
Seminar=10 %
Attendance= 10 %

Question Paper Pattern

Part A: includes two sub sections

Part A 1 (10X1=10 marks)
One word question/ Fill in/ /True or False/ Multiple Choice Questions
Two Questions from Each unit

Part A 2(5X2=10 marks)
Short Answers/ Match the following
One question from each unit
Total Marks - 20

Part B: (5X5=25 marks)
Paragraph Answers
Either/ or type, One Question from each unit

Part C: (10X3=30)
Essay Type Answers
Answer 3 out of 5 Questions
One Question from each unit

Part A: K1 Level
Part B: K2, K3 and K4 Level
Part C: K5 and K6 Level

Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S.No.	Level	Parameter	Description
1	K1	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/ Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analyzing	The learner distinguishes among different parts
5	K5	Evaluation/Evaluating	The learner justifies and or decision
6	**K6**	Synthesis/Creating	The learner creates a new product or point of view

WEIGHTAGE of K –LEVELS IN QUESTION PAPER

(Cognitive Level) K-LEVELS →	Lower Order Thinking			Higher Order Thinking			Total
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	
END SEMESTER EXAMINATIONS (ESE)	20	25			30		**75**
Continuous Internal Assessment (CIA)	20	25			30		**75**

QUESTION PATTERN FOR END SEMESTER EXAMINATION/ CONTINUOUS INTERNAL ASSESSMENT		
PART		**MARKS**
PART –A I. (No choice, One Mark) **TWO** questions from each unit **II.** (No choice, Two Mark) **ONE** question from each unit	(10x1=10) (5x2=10)	**20**
PART –B (Either/ or type, 5-Marks) **ONE** question from each unit	(5x5=25)	**25**
PART –C (3 out of 5) (10 Marks) **ONE** question from each unit	(3x10=30)	**30**
	Total	**75**

BLUE PRINT OF QUESTION PAPER FOR END SEMESTER EXAMINATION							
DURATION: 3.00 Hours.							**Max Mark :75**
K-LEVELS / **PART**	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**Total Marks**
PART –A (One Mark, No choice) (10x1=10)	10						**10**
(2-Marks, No choice) (10x2=20)	10						**10**
PART –B (5-Marks) (Either/or type) (5x5=25)		5	10	10			**25**
PART –C (10 Marks) (3 out of 5) (3x10=30) Courses having only **K5, K6** levels, K5 level- 3 Questions, K6 level - 2 Questions **(One K6 level question is compulsory)**					20	10	**30**
Total	**20**	**05**	**10**	**10**	20	10	**75**

EVALUATION

GRADING SYSTEM

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added and converted as final mark. The marks thus obtained will then be graded as per the scheme provided in Table-1.

Grade Point Average (GPA) will be calculated from the first semester onwards for all semester. From the second semester onwards, the total performance with in 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:

$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{I=1}^{n} C_i}$	$WAM(\text{Weighted Average Marks}) = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{I=1}^{n} C_i}$
Where, C_i is the Credit earned for the Course i G_i is the Grade Point obtained by the student for the Course i M_i 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.

CLASSIFICATION OF FINAL RESULTS:

i. The classification of final results shall be based on the CGPA, as indicated in Table-2.

ii. 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 5.00and 5.99 shall be declared to have qualified for their Degree in the respective programmes as 'Excellent', 'Very Good', 'Good', and 'Above Average' respectively.

iii. Absence from an examination shall not be taken an attempt.

Table- 1: Grading of the Courses

Marks Range	Grade Point	Corresponding Grade
90 and above	10	O
80 and above and below 90	9	A+
70 and above and below 80	8	A
60 and above and below 70	7	B+
50 and above and below 60	6	B
Below 50	NA	RA

NA- Not Applicable, RA- Reappearance

The candidates' performance in every current semester is indicated by **Semester Grade Point Average (SGPA)** and from the second semester onwards, the continuous performance including previous semester/s is indicated by **Cumulative Grade Point Average (CGPA)**

Table-2: Final Result

CGPA	Corresponding Grade	Classification of Final Result
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

*****The candidates who have passed in the first appearance and within the prescribed duration of the PG Programme are eligible. If the candidate's Grade is O/A+ with more than one attempt, the performance is fixed as "Very Good"

VISION

Imparting quality education in Biochemistry to make the students to document the biological resources with scientific validation so as to enhance the quality of life.

MISSION

- To provide a learning environment to the students to understand, analyze and augment the basic analytical skills in Biochemistry.
- To expose the students and make them well versed in the various biochemical processes and update their knowledge and skills in advanced biochemical techniques.

PROGRAMME OUTCOMES FOR M.Sc., DEGREE PROGRAMMES

PO. No	Programme Outcomes (*Upon completion of the M.Sc., Degree Programme, the Post graduate will be able to)*
PO-1:	**Disciplinary Knowledge**: demonstrate in-depth knowledge and understanding of theories, policies, and practices in one or more disciplines that form a part of a Post Graduate program of study in Master of Science.
PO-2:	**Critical Thinking and Problem Solving**: apply analytic thought to a body of knowledge, analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence, identify relevant assumptions or implications, formulate coherent arguments, critically evaluate practices, policies and theories by following scientific approach to knowledge development: solve problems and extrapolate the same to real life situation.
PO-3:	**Information/digital literacy and Communication Skills:** use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data: communicate thoughts and ideas analytically and effectively in writing and orally using appropriate media, and present complex information in a clear and concise manner to different groups.
PO-4:	**Research-related skills:** Conduct independent inquiry in a chosen scientific discipline, demonstrate sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesizing and articulating; recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; plan, execute and report the results of an experiment or investigation.
PO-5:	**Scientific reasoning and Reflective Thinking:** analyze, interpret and draw conclusions from quantitative/qualitative data and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; critically and sensibly evaluate life experiences, with self-awareness and reflexivity of both self and society.
PO-6:	**Multidisciplinary Approach, Innovation and Entrepreneurship:** propose novel ideas of interdisciplinary approach in providing better solutions and new ideas for the sustainable developments; identify opportunities, entrepreneurship vision and use of innovative ideas to create value and wealth for the betterment of the individual and society.
PO-7:	**Moral and ethical awareness/reasoning:** embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work, demonstrate the ability to identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, appreciate environmental and sustainability issues, and adopt objective, unbiased and truthful actions in all aspects of work.
PO-8:	**Self directed Learning:** work independently, identify appropriate resources required for a project, and manage a project till completion.
PO-9:	**Lifelong Learning:** engage in continuous learning for professional growth and development, acquire knowledge and skills, adapt to changing environment and to changing trades and demands of work place through knowledge / skill Development/ reskilling.
PO-10:	**Multicultural Competence, Social Interaction and Effective Citizenship:** understand the values and beliefs of multiple cultures, global perspectives, engage and interact respectfully with diverse groups and elicit views of others, mediate disagreements and help reach conclusions in group settings, and demonstrate empathetic social concern and equity centered national development

PROGRAMME SPECIFIC OUTCOMES

PSO. No	**Programme Specific Outcomes** (***Upon completion of the M.Sc., Degree Programme, the Post graduate will be able to)***
PSO1:	Understand the principles and methods of various techniques in Biochemistry, Immunology, Microbiology, Enzyme kinetics and Molecular Cell Biology. Based on their understanding, the students may would be able to design and execute experiments during their final semester project, and further research programs.
PSO2:	Insight on the structure-function relationship of biomolecules, their synthesis and breakdown, the regulation of these pathways, and their importance in terms of clinical correlation. Students will also acquire knowledge of the principles of nutritional biochemistry and understand diseases and their prevention.
PSO3:	To understand the concepts of cellular signal transduction pathways and the association of aberrant signal processes with various diseases. Acquire insight into the immune system and its responses, and use this knowledge in the processes of immunization, vaccine development, transplantation and organ rejection.
PSO4:	To visualize and appreciate the central dogma of molecular biology, regulation of gene expression, molecular techniques used in rDNA technology, gene knock-out and knock-in techniques.
PSO5:	To create awareness in students about the importance of good laboratory practices and the importance of ethical and social responsibilities of a researcher. Teach them how to review literature and the art of designing and executing experiments independently and work as a part of a team

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SUNDARAKKOTTAI, MANNARGUDI – 614016.

TAMILNADU, INDIA.

M.Sc., BIOCHEMISTRY COURSE STRUCTURE UNDER CHOICE BASED CREDIT SYSTEM LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS-LOCF)

(For the candidates admitted from the academic year 2023-2024)

ELIGIBILITY: A pass in B.Sc. with Biochemistry / Chemistry /Biotechnology / Microbiology / Molecular Biology / Biology / Life Sciences / Botany / Zoology / Food Science & Nutrition Dietetics from any recognized university in India or abroad.

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	Ins. Hours/ Week				Credit	Exam Hous	Marks		Total
						L	T	P	S			CIA	ESE	
I	Part A	Core Course –I	P23BC101	Basics of Biochemistry	6	5	1	0	0	5	3	25	75	100
		Core Course –II	P23BC102	Biochemical and Molecular Biology Techniques	6	5	1	0	0	5	3	25	75	100
		Core Practical-I	P23BC103P	Biomolecules and Biochemical Techniques	6	0	0	6	0	3	3	25	75	100
	Part B (i)	Elective Course–I	P23BCE11A/ P23BCE11B/ P23BCE11C	Microbiology and Immunology/ Nanotechnology/ Biochemical Toxicology	5	4	1	0	0	3	3	25	75	100
		Elective Course–II	P23BCE12A/ P23BCE12B/ P23BCE12C	Energy and Drug Metabolism/ Genetics/ Biotechnology	5	4	1	0	0	3	3	25	75	100
	Part B (ii)	Non Major Elective - I			2	2	0	0	0	2	3	25	75	100
		TOTAL			**30**	**20**	**4**	**6**	**0**	**21**	-	-	-	**600**
II	Part A	Core Course –III	P23BC204	Physiology and Cell Biology	6	5	1	0	0	5	3	25	75	100
		Core Course-IV	P23BC205	Enzymology	6	5	1	0	0	5	3	25	75	100
		Core Practical-II	P23BC206P	Enzymology, Microbiology and Cell Biology	6	0	0	6	0	3	3	25	75	100
	Part B (i)	Elective Course-III	P23BCE23A/ P23BCE23B/ P23BCE23C	Ecology and Environmental Sciences/Industrial Microbiology/Plant Biochemistry	5	4	1	0	0	3	3	25	75	100
		Elective Course-IV	P23BCE24A/ P23BCE24B/ P23BCE24C	Biosafety, Lab Safety and IPR / Genomics and Proteomics/ Herbal Technology	5	4	1	0	0	3	3	25	75	100
	Part B (ii)	Non Major Elective - II			2	2	0	0	0	2	3	25	75	100
	Part B (iii)	Internship/Industrial Activity			0	0	0	0	0	0		-	-	-
		TOTAL			**30**	**20**	**4**	**6**	**0**	**21**	-	-	-	**600**

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	Ins. Hours/ Week				Credit	Exam Hours	Marks		Total
						L	T	P	S			CIA	ESE	
III	Part A	Core Course –V	P23BC307	Cellular Metabolism	6	5	1	0	0	5	3	25	75	100
		Core Course –VI	P23BC308	Clinical Biochemistry	6	5	1	0	0	5	3	25	75	100
		Core Practical-III	P23BC309P	Clinical Biochemistry	6	0	0	6	0	3	3	25	75	100
		Core Industry Module	P23BCI31	Pharmaceutical Biochemistry	5	4	1	0	0	3	3	25	75	100
	Part B (i)	Elective Course –V	P23BCE35A/ P23BCE35B/ P23BCE35C	Research Methodology/ Biostatistics and Data Sciences / Gene Editing, Cell and Gene therapy	5	3	1	1	0	3	3	25	75	100
	Part B (ii)	Skill Enhancement Course	P23SEBC31	Clinical Lab Technology	2	2	0	0	0	2	3	25	75	100
	Part B (iii)	Internship/Industrial Activity			0	0	0	0	0	2		-	-	-
				TOTAL	**30**	**19**	**4**	**7**	**0**	**23**	**-**	**-**	-	**600**
IV	Part A	Core Course – VII	P23BC410	Molecular Biology	5	4	1	0	0	5	3	25	75	100
		Core Course-VIII	P23BC411	Developmental Biology	5	4	1	0	0	5	3	25	75	100
		Core Practical-IV	P23BC412P	Molecular Biology Techniques	6	0	0	6	0	3	3	25	75	100
		Core Project	P23BCPW	Project with Viva Voce	8	0	2	6	0	7	3	25	75	100
	Part B (i)	Elective Course – VI (Industry/ Entrepreneurship)	P23BCE46A/ P23BCE46B/ P23BCE46C	Forensic Science / Phytotherapeutics/ Advances in Clinical Research	4	3	1	0	0	3	3	25	75	100
	Part B (ii)	Professional Competency Course	P23PCBC41	Life Sciences for Competitive Examination	2	2	0	0	0	2	3	25	75	100
	Part C	Extension Activity			0	0	0	0	0	1	-	-	-	-
	TOTAL				**30**	**13**	**5**	**12**	**0**	**26**	-	-	-	**600**
GRAND TOTAL					**120**	**72**	**17**	**31**	**0**	**91**				**2400**
Extra Credit				MOOC/ SWAYAM/ NPTEL	**-**	**2**	-	-	-	**-**				
				Value Added Courses (At least One Per Year)	**-**	**2**	-	-	-	**-**				

CREDIT DISTRIBUTION FOR PG PROGRAMME

S.No.	Courses	No. of Courses	Total Credits
Part A	Core Course	8	40
	Core Practical	4	12
	Project Work with Viva Voce	1	07
	Core Industry Module	1	03
Part B (i)	Elective Course	6	18
Part B (ii)	Non Major Elective	2	04
	Skill Enhancement Course	1	02
	Professional Competency Course	1	02
Part B (iii)	Internship	1	02
Part C	Extension Activity	1	01
	Total	**26**	**91**

L-Lecture **T-Tutorial** **P-Practical** **S-Seminar**

Part A component and Part B (i) will be taken into account for CGPA calculation for the postgraduate programme and the other components of Part B and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree.

Note:

		CIA	ESE
1	Theory	25	75
2	Practical	25	75
3	Separate passing minimum is prescribed for Internal and External marks		

FOR THEORY

The passing minimum for CIA shall be 40% out of 25 marks [i.e. 10 marks]

The passing minimum for University Examinations shall be 40% out of 75 marks [i.e. 30 marks]

FOR PRACTICAL

The passing minimum for CIA shall be 40% out of 25 marks [i.e. 10 marks]

The passing minimum for University Examinations shall be 40% out of 75 marks [i.e. 30 marks]

NON MAJOR ELECTIVE COURSES (NME) OFFERED BY THE DEPARTMENT

Semester	Part	Course	Course Code	Title of the Course
I	Part B (ii)	NME-I	P23NMEBC11	Nutritional Biochemistry
II		NME-II	P23NMEBC22	Molecular Basis of Disease and Therapeutic Strategies

SEMESTER III

Semester: III-CC-V: Cellular Metabolism
Ins. Hrs./Week:6 **Course Credit:5** **Course Code:** P23BC307

UNIT- I: Carbohydrate Metabolism **(18 Hours)**

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

UNIT- II: Lipid Metabolism **(19 Hours)**

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

UNIT- III: Nucleic acid Metabolism **(18 Hours)**

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

UNIT- IV: Amino acids Metabolism **(19 Hours)**

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

aspartate, glycine and serine. Transamination, and deamination. The urea cycle and its regulation.

UNIT- V: Metabolic Disorders (16 Hours)

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

Total Lecture Hours-90

COURSE OUTCOME

The students are able to

1. Appreciate the modes of synthesis and degradation of glucose and will be able to justify the pros and cons of maintain the blood sugar level
2. Gain knowledge on polysaccharide metabolism and glycogen storage disease
3. Acquaint with the making and braking of nucleotides
4. Differentiate the diverse reaction a particular amino acid can experience
5. Correlate the disturbance of metabolic reactions to clinical manifestations with reference to heme and sulphur metabolism

TEXT BOOK(S)

1. David L.Nelson and Michael M.Cox (2012). Lehninger Principles of Biochemistry. 6th Edition, W.H.Freeman & Co Ltd., New York.
2. David Nelson L and Michael Cox. (2021). Lehninger Principles of Biochemistry. 8th Edition, W.H.Freeman & Co Ltd., New York.
3. Voet.D and Voet. J.G (2010) Biochemistry, 4th Edition, John Wiley & Sons, Inc.
4. Metzler D.E (2003). The chemical reactions of living cells. 2nd Edition, Academic Press.
5. Zubay G.L (1999). Biochemistry, 4th Edition, Mc Grew-Hill.
6. Wiley (2010). Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin (Editor).
7. James M.Orten & Otto.W.Neuhan (2013). Human Biochemistry –10th Edition - The C.V.Mosby Company

REFERENCE BOOK(S)

1. Berg JM, Tymoczko JL, and Stryer L. (2012). Biochemistry, 7th Edition, Freeman and Company, New York.
2. David A Bender, Shauna MC Cunningham. (2021). Introduction to Nutrition and Metabolism, 6th Edition, CRC Press, Florida, USA.
3. David Nelson L and Michael Cox. (2021). Lehninger Principles of Biochemistry. 8th Edition, W.H.Freeman & Co Ltd., New York.
4. Sareen S Gropper, Jack L Smith, & Timothy P Carr. (2018). Advanced Nutrition and Human Metabolism, 7th Edition, Cenage Learning Publishers, USA
5. Victor Rodwell and David Bender. (2018). Harper's Illustrated Biochemistry, 31st Edition, Paperback – Illustrated, McGraw-Hill Education, New York

E RESOURCES

1. https://www.embopress.org/doi/full/10.1038/msb.2013.19
2. https://people.wou.edu/~guralnl/450Glycogen%20metabolism.pdf
3. https://www.pdfdrive.com/lippincotts-biochemistry-6th-edition-e41485405.html
4. https://www.pdfdrive.com/biochemistrystrayer-e25312085.html
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243375/
6. https://www.researchgate.net/publication/334458898_Urea_Cycle
7. https://www.researchgate.net/publication/51233381_Heme_biosynthesis_and_its_regulation_Towards_understanding_and_improvement_of_heme_biosynthesis_in_filamentous_fungi

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SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
(AUTONOMOUS)
SUNDARAKKOTTAI, MANNARGUDI- 614016
(For the Candidates admitted in the academic year 2023 – 2024)
DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: III-CC-VI: Clinical Biochemistry
Ins. Hrs./Week:6 **Course Credit: 5** **Course Code:** P23BC308

UNIT- I: Biochemical Investigation and Disorders of blood (18 Hours)

Biochemical investigations in diagnosis, prognosis, monitoring, screening: Specimen collection – blood, (primary /Secondary specimen), urine and CSF. Preservation of biological specimens -blood, urine, CSF and amniotic fluid. Biological reference ranges.

Disorders of blood cells: Hemolytic, iron deficiency and aplastic anemia and diagnosis, sickle cell anaemia, thalassemia, HBA1C variants. Porphyrias, Thrombocytopenia, Causes of leucopenia, leukemia and leucocytosis. Disorders of blood clotting mechanism - Von willebrand's disease, Hemophilia A, B and C, diagnostic test for clotting disorders, D-dimer and its clinical significance.

UNIT- II: Diabetes mellitus: pathology and complications (18 Hours)

Acute changes; Chronic complications: Diabetic nephropathy, neuropathy, retinopathy and Diabetic foot ulcers, Random/Fasting/PP glucose testing, Impaired glucose tolerance (IGT), Impaired fasting glucose (IFT), Diagnosis-by GTT, Pre-diabetes, Gestational DM, Glycosylated Haemoglobin (HBA1c) ; Glycated albumin, Hypoglycaemia and critical alert value for glucose. Markers of complications of Diabetes mellitus: Metabolic syndrome, Lipid profile and lipoproteinemia, Atherosclerosis, Micralbuminuira, eGFR. Point of care testing for glucose (Glucometers) and continuous glucose monitoring (CGM): principle and its use. Major groups of anti-diabetic drugs. Diet and life style modifications.

UNIT- III: Diagnostic Enzymology and Pre- and post-natal testing (19 Hours)

Diagnostic Enzymology: Clinically Important Enzymes and Isoezyme as diagnostic markers: Clinical significance of AST, ALT, ALP, ACP, CK, γ-GT, amylase, pseudocholinesterase and their pattern in .Myocardial infarction; Liver disease, Bone disease, Muscle disease, Cancer (tumor markers), GI tract pancreatitis; Enzymes as therapeutic agents.

Pre and post-natal testing: Amniocentesis, prenatal detection of inborn errors of metabolism in developing fetus- Autosomal recessive mode of inheritance- cystic fibrosis, X linked recessive inheritance-Duchenne muscular dystrophy. New born screening (NBS) for in born errors of metabolism, Tandem mass spectrometry application in NBS.

UNIT- IV: Liver and Renal function tests (18 Hours)

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

Renal function tests - tests for glomerular and tubular function-Acute and chronic renal failure-Glomerulonephritis, Nephrotic syndrome, uraemia-urinary calculi-Nephrocalcinosis and Nephrolithiasis-causes, pathology and symptoms. Chronic kidney disease. Dialysis-Hemodialysis and peritoneal dialysis.

UNIT V: Electrolyte and Hormonal disorders (17 Hours)

Electrolyte disorder: calcium: hypercalcemia and hypocalcemia; Calcium homoestasis in Blood; phosphate: hyperphosphatemia or hypophosphatemia; Clinical significance: Potassium: hyperkalaemia and hypokalaemia, Sodium: hypernatremia and hyponatremia; Chloride: hyperchloremia, hyporchloremia.

Hormonal disorders and diagnostics: T3, T4 and TSH in the diagnosis of thyroid disorders; Diagnostic methods for disorders associated with adrenal, pituitary and sex hormones - Addison's disease, Cushing's syndrome, pituitary tumour, Hypopituitarism, Hypogonadism

Total Lecture Hours -90

COURSE OUTCOME

The students are able to

1. Recall the biological significance of sample collection and awareness of the diagnostic/screening tests to detect common non-communicable diseases so as to understand role of laboratory investigations for biochemical parameters and understand the disorders associated with blood.
2. Understand the etiology of metabolic diseases like diabetes and atherosclerosis and avoid such lifestyle disorders by healthy eating and correlate the symptoms with underlying pathology based on diagnostic and prognostic markers.
3. Acquire knowledge on the diagnostic application of serum/plasma enzymes to correlate their levels with the organ pathologies associated with specific diseases and also describe the role of pre and post-natal diagnosis leading to healthy progeny.
4. Perform the tests related to liver and kidney functions and interpret the results
5. Link the serum electrolyte and hormone levels and clinical symptoms with underlying their disturbances.

TEXT BOOK(S)

1. Thomas M. Devlin (2014) Textbook of Biochemistry with Clinical Correlations. 7th Edition. John Wiley & Sons
2. Montgomery R, Conway TW, Spector AA (1996), Biochemistry: A Case-Oriented Approach. 6th Edition, Mosby Publishers, USA.
3. Dinesh Puri, (2020) Text book of Biochemistry: A clinically oriented approach – 4th Edition, Elsevier.
4. M.N.Chatterjee and Rana Shinde (2012).Textbook of Medical Biochemistry. 8th Edition, Jaypee Brothers Medical Publishers.
5. Clinical Case Discussion In Biochemistry A Book On Early Clinical Exposure (ECE), Poonam Agrawal, (2021), CBS Publishers & distributors pvt. Ltd
6. Graham Basten. (2011). Introduction to Clinical Biochemistry, Interpreting Blood Results. Book Boon. 2nd Edition. Ventus Publishers, USA.

REFERENCE BOOK(S)

1. Dennis Kasper and Eugene Braunwald. (2005). Principles of Internal Medicine. Harrison's Vol 1 & 2, 16th Edition, *McGraw-Hill* Publishers, New York.
2. Harold Varley. (2006). Practical Clinical Biochemistry, 6th Edition, CBS Publishers, Chennai.
3. Lippincott William and Wilikns. (2018). Clinical Chemistry, Principles, Techniques, Correlations with Access, 8th Edition, Michael Bishop publishers, USA.
4. Scriver CR, Beaudet AL, Sly WS, Valle D, Childs B, Kinzler KW, and Vogelstein B. (2001). The Metabolic & Molecular Basis of inherited Diseases, 8th Edition, McGraw Hill Publishers, New York.
5. Thomas M Devlin. (2006). Textbook of Biochemistry with Clinical Correlation, 2nd Edition, Wiley and Sons Publishers, New York.
6. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2018) , 8th Edition, Saunders.
7. Rooma Devi, Aman Chauhan, Simmi Kharb, Chandra Shekhar Pundir, (2023). Clinical Biochemistry-A Laboratory Guide, 1st Edition, Jenny Stanford publishers, New York.

E RESOURCES

1. https://diabetesjournals.org/clinical/article/40/1/10/139035/Standards-of-Medical-Care-in-Diabetes-2022
2. https://doi.org/10.2337/diaspect.16.1.32
3. https://www.researchgate.net/publication/335830829_Quality_Control_in_a_Clinical_Laboratory
4. https://labpedia.net/quality-control-of-the-clinical-laboratory/
5. https://journals.sagepub.com/doi/full/10.1016/j.jala.2008.12.001
6. https://doi.org/10.1016/B978-0-12-407821-5.00004-8
7. https://www.westgard.com/clia.html
8. https://www.labroots.com/webinar/bio-rad-unity-solution-molecular-quality-control-data-management

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DEPARTMENT OF BIOCHEMISTRY

M.Sc., BIOCHEMISTRY

Semester: III-CP-III: Clinical Biochemistry

Ins. Hrs./Week: 6 **Course Credit: 3** **Course Code:** P23BC309P

I. Haematology:

RBC count, WBC count – total and differential count, ESR, PCV, MCV. Bleeding Time, Clotting Time and Estimation of hemoglobin. Determination of Electrolytes: Sodium, Potasium and Calcium.

II. Liver function test:

Estimation of bilirubin – direct and indirect. Estimation of plasma protein, A/G ratio, Prothrombin Time (PT), Assay of serum glutamate oxaloacetate transaminase, alkaline phosphatase, Gamma-glutamyltransferase (GGT), isoenzyme separation of LDH by electrophoresis.

III. Renal function test:

Collection and Preservation of Urine sample
Qualitative tests for normal and pathological components of urine.
BUN: Estimation of blood Urea, creatinine, and uric acid. Urea clearance test

IV. Estimation of blood glucose by orthotoluidine and glucose oxidase method. Determination of glycosylated Hb. Glucose tolerance test- Kit method
Lipid profile: Estimation of cholesterol by Zak's method, lipoprotein profile, estimation of ketone bodies, estimation of triglycerides, free fatty acids and phospholipids.

V. Group Experiments

a. Antigen – Antibody Reaction - HCG kit method, RA kit method
b. Phlebotomy –Venipuncture, Different techniques of venipuncture
c. Collection of blood, serum or plasma separation and storage
d. Automation in Clinical Biochemistry - Autoanalyser, Semi autoanalyser

Total Hours- 90

COURSE OUTCOME

The students are able to

1. Acquire knowledge and skill in hematology techniques and get knowledge to interpret the electrolyte concentration in serum.
2. Assess the Liver Function and interpret the biochemical investigation in a given clinical situation.
3. Perform the Renal function test to assess the function of Kidney and report the abnormal parameters with reference range will be achieved by the student
4. Estimate the blood glucose content and lipid profile, to evaluate the alterations and record the observation in accordance to reference range.

5. Acquire practical skills to work in health care sector and assist them to understand the automation process in clinical labs.

TEXT BOOK(S)

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

REFERENCE BOOK(S)

1. Alan H Gowenlock. (1998). Varley's Practical Clinical Biochemistry, 6th Edition, CBS Publishers, India.
2. Godkar B. (2020). Textbook of Medical Laboratory Technology Vol 1 & 2 Paperback, 3 rd Edition, Bhalani Publisher, New Delhi.
3. Kanai L Mukerjee. (1996). Medical Lab Technology, Vol I & II, 1st Edition, Tata Mcgraw Hill Publishers, New York, USA.
4. Ranjna Chawla. (2014). Practical Clinical Biochemistry Methods and Interpretations (Paperback). 4th Edition, Jaypee Brothers Medical Publishers, Tamil Nadu.
8. Kanai L Mukerjee. (1996). Medical Lab Technology Vol I & II, 3rd Edition, Tata McGraw Hill Publishers, New Delhi.
9. Rooma Devi, Aman Chauhan, Simmi Kharb, Chandra Shekhar Pundir, (2023). Clinical Biochemistry-A Laboratory Guide, 1st Edition, Jenny Stanford publishers, New York.

E RESOUCES

1. https://www.researchgate.net/publication/260182512 Practical_Manual in_ Bio chemistry __ and_ Clinical_Biochemistry
2. https://main.icmr.nic.in/sites/default/files/upload_documents/ GCLP_ Guidelines_ 2020_ Final.pdfhttps://www.westgard.com/clia.html
3. https://www.researchgate.net/publication/263929434_Biochemistry
4. https://ucms.ac.in/Lectures-C-2020/Renal%20function%20Tests%20-%20PPT.pdf
5. https://youtu.be/i2PfjEks4GQ
6. https://www.euro.who.int/__data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf

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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: III- CIM: Pharmaceutical Biochemistry
Ins. Hrs./Week: 5 **Course Credit: 3** **Course Code:** P23BCI31

UNIT- I: General concept of Drug **(14 Hours)**

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

UNIT –II: Bioinformatics approaches for drug development **(16 Hours)**

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

UNIT- III: Drug metabolism and interactions **(17 Hours)**

Drug-receptor interactions, receptor theories and drug action, Xenobiotics, xenobiotics phases (Phase-I, Phase-II and Phase-III), role of cytochrome P450 oxidases and glutathione S-transferases in drug metabolism, factors affecting drug metabolism, Enzymes as a drug target, Kinase inhibitors, ATPase inhibitors, drug protein interaction, Drug DNA interaction. Basic ligand concepts-agonist, antagonist, partial agonist, inverse agonist, efficiency and potency. Forces involved in drug-receptor complexes. Receptor classification – the four super families. Receptor binding assays- measurement of Kd, Bmax and IC_{50}.

UNIT IV: Antimicrobial Agents **(15 Hours)**

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

UNIT V: Clinical Trials **(13 Hours)**

Clinical trials (Phase-I, Phase-II, Phase-III and Phase-IV clinical trial). Main features of clinical trials, including methodological and organizational considerations and the principles

of trial conduct and reporting. Key designs surrounding design, sample size, delivery and assessment of clinical trials.

Total Lecture Hours-75

COURSE OUTCOME

The students are able to

1. Understand and explain the basic concepts of drug discovery and drug development process.
2. Review the different software and computational tools which aid in the design of drugs and its rationalization.
3. Learn about the chemical pathways of biotransformation of drugs
4. Acquire knowledge on mode of actions of antimicrobials
5. Analyze the different stages of the drug discovery process with the target & hit identification, assays for drug screening and preclinical studies.

TEXT BOOK(S)

1. Textbook of Drug Design. Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.
2. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA, (2005).
3. Gordan Gibson, G. and Paul Skett. Nelson Thornes, 1999. Introduction to Drug Metabolism, 3rd Edition, UK.
4. Haque SS and Randhawa SS. (2017). Pharmaceutical Biochemistry. 2nd edition, S.Vikas and Company 3. Harbans Lal, 2018. Essentials of Pharmaceutical Biochemistry. 2nd Edition, CBS publishers and Distributors.
5. Jayashree Ghosh, (2010). A Textbook of Pharmaceutical Chemistry, 3rd Edition, S.Chand & Company Ltd., New Delhi.
6. Kadam SS, Mahadik R. (1998). Text Book of Medicinal Chemistry, Vol. 15th Edition. Nirali Prakashan Publishers.
7. Tripathi KD. (2010). Essentials of Medical Pharamacology, 7th Edition, Jaypee Publishers

REFERENCE BOOK(S)

1. Charifson P., Marcel Dekker Inc. Practical Application of Computer-Aided Drug Design, Ed.
2. Ed. Kubinyi H., Ledien (2013). 3D QSAR in Drug Design: Theory, Methods and Applications.
3. Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns, EH, Lipinski CA, Thakker DR and Wang B, AAPS Press, (2004).
4. HP Rang. (2006). Drug Discovery and Development; Technology in Transition. Elsevier Ltd 1st Edition.
5. T. P. Kenakin. (2012). Pharmacology in Drug Discovery. Elsevier, 1st Edition.
6. Abdul wahab and Shahid Ullah khan, (2015). Handbook of Pharmaceutical Biochemistry for Health Professionals. LAP LAMBERT Academic Publishing.
7. Bertram Katzung, (2012). Clinical Pharmacology, 12th Edition, Lange Publishers.
8. Donald Cairns, (2012). Essentials of Pharmaceutical Chemistry, 4th Edition, Pharmaceutical Press.

9. Robert K. Murray, Daryl K. Granner, Peter A. Mayer and Victor W. Rodwell, Mc Graw Hill, New York, (2006). Harper's Biochemistry. 25th Edition. Tata Mcgraw Hill Publishing Company.
10. Thomas L. Lemke, David A. Williams, Victoria F. Roche and S. William Zito, Foye's Wolters Kluwer, (2012). Foye's Principles of medicinal Medicinal Chemistry. 7th Edition, Lippincott Williams & Wilkins publisher.
11. Vyas SP, Kohli DV. (2019). Pharmaceutical Biochemistry,1st edition, CBS Publishers
12. Mark Ashton, Paul W. Groundwater, Sophie Stocker, Adam Todd (2024). An Integrated Guide to Human Drug Metabolism-From Basic Chemical Transformations to Drug-Drug Interactions, 1st Edition.

E- RESOURCES

1. https://guides.lib.uiowa.edu/c.php?g=132196&p=863259
2. https://libguides.library.usyd.edu.au/c.php?g=508174&p=3476667
3. https://guides.library.usciences.edu/ChemistryBioChemPharmaceuticalChem
4. https://epgp.inflibnet.ac.in/
5. https://guides.lndlibrary.org/pharmacy/pharm-books

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Semester: III-EC V: Research Methodology

Ins. Hrs. / Week: 5 **Course Credit: 3** **Course Code:** P23BCE35A

UNIT- I: Research Ethics **(18 Hours)**

Philosophy- definition, nature, scope and concept. Ethics- definition, moral philosophy, nature of moral judgments and reactions. Ethics with respect to science and research - Scientific misconducts- falsification, fabrication, and plagiarism- Use of plagiarism software- Turnitin, Urkund and other open source software tools. Redundant publications- duplicate and overlapping publications. Publication ethics- definition and importance. Publication misconduct- definition, concept, problems that lead to unethical behavior, types, violation of publication ethics, authorship and contributor ship. Software tool to identify predatory publications developed by SPPU. Subject specific ethical issues- authorship, Conflicts of interest.

UNIT-II: Research **(16 Hours)**

Research- Definition, importance and characteristics. Research problems- Definition, selection and sources of research problems. References in research – Books, Journals and Internet Sites. Scientific Writing- Definition and kinds of scientific documents – research paper, review paper, book reviews, thesis, conference and project reports. Components of a research paper. Preparation and submission of research project proposals to funding agencies. Selection of journals for publication- Impact factor– Citation index and H index, Thesis writing- Components.

UNIT-III: Data Presentation **(12 Hours)**

Data- Definition, source, types and collection, Primary and secondary data. Classification- chronological, alphabetical, geographical, qualitative and quantitative classification. Frequency distribution. Tabulation of data-components, rules and classifications. Diagrammatic presentation of data- Simple Bar, Multiple Bar, Component Bar, Percentage Bar, Pie chart, Pictogram, Cartograms. Graphical presentation of data-rules and classification.

UNIT-IV: Data Processing **(15 Hours)**

Measures of central tendency- Definition, arithmetic mean—Direct and shortcut method; median-individual data, discrete series, continuous series; mode-grouping table and analysising table method. Measures of Dispersion - quartile deviation, mean deviation, standard deviation, Coefficient of variation. Correlation-types, Karl Pearson coefficient of correlation and Regression–Rank correlation coefficient. Regression analysis.

UNIT-V: Data Analysis **(14 Hours)**

Sampling distribution and test of significance- Populations and samples, Hypothesis and its testing, characteristics of hypothesis, Null hypothesis- Type I & II errors and alternative

hypothesis, Confidential level, Test of significance- Parametric test - Student ‘t’ test. Analysis of variance– ‘F’ test. Chi square test and goodness of fit.

Total Lecture Hours-75

COURSE OUTCOME

The students are able to

1. Acquire awareness of ethical aspects on research and development including plagiarism issues and equal opportunities/equal treatment
2. Develop skills in identification of research problem.
3. Apply the methods while working on a research project work and appreciate the technique of result analysis, interpretation and writing the report
4. Discuss the methods of processing of data in research studies, classify and explain the various methods of central tendency and dispersion, determine the measures of asymmetry in research
5. Explain the basic concepts in testing of hypothesis, types of errors, steps and limitations of hypothesis testing

TEXT BOOK(S)

1. Antonisamy S. Prasanna Premkumar and Solomon Christopher. (2017). Principles and Practice of Biostatistics, 1st Edition, Elsevier Publishers, India.
2. Bratati Banerjee. (2018). Methods in Biostatistics For Medical Students and Research Workers, 9th Edition, Jaypee Brothers Medical Publishers, New Delhi.
3. Indranil Shah and Boddy Paul. (2020). Essentials of Biostatistics & Research Methodology, 3rd Edition, Academic Publishers, Kolkata.
4. Prasanth K. (2017). Guide to Research Methodology and Biostatistics, 1st Edition, CBS
5. Publishers, New Delhi.
6. Veer Bala Rastogi. (2015). Biostatistics, 3rd Edition, Medtech Publishers, USA.

REFERENCE BOOK(S)

1. Dubey Diwedi and Usman Srivastava. (2019). Biostatistics and Research Methodology, 1st Edition, Vikas & Co Publishers, Noida.
2. Gupta SP. (2017). Statistical Methods, 43rd Edition, Sultan Chand & amp; Sons Publishers, New Delhi.
3. Sharma Suresh. (2016). Research Methodology and Biostatistics: A Comprehensive Guide for Health Care Professionals, 1st Edition, Elsevier Publishers, India.
4. Wayne W Daniel. (2012). Biostatistics: A Foundation for Analysis in the Health Sciences, (Wiley Series in Probability and Statistics), 10th Edition, John & Wiley Publishers, New Jersey.
5. Wayne W. Daniel and Chad L. Cross. (2014). Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th Edition, Wiley Publishers, New Jersey.
6. Kothari C R, (2023) Research Methodology-Methods and Techniques, New Age International publisher.

E-RESOURCES

1. https://digitalguardian.com/blog/what-data-classification-data-classification-definition
2. https://www.formpl.us/blog/research-report
3. https://www.mooc-list.com/tags/biostatistics
4. https://www.mooc-list.com/tags/researchmethodology
5. https://www.westga.edu/academics/research/vrc/assets/docs/tests of significance notes.pdf

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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: III- EC-V: Biostatistics and Data Sciences
Ins. Hrs./Week: 5 **Course Credit: 3** **Course Code:** P23BCE35B

UNIT- I: Data Presentation **(15 Hours)**

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

UNIT- II: Data Processing **(15 Hours)**

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

UNIT- III: Data Analysis I **(15 Hours)**

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

UNIT –IV: Data Analysis II **(15 Hours)**

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

UNIT –V: Data Science **(15 Hours)**

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

Total Lecture Hours-75

COURSE OUTCOME

The students are able to

1. Understand the concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables.
2. Acquire knowledge on the criteria for the independence of data based on attributes. Measures of central tendency, Dispersion, Skewness and Kurtosis.

3. Learn the different sampling methods and analysing statistical significance.
4. Understand the student's t test, ANOVA, Chi square test to analyse the significance of various research.
5. Learn on data science, algorithm for machine learning, artificial intelligence and big data, their applications in clinical and pharma domain .

TEXT BOOK(S)

1. Zar, J.H. (1984) Bio Statistical Methods, Prentice Hall, International Edition.
2. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), An Introduction to Biostatistics, 2nd Edition, Prestographik, Vellore, India,
3. Warren, J; Gregory, E; Grant,R (2004), Statistical Methods in Bioinformatics,1st Edition, Springer
4. Milton, J.S.(1992),. Statistical methods in the Biological and Health Sciences, 2nd Edition , Mc Graw Hill,
5. Rosner,B (2005), Fundamentals of Biostatistics, Duxbury Press.
6. Thomas W. MacFarland (2024). Introduction to Data Science in Biostatistics Using R, the Tidyverse Ecosystem, and APIs.

REFERENCE BOOK(S)

1. Dubey Diwedi and Usman Srivastava. (2019). Biostatistics and Research Methodology, 1st Edition, Vikas & Co Publishers, Noida.
2. Gupta SP. (2017). Statistical Methods, 43rd Edition, Sultan Chand & Sons Publishers, New Delhi.
3. Sharma Suresh. (2016). Research Methodology and Biostatistics: A Comprehensive Guide for Health Care Professionals, 1st Edition, Elsevier Publishers, India.
4. Wayne W Daniel. (2012). Biostatistics: A Foundation for Analysis in the Health Sciences, (Wiley Series in Probability and Statistics), 10th Edition, John & Wiley Publishers, New Jersey.
5. Wayne W. Daniel and Chad L. Cross. (2014). Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th Edition, Wiley Publishers, New Jersey.

E RESOURCES

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

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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: III- EC-V: Gene Editing, Cell and Gene therapy
Ins. Hrs./Week: 5 **Course Credit: 3** **Course Code:** P23BCE35C

UNIT- I: Gene Editing **(15 Hours)**

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

UNIT- II: Gene and cell therapy **(15 Hours)**

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

UNIT- III: Vectors for Gene therapy **(15 Hours)**

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

UNIT- IV: Stem cells and tissue regeneration **(15 Hours)**

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

UNIT- V: Regulation of Gene Therapy **(15 Hours)**

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

Total Lecture Hours-75

COURSE OUTCOME

The students are able to

1. Read, and evaluate scientific articles within the subjects of immune therapy, gene therapy and cell therapy.
2. Clone gene of their interest for several downstream purposes with a robust comprehension about wide variety of applicable gene delivery vectors.
3. Provide examples of diseases that can be treated with immune therapy, gene therapy and cell therapy.
4. Identify knowledge gaps and need for further research within their chosen topic of immune therapy, gene therapy or cell therapy.
5. Critically discuss and reflect on ethical and social aspects of using immune, gene or cell therapy and the student will be persuaded to contemplate on upcoming technologies for futuristic benefits.

TEXT BOOK(S)

1. Dubey RC. (2014). Book on Biotechnology, 5th Edition, S. Chand and company Publishers, New Delhi. 2. Jognand SN. 2006. Gene Biotechnology, 2nd Edition, Himalaya Publishing House, Bengaluru, Karnataka.
2. Singh BD. (2007). Biotechnology, 3rd Edition, Kalyani Publishers, Chennai, Tamil Nadu.
3. Tyagi ID. (2005). Biotechnology and Genetic Engineering, 1st Edition, Jain Brothers Publishers, Bengaluru, Karnataka.
4. Verma PS. and Agarwal VK. (2009). Genetic Engineering, 1st Edition, S. Chand Publishers, New Delhi. 6. Wulf Crueger. 2016. Biotechnology: A Textbook of industrial microbiology, 2nd Edition, CBS Publishers, New Delhi, India.
5. Glick R. and J. J. Pasternak. (2002). Molecular Biotechnology, 3rd Edition. ASM Press, Washington, USA.
6. Old R.W and S.B. Primrose. (1989). Principles of gene manipulation, 4th Edition. Blackwell Scientific Publications, London.
7. J.J. Pasternak, (2005). An Introduction to Human Molecular Genetics (2nd Edition),
8. Thomas F. Kresina Upadhyay, S. K. (2021). An Introduction to Molecular Medicine and Gene Therapy 1st Edition.
9. Tom Strachan & Andrew Read, (2010). Human Molecular Genetics. 4th Edition,
10. Totowa NJ, USA; Oct. (2003). Stem Cells Handbook: Stewart Sell, Humana Press;

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1. Brown TA. (2006). Gene Cloning and DNA Analysis: An Introduction, 5th Edition, Wiley Blackwell Publishers, Hoboken, New Jersey.
2. Gardner AG. Simmons MJ. (2006). Principles of Genetics, 8th Edition, John Wiley and Sons Publishers, New Jersey.
3. Griffiths AJF. Wessler SR, Doebley J and Carroll SB. (2010). Introduction to Genetic Analysis, 10th Edition, W. H. Freeman Publishers, New York.
4. Harry Levine, Harry Levine. (2006). Genetic Engineering: A Reference Handbook Illustrated Edition, ABC-CLIO Publishers, Santa Barbara, California.
5. Primrose SM and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishers, Hoboken, New Jersey.

6. David M Glove. 1984. Gene cloning - The mechanisms of DNA manipulations. Chapman and Hall, New York.
7. Ernst L Winnacker. 2002. From genes to clones - Introduction to gene technology. VCR Pub., Weinheim.
8. James D Watson. et al. 1992. Recombinant DNA. WH freeman and Co., NY.
9. Advanced Textbook on Gene Transfer, Gene Therapy and Genetic Pharmacology Principles, Delivery and Pharmacological and Biomedical Applications of Nucleotide-Based Therapies (2019) 2nd edition, Edited by: Daniel Scherman (National Scientific Research Center (CNRS), France)

E-RESOURCES

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3. https://www.mooc-list.com/tags/genetics
4. https://www.mooc-list.com/tags/genetically-modified-organisms
5. https://ncert.nic.in/ncerts/l/lebo105.pdf
6. https://www.pdfdrive.com/an-introduction-to-genetic-engineering-e40034206.html
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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: III- SEC: Clinical Lab Technology

Ins. Hrs./Week:2 **Course Credit:2** **Course Code:** P23SEBC31

UNIT-I: Collection, transport, analysis of specimen **(06 Hours)**

Blood, routine urine, feces, sputum, semen, CSF Documentation of samples & results. Disposal of laboratory/ hospital waste-Non infectious waste, biomedical waste, infected sharp waste disposal, infected non sharp disposal – color coding as per guidelines.

UNIT-II: Determination of Blood group and Rh factor **(06 Hours)**

Determination of Blood group and Rh factor, Basic blood banking procedures- cross matching, screening test. Blood transfusion and hazards.

UNIT-III: Estimation of blood and Urine **(06 Hours)**

Estimation of blood sugar by Enzymatic method, HbA1C, Qualitative and quantitative analysis of urine sample- NPN-urea, uric acid, creatinine. Mineral, vitamin and CSF analysis.

UNIT-IV: Immuno diagnostics **(06 Hours)**

Widal test, VDRL test, ASO, RA, CRP and Complement fixation Test. RIA, ELISA, Skin test – Montaux and Lepramin test.

UNIT-V: Assay of enzymes and hormones **(06 Hours)**

Assay of clinically important enzymes- LDH, creatine kinase, transaminases, phosphatases - Estimation of clinically important hormones – Insulin, Thyroid and Reproductive hormones and its clinical significance.

Total Lecture Hours: 30

COURSE OUTCOME

The students are able to

1. Acquire knowledge about Collection and preservation of biological samples.
2. Estimate the various constituents in biological sample.
3. Perform the routine procedures adopted in blood bank.
4. Analyze and interpret the values for both normal and disease conditions.
5. Assay the enzymes and hormones &interpret clinical implications.

TEXT BOOK(S)

1. Kanai L Mukherjee and Anuradha Chakravarthy. (2022). Medical Laboratory Technology IV th Edition,Vol I,
2. Ramnik Sood, (2006). Text Book of Medical Laboratory Technology, Jaypee Publishers.
3. Tietz, N. (2018). Fundamentals of Clinical Chemistry and Molecular Diagnostics 8th Edition, W.B. Saunders Company.

4. Varley's by Alan H Gowenlock, (1988). Practical Clinical Biochemistry- published by CBS Publishers and distributors, India. 6th Edition.
5. Manipal Manual of Clinical Biochemistry (For Med. Lab. And Msc Stud.) (2013). 4th Edition.

REFERENCE BOOK(S)

1. Bergey's manual of determinative bacteriology by Edited by John G. Holt REF Desk QR81.A5 1994ISBN: 0683006037.
2. David S. Jacobs, (2004). Laboratory test handbook : concise, with disease index by REF RB38.2L327, ISBN: 9781591950806.
3. Kanai L Mukerjee. (1996). Medical Lab Technology, Vol I & II, 1st Edition, Tata Mcgraw Hill Publishers, New York, USA.
4. Ranjna Chawla. (2014). Practical Clinical Biochemistry Methods and Interpretations (Paperback). 4th Edition, Jaypee Brothers Medical Publishers, Tamil Nadu.
5. Kanai L Mukerjee. (1996). Medical Lab Technology Vol I & II, 3rd Edition, Tata McGraw Hill Publishers, New Delhi.
6. Rooma Devi, Aman Chauhan, Simmi Kharb, Chandra Shekhar Pundir, (2023). Clinical Biochemistry-A Laboratory Guide, 1st Edition, Jenny Stanford publishers, New York.

E-RESOURCES:

1. https://www.youtube.com/watch?v=QNYlX5Ne9lQ
2. https://www.slideshare.net/doctorrao/agglutination-tests-and-immunoassys
3. https://microbenotes.com/introduction-to-precipitation-reaction/
4. https://www.researchgate.net/publication/260182512 Practical_Manual in_ Bio chemistry _ and_ Clinical_Biochemistry
5. https://www.euro.who.int/__data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf

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SEMESTER IV

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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: IV- CC-VII: Molecular Biology
Ins. Hrs./Week: 5 **Course Credit: 5** **Course Code:** P23BC410

UNIT- I: Mendel's laws of inheritance **(15 Hours)**
Dominance-complete, incomplete and co- dominance, multiple alleles-gene mapping in haploids and diploids, recombination mapping- restriction mapping- modes of gene information transfer in bacterial- conjugation, transformation and transduction. The bacterial chromosome, the eukaryotic genome- chromosome structure – Histones, Nucleosome, chromatin- heterochromatin, euchromatin, chromatin remodeling, DNAase hypersensitive sites, genome organization – the C-value paradox, reassociation kinetics, repetitive sequences, gene amplification, telomeres, pseudogenes, split genes, organelle genomes – mitochondrial and chloroplast genome.

UNIT- II: DNA replication and repair **(15 Hours)**
Enzymes of replication, prokaryotic replication mechanisms, primosome and replisomes, eukaryotic DNA replication, the role of topoisomerases and telomerase, regulation of replication, difference between prokaryotic and eukaryotic replication. Mutations -Types of mutations, mechanisms of mutations, mutagenic agents. DNA repair mechanisms – Direct repair, excision repair, mismatch repair, recombination repair, SOS response, eukaryotic repair systems. Recombination and mobile genetic elements- the Holliday model, the general recombination in *E.coli*, site specific recombination, transposons and retroposons.

UNIT III: Transcription and Translation **(15 Hours)**
Transcription – Prokaryotic transcription-subunits of RNA polymerase, E. coli promoters, sigma factor and promoter recognition, alternative sigma factors, initiation, elongation, Rho-dependent and independent termination of transcription. Eukaryotic transcription- Initiation, promoter elements, RNA polymerases, transcription factors, regulatory sequences in eukaryotic protein – coding genes, CpG islands, enhancers.
Translation – organization of the ribosome, the genetic code, evidence for a triplet code, deciphering the genetic code, wobble hypothesis, deviation in the genetic code, unusual codons. Activation, initiation, elongation and termination of translation in E. coli. The role of tRNA and rRNA, suppressor tRNAs and inhibitors of protein synthesis. Comparison of prokaryotic translation with eukaryotic translation.

UNIT- IV: Gene Expression **(15 Hours)**
Regulation of gene expression in prokaryotes-– Positive and negative control, the lac operon, identification of operator and regulator sequences by mutations, induction and repression, Foot-printing and gel-shift assays for identification of protein-DNA interactions. Catabolite repression. *Trp* operon – Attenuation, alternative secondary structures of *trp* mRNA.

Regulation of gene expression in eukaryotes- Response elements, DNA-binding motifs, steroid receptors, association of methylation and histone acetylation with gene expression.

UNIT V: Post Translational and transcriptional Modifications (15 Hours)

Post transcriptional modifications in eukaryotes- RNA processing- mRNA 5' capping and 3'poly-adenylation, introns and exons, RNA splicing,- spliceosome assembly, alternative splicing, processing of tRNA and rRNA, self-splicing, ribozymes, RNA editing- substitution and insertion/deletion editing, Genome editing-CRISPR- Cas technology.

Post translational modification of proteins- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation, Protein sorting – signal peptides, transport of secretory proteins, Golgi and post-golgi sorting, coated vesicles, targeting of mitochondrial, lysosomal and nuclear proteins, Protein degradation-Ubiquitination of proteins, Protein folding-chaperones

Total Lecture Hours-75

COURSE OUTCOME

The students are able to

1. Comprehend the organization of genomes, the molecular basis of DNA replication, recombination and transposition, the significance of these processes, the various ways in which the DNA can be damaged leading to mutations and lesions and the different ways in which they are repaired
2. Gain knowledge about how genes are transcribed and translated in prokaryotes and eukaryotes and how these processes are regulated, recognize the nature of the genetic code and the various experimental approaches used to crack the code
3. Acquire knowledge of the molecular basis of RNA processing and RNA splicing and the various human pathologies that can result from defects of RNA modification.
4. Learn the techniques of gene silencing and its applications.
5. Apply the knowledge they have gained in understanding the above vital life processes to enhancing their analytical and problem-solving skills and develop an interest to pursue high quality research.

TEXT BOOK(S)

1. Ajay Paul. (2007). Textbook of Cell and Molecular Biology. Books and Allied, Kolkata
2. Cram, (2015), Text Book of Principles of Molecular Biology.
3. David Freifelder, (2008), Molecular Biology. 2nd Edition, Narosa Publications, NewDelhi.
4. Geoffrey Cooper, Robert E Harsman, (2004), The Cell- A Molecular Approach, 3rd Edition, ASM Press.
5. Harvey Lodish, Arnold Berk, Chris A Kaser , (2010). Molecular cell Biology. 5th Edition.
6. Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition; Wiley, India
7. Griffith A. F, Doebley J, Peichel C, David A, Wassarman DA; An Introduction to Genetic Analysis 12th edition,, Albion Press.W.H.Freeman & Co, New York.

REFERENCE BOOK(S)

1. De Robertis and De Robertis. (1990). Cell and Molecular Biology. Saunders, Philadelphia.
2. De Robertis and De Robertis, (2001). Cell and Molecular Biology, 8th Edition, Wolters Kluwer India Pvt Ltd.
3. Alberts et al., (2002). Molecular Biology of the Cell, 4th Edition, Garland Science Inc.
4. Gerald Karp, (2004). Cell and Molecular Biology, 4th Edition, John Wiley & Sons, Inc, New York.
5. Cox, M., Michael., Nelson, L.D. (2008). Principles of Biochemistry, 5th Edition. W.H. Freeman and company, Newyork.
6. Dale,W.J. and Schontz, (2007). From Genes to Genomes. V.M. John wiley & sons ltd., England.
7. Flint. S.J, L.W. Enquist, R.M. Krug, V.R. Racaniello and A.M. Skalka, (2000). Principles of Virology, ASM Press, Washington D.C
8. Kieleczawa,J. (2006), DNA Sequencing II. Jones and Bartlett Publishers, Canada.
9. Koenberg, A.and Baker, A.T. (2005). DNA Replication. 2nd edition. University Science Book, California.
10. Watson, Baker, Bell, Gann, Levine and Losick. (2006). Molecular Biology of the Gene, 5th Edition, Pearson Education.
11. Rebecca Heald , Keith Roberts , David Morgan , Peter Walter) , Bruce Alberts. (2022). Molecular Biology of the Cell. W. W. Norton & Company Publishcation. Publisher Imprint: W. W. Norton & Company. International Edition.

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4. https://mooc.es/course/molecular-biology/
5. https://onlinecourses.swayam2.ac.in/cec20_ma13/preview
6. https://learn.genetics.utah.edu/
7. https://www.cellbio.com/education.html
8. https://lifescienceinteractive.com/category/molecular-biology/

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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: IV- CC-VIII: Developmental Biology
Ins. Hrs./Week: 5 **Course Credit: 5** **Course Code:** P23BC411

UNIT- I: Overview of Developmental biology **(15 Hours)**
Background of Developmental biology - Principles of developmental biology –Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

UNIT- II: Model organisms **(15 Hours)**
Gametogenesis – production of gametes, Formation of zygote, fertilization and early development: molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. Drosophila Developmental biology- Axis formation, Genes & mutation. *C.elegans* – Vulva formation, Axis formation.

UNIT- III: Regeneration Developmental Biology **(15 Hours)**
Stem cells – Definition, Classification, Embryonic and adult stem cells, properties, identification, Culture of stem cells, Differentiation and dedifferentiation, Stem cellmarkers, techniques and their applications in modern clinical sciences. Three- dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.

UNIT- IV: Morphogenesis & Organogenesis **(15 Hours)**
Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens formation, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

UNIT- V: Cellular senescence and Cell fate decision **(16 Hours)**
Cellular senescence – concepts & Frizzled receptor in Development and disease. Diabetes and developmental biology, Cell death pathways in developments. Markers of important diseases.

Total Lecture Hours-75

COURSE OUTCOME
The students are able to
1. Grasp knowledge about the background of developmental biology
2. Gain abundant knowledge about model oraganisms and gametogenesis
3. Acquire knowledge about stem cells and their applications in regenerative therapy
4. Understand about morphogenesis and organogenesis

5. Learn the basics of cell death mechanisms and cell fate decision

TEXT BOOK(S)

1. Browder LW. Erickson CA and Jeffery WR. (1991). Developmental Biology. 3rd Edition, Saunder College Publishing House, Philadelphia, USA.
2. Gilbert SF. (2010). Developmental Biology, 9th Edition. Sinauer Associates Inc. Massachusetts, USA.
3. Sarin C. (1990). Genetics. Tata McGraw–Hill Publishing Co. Ltd., New Delhi.
4. Sastry KV, Vineeta Shukla. (2018). Developmental Biology. 2nd Edition, Rastogi Publications, Meerut.
5. Strickberger, (2002). Genetics, 3rd Edition, Prentice Hall of India, New Delhi.

REFERENCE BOOK(S)

1. Alberts B. (2002). Developmental Biology. 3rd Edition. Garland Science, USA.
2. Balinsky, (2012). An Introduction to Embryology, 6th Edition, Cenage Learning India, Uttar Pradesh.
3. Brain K Hall, Wendy M Olson, (2006). Keywords and Concepts in Evolutionary Developmental Biology, New Edition. Hardward University Press, Cambridge,USA.
4. Diwan AP, Dhakad NK. (1996). Animal Regeneration, 3rd Edition, Anmol Publications Ltd, India.
5. Gilbert SF. (2010). Developmental Biology, 9th Edition, Sinauer Associates Inc. Massachusetts, USA.
6. Gayatree Hazarika (2022). Developmental Biology, 2th Edition, Ashok Book Stall Publications Ltd, India.

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2. https://lib-ebooks.com/developmental-biology-12th-edition-pdf/
3. https://www.worldcat.org/title/developmental-biology/oclc/698642961
4. https://sites.google.com/a/indonesia-fb48a.web.app/yjuikuopoiukuy/-pdf-download-developmental-biology-by-scott-f-gilbert
5. http://www.freebookcentre.net/Biology/Plant-Biology-Books.html
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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: IV-CP VI: Molecular Biology Techniques
Ins. Hrs. /Week: 6 **Course Credit: 3** **Course Code:** P23BC412P

1. Isolation of Plasmid DNA from bacterial culture.
2. Isolation of Genomic DNA.
3. Isolation of chromosomal DNA from animal tissues.
4. Spectrophotometric analysis of purity of isolated DNA
5. Separation of genomic and plasmid DNA fragment by Agarose gel electrophoresis
6. Restriction digestion of DNA
7. Estimation of DNA by Diphenylamine method.
8. Isolation of RNA from animal tissues.
9. Analysis of RNA by formaldehyde – Agarose electrophoresis.
10. Estimation of RNA by Orcinol method
11. Extraction of protein from animal tissue.
12. Separation of proteins by agarose gel electrophoresis
13. Separation of proteins by SDS-PAGE
14. Estimation of protein by Lowry's method and Biuret's method
15. PCR – Demonstration

Total Hours-90

COURSE OUTCOME

The students are able to

1. Understand how to extract and quantify DNA from samples.
2. Learn about extraction and quantification of RNA from samples
3. Acquire knowledge about the basics of Molecular techniques
4. Inculcate in-depth knowledge about electrophoresis techniques
5. Learn the principle and procedure for PCR and Blotting techniques

TEXT BOOK(S)

1. Chaitanya KV. (2013). Cell & Molecular Biology- A Lab manual. Kindle edition, Practice Hall India Learning Private Limited, New Delhi.
2. Harshal A Pawar. (2018). A practical Book on Pharmacognosy and Phytochemistry I. Ist edition. Everest Publishing House, Maharashtra, India.
3. Jayaraman J. (2000). Manuals in Biochemistry, 3rd Edition, New Age International Publishers, Karnataka, India.
4. Nigam. (2007). Lab Manual *of* Biochemistry, 1st Edition, Tata McGraw-Hill Education, USA.
5. Plummer T. (2001). Practical Biochemistry, 3rd Edition, McGraw Hill Publishing Company, USA.

REFERENCE BOOK(S)

1. Deepak Som. (2018). Practical Manual of Molecular Biology, 2nd Edition. Kaav Publications, New Delhi.
2. Gupta MK. (2016). A practical manual of phytochemistry and pharmacognosy, Print Edition, Notion press, Chennai, India.
3. Khalid Z. Masoodi, Sameena Maqbool Lone, (2021). Advanced methods in molecular biology and biotechnology, 1st Edition, Academic Press, USA.
4. Mayur R. Bhurat. (2019). A Practical Book of Pharmacognosy and Phytochemistry – II. Ist Edition. Nirali Prakashan Publishers, New Delhi.
5. Sawhney SK, Randhir Singh. (2005). Introductory practical Biochemistry, 2nd Edition, Alpha Science International Limited, United Kingdom.
6. J. Sambroke, E.F. Fritsch & T.Maniatis. Molecular cloning – A laboratory manual.
7. James .J. Greene, Veningalla. B. Rao. Recombinant DNA principles and methodologies
8. S. Sivaranjani, S. Ramadevi, V. Ramabhai, P. Everest Helen Rani and A. Gejalakshmi (2023). Molecular Biology Practical Handbook, AkiNik Publications.

E-RESOURCES

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3. https://www.mdpi.com/1420-3049/23/2/463
4. https://www.researchgate.net/publication/224870589_Agarose_Gel_Electrophoresis_for_the_Separation_of_DNA_Fragments
5. https://www.kopykitab.com/A-Practical-Book-Of-Pharmacognosy-And-Phytochemistry-II

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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: IV-EC VI: Forensic Science
Ins. Hrs. /Week: 4 **Course Credit: 3** **Course Code:** P23BCE46A

UNIT- I: Forensic Science **(12 Hours)**
Forensic Science: Definition, History and Development, Scope and Need, Basic Principles, Branches of Forensic Science, Tools and Techniques of Forensic Science. Forensic Science Laboratories: Organizational setup of CFSL, FSL, GEQD, FPB, NICFS, CDTS, NCRB, NPA. Mobile Forensic Science Laboratory. Education of Forensic Science, Role of Media, Human Right and Criminal Justice System.

UNIT-II: Analysis of Blood **(12 Hours)**
Fresh blood – grouping and typing of fresh blood samples including enzyme types. Analysis of stains of blood and allied body fluids for their groups and enzyme tests. Disputed paternity and maternity problems – DNA extraction and profiling techniques. Wild life forensics – Scope, evidences and identification.

UNIT-III: Analysis of body fluids **(12 Hours)**
Analysis of illicit liquor including methyl and ethyl alcohol and alcohol in body fluids and breathe. Analysis of chemicals in trap cases - Petroleum product, Chemical examination of insecticides, pesticides and psychotropic drugs – Sedatives, stimulants, opiates and drugs of abuse. Detection of poisons from viscera, tissues and body fluids. . Examination and identification of saliva, milk, urine and faecal matter

UNIT-V: Identification tests **(12 Hours)**
History, classification, search, lifting and examination of fingerprints, development of latent fingerprints by various methods. Identification of hair, determination of species origin, sex, site and individual identification from hair Medicolegal aspects of wounds, Post-mortem examination and PM changes, asphyxia death, sexual offences, infanticide. Forensic psychiatry and lye detection.

UNIT - V: Forensic Ethics **(12 Hours)**
Introduction, Definition, Scope, Ethics in Forensic Science, Professionalism and ethics: Importance of professional ethics, the importance Of professional ethics to science practitioners, development of code of conduct and code of ethics for Forensic Science; Application of codes and ethics, How ethical requirements impact the daily work of a forensic scientist; Ethical dilemmas and their resolution.

Total Lecture Hours-60

COURSE OUTCOME

The students are able to,

1. Gain knowledge on basics of forensic science and method for collection and preservation of samples
2. Assess the paternity, maternity problems and DNA profiling
3. Identify the presence of alcohol, insecticides and pesticides in body fluids
4. Detail on the test performed to identify the presence of drugs and poisons in body fluids
5. Identify species and sex from the available body fluids

TEXT BOOK(S)

1. Henry Lee (2001). Crime Scene Handbook. San Diego, Calif. : London : Academic Publication.
2. Shrikant H. Lade Forensic Biology. 2nd Edition, CRC press. Boca Raton London New York.
3. Ross M. Gardner, Donna R. Krouskup (2021). Practical Crime Scene Processing and Investigation, Third Edition.
4. Stuart H. James, Forensic Science: An Introduction to Scientific and Investigative
5. Techniques. 3rd Edition.
6. Richard Saferstein. (2006). Criminalistics: An Introduction to Forensic Science, 9th Edition. Pearson publication.
7. Brent E.Turvey, (2011). Criminal Profiling: An Introduction to a Behavioral Evidence Analysis, 3rd Edition. Academic Press Publication.
8. Barry, A.J. (2003). Fisher- Techniques of Crime Scene Investigation, 7th ed. R.C. Press, New York.

REFERENCE BOOK(S)

1. Norah Rudin & Keith Inman , (2001). An Introduction to Forensic DNA Analysis , Second Edition. CRC Press, USA.
2. Saferstein, Richard E. (2004). Forensic Science Handbook, Volume 2 & 3. Pearson Publication.
3. B.R. Sharma, Forensic Science in Criminal Investigation and Trial, 4th Edition.
4. Parikh C.K. (2023). Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology: 9th Edition, CBS Publishers and Distributors Pvt. Ltd.
5. Barrard and Gerald, (2002).The Identification of Firearms and Forensic ballistics: Special Edition. Palladium Press.

E-RESOURCES

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2 https://www.fbi.gov/file-repository/handbook-of-forensic-services- pdf.pdf/view
3. http://www.forensic-science-society.org.uk/

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DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: IV-EC- VI: Phytotherapeutics
Ins. Hrs. /Week: 4 **Course Credit: 3** **Course Code:** P23BCE46B

UNIT-I: Phytomedicine **(12 Hours)**
History of herbs as source of drugs and drug discovery, Classification and characteristics of herbal medicine, Dosage forms, Standardization and quality evaluation of herbal drugs, methods, Health care systems – Fundamental concepts of Ayurveda, Siddha, Unani and Homoeopathy systems of medicine, Differences between Traditional and Conventional medicine.

UNIT-II: Extraction Techniques **(12 Hours)**
Medicinal plants-bioactive principles: methods of extraction, screening and isolation, Recent advances in extractions with emphasis on selection of method and choice of solvent for extraction, successive and exhaustive extraction and other methods of extraction - microwave assisted extraction, Methods of fractionation

UNIT-III: Drug Constituents **(12 Hours)**
Biosynthesis, Occurrence and function of following phytopharmaceuticals contai ning drugs: Alkaloids (Quinine, Morphine, Atropine) flavonoids (Quercetin and Rutin.), terpenoids (Menthol and Eugenol) steroids (Glycyrrhizin and Digitoxin), C Glycosides (Sennosides, Glycyrrhizin and Digitoxin), carotenoids (Lycopene and β-Carotene), Antibiotics (Penicillin and Tetracycline)00

UNIT-IV: Phytopharmacological Screening **(12 Hours)**
Introduction of advanced screening methods, toxicity studies as per OECD guidelines and study of phytopharmacological screening for following categories of drugs: Antiinflammatory, antiulcer, antifertility, anticancer, antidiabetics and antihepatotoxic and antioxidants.

UNIT- V: Herbal Cosmetics **(12 Hours)**
Cosmetics preparations: Incorporating the herbal extracts in various cosmetic formulations like Skin care preparations (Creams and Lotions), Sunscreens and Sunburn applications, Hair care preparations (Hair oils and Hair shampoos) and Beautifying preparations (Lipsticks, Face powders and Nail polish).

Total Lecture Hours-60

COURSE OUTCOME
The students are able to
1. Know the difference between traditional and conventional medicine.
2. Learn the different methods of extraction of active constituents from plant.
3. Acquire knowledge about the different class of medicinal compounds.
4. Understand as to how herbs influence human physiology and pharmacologically helpful as therapeutics.
5. Gain the knowledge on how the plants are used as the source of cosmetics.

TEXT BOOK(S)

1. Biren Shah, Seth AK. (2010). Text Book of Pharmacognosy and Phytochemisytry, 1st Edition, Reed Elsevier, India.
2. Heinrich Michael, (2018). Fundmentals of Pharmacognosy and Phytotherapy, 3rd Edition, Elsevier Health Sciences, India.
3. Jain Usman, Jadhav, Tanvir, (2020). A Textbook of Phytochemistry, S.Vikas and Company, Jalandhar, India.
4. Kokate CK, Purohit AP. (2006). Pharmacognosy, 31st Edition. Nirali Prakashan Publishers, Pune, India.
5. Singh MP and Panda H. (2005). Medicinal Herbs with their formulations, 1st Edition, Daya Publishing House, Delhi.

REFERENCE BOOK(S)

1. Iqbal Ramzan. (2015). Phytotherapies, Efficacy, safety and regulation, Kindle Edition, John Wiley & Sons, Inc. New York, USA
2. Khan IA and Khanum A. (2004). Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, 1st Edition, Ukkaz Publications, Hyderabad.
3. Michael Heinrich, Joanne Barnes, (2017). Fundamentals of Pharmacognosy and Phytotherapy, 3rd Edition, Elsevier Publishers, New York.
4. Purohit SS. (2005). Agricultural Biotechnology, 7th Edition, Updesh Purohit Publishers, Jodhpur.
5. Slater A, Scott NW and Fowler MR. (2004). Plant Biotechnology. The genetic manipulation of plants, 2nd Edition, Oxford University Press, Oxford.

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1. https://www.slideshare.net/MarwaFayed1/phytotherapy-1-2020-184509192
2. https://www.intechopen.com/books/herbal-medicine/introductory-chapter-introduction-to-herbal-medicine
3. https://publications.iarc.fr/_publications/media/download/2627/243766665abcdd12254dfd3ab98a0e47ab582f6c.pdf
4. https://www.slideshare.net/mrmodaq/herbal-medicine-43566287
5. https://www.intechopen.com/books/herbal-medicine/introductory-chapter-introduction-to-herbal-medicine

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SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
(AUTONOMOUS)
SUNDARAKKOTTAI, MANNARGUDI- 614016
(For the Candidates admitted in the academic year 2023 – 2024)
DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: IV-EC- VI: Advances in Clinical Research
Ins. Hrs. /Week: 4 **Course Credit: 3** **Course Code:** P23BCE46C

UNIT- I: Introduction to clinical research **(12 Hours)**
Introduction to clinical research, terminologies and definition in clinical research, origin and history of clinical research, difference between clinical research and clinical practice, types of clinical research, phases of clinical research, clinical trials in India - the national perspective, post marketing surveillance, pharmaceutical industry - global and Indian perspective, clinical trial market, career in clinical research.

UNIT- II: Pharmacology and drug development **(12 Hours)**
Introduction to pharmacology, concept of essential drugs, routes of drug administration, introduction to drug discovery and development, hurdles in drug development, sources of drugs, basics of drug, discovery & development, approaches to drug discovery, evolutionary classification of the strategies for drug discovery, emerging technologies in drug discovery, preclinical testing, investigational new drug application, clinical trials, new drug application and approval, pharmacokinetics, pharmacodynamics, recent advances - pharmacogenomics and protein based therapies.

UNIT- III: Ethical considerations and guidelines in clinical research **(12 Hours)**
Historical guidelines in clinical research, Nuremberg code, declaration of Helsinki, Belmont report, international conference on harmonization (ICH)-brief history of ICH, structure of ICH, ICH harmonization process, guidelines for good clinical practice, glossary, the principles of ICH GCP, institutional review board / independent ethics committee, investigator, sponsor, clinical trial protocol and protocol amendment(s), investigator's brochure, essential documents for the conduct of a clinical trial.

UNIT- IV: Regulation in clinical research and management **(12 Hours)**
Introduction of clinical trial regulation, European Medicine Agency, US FDA, drug and cosmetic act, Schedule Y, ICMR Guideline. Clinical Trial Management project management, protocol in clinical research, informed consent, case report form, investigator's brochure (IB), selection of an investigator and site, clinical trial stakeholders, ethical and regulatory submissions, documentation in clinical trials, pharmacovigilance, training in clinical research, roles and responsibilities of clinical research professionals.

UNIT- V: Clinical data management **(12 Hours)**
Introduction to CDM, CRF Design, clinical data entry, electronic data capture, data validation, discrepancy management, clinical data coding, SAE reconciliation, quality assurance & clinical data management, guideline & regulation in clinical trial data.

Total Lecture Hours-60

COURSE OUTCOME:

The students are able to

1. Discuss the basic introductory knowledge on the clinical research
2. Compare the protocols related to the clinical trial procedures in India and abroad
3. Apply the GLP in clinical research lab
4. Test the activity of the newly formulated drugs in experimental animals
5. Evaluate the formulations preparation and usage of the newly revealed drug for human consumption and design the protocols for clinical trials

TEXT BOOK(S):

1. Lawrence M Friedman, Fundamentals of Clinical Trials, 5th Edition: Springer Publications.
2. David Machin and Simon day, (2004). Text Book of Clinical Trials, John Wiley publications.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000, 2014, 2017. Indian Council of Medical Research, New Delhi.
4. Tom Brody, (2016). Clinical Trials, Second Edition. Elsevier Publications.
5. John I Gallin, (2002). Principle and Practice of Clinical Research, Second Edition.
6. WHO, (2001). Health Research Methodology. Second Edition.

REFERENCE BOOK(S)

1. Charles R. Creig, and Robert E. Stitzel, Lippincott Williams & Wilkins. Modern Pharmacology with clinical correlations, 6th Edn.,
2. McGraw- Hill Medical, (2012). Applied Biopharmaceutics and Pharmacokinetics, Shar gel, L. et al ., 6 th Edition.
3. Julia Lloyd and Ann Raven Ed. (1994). Handbook of clinical research. Churchill Livingstone, Edinburgh.
4. Giovanna di Ignazio, Di Giovanna and Haynes, (2018). Principles of Clinical Research. CRC Press / BSP Books.
5. R K Rondels, S A Varley, C F Webbs, (2000). Clinical Data Management edited. 2nd Edition. Wiley Publications.
6. David Machin, Simon Day and Sylvan Green, (2005). Textbook of Clinical Trials, John Wiley and Sons.

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1. https://www.amazon.in/Advancements-Clinical-Research-Advances-Experimental-ebook/dp/B01MPY9EON
2. https://www.slideshare.net/slideshow/clinical-research-208096411/208096411
3. https://www.msdmanuals.com/en-in/professional/clinical-pharmacology/concepts-in-pharmacotherapy/drug-development
4. https://journals.lww.com/ijaweb/fulltext/2017/61030/regulatory_requirements_for_clinical_trials_in.2.aspx
5. https://en.wikipedia.org/wiki/Clinical_data_management

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(For the Candidates admitted in the academic year 2023 – 2024)
DEPARTMENT OF BIOCHEMISTRY
M.Sc., BIOCHEMISTRY

Semester: IV-PCC: Life Sciences for Competitive Examination
Ins. Hrs. /Week: 2 **Course Credit: 2** **Course Code:** P23PCBC41

UNIT- I: Basics of Taxonomy **(06 Hours)**
Principles & methods of taxonomy, classical & modern methods of taxonomy of plants, animals and microorganisms. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Herbarium preparation.

UNIT- II: System of classifications **(06 Hours)**
Outline classification of plants, animals & microorganisms, structural details: Important criteria used for classification in each taxon. Classification of plants (Benthem and Hooker), animals (Whitaker's) and microorganisms. Prokaryote and eukaryote cell: structural and function of cell wall, mitochondria, chloroplast, ribosomes, E.R., Golgi complex and nucleus.

UNIT- III: Plant hormones and Nitrogen metabolism **(06 Hours)**
Plant hormones - Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Sensory photobiology & Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks. Nitrogen metabolism- Nitrate and ammonium assimilation.

UNIT- IV: Photosynthesis and plant physiology **(06 Hours)**
Photosynthesis - Light reaction and dark reaction fixation C3, C4 and CAM pathways, photorespiratory pathway. Translocation of water, ions, solutes and macromolecules from soil-xylem and phloem, transpiration, introduction to secondary metabolites. Stress physiology. Response of plants to biotic (pathogens and insects) and abiotic (water, temp and salt) stresses.

UNIT- V: Environmental hazards and management **(06 Hours)**
Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Bioremediation; Phytoremediation; Solid waste management: toxic effects and treatments, methods, technologies for management of hospital waste - incineration, autoclaving, mechanical/chemical, microwave, plasma torch, detoxification, advanced wet oxidation and thermal, dry heat.

Total Lecture Hours-30

COURSE OUTCOME

The students are able to

1. Acquire knowledge on the basics in classification and naming plants and herbarium preparation
2. Comprehend systematic classification of plants and animals
3. Understand the biosynthesis and biological role of plant hormones and ecosystem
4. Recognize the correlation between photosynthesis, photoperiodism and nitrogen metabolism
5. Exploit the pollutants and various method of bioremediation

TEXT BOOK(S)

1. Verma, P. S & Agarwal, V. K. (2003). Cytology, Genetics, Evolution and Ecology, S. Chand & Co Ltd.,
2. Verma, S.K. (1999).Text Book of Plant Physiology. S.Chand & Co Ltd.,
3. Srivastava HS and Shankar N. (2008). Plant physiology and Biochemistry, 1st Edition, 7th Reprint (1st Edition): 2018-19, Rastogi Publications, Meerut.
4. Pandey SN and Sinha BK. (2008). Plant Physiology, 4thEdition, VIKAS publishing House Pvt Ltd, New Delhi.
5. Buchanan B, Gruissem W, and Jones R. (2015). Biochemistry and Molecular Biology of Plants, 2nd Edition, Wiley-Blackwell Publishers, USA.
6. Lincoln Taiz and Eduardo Zeiger. (2012). Plant Physiology, 5th Edition, Amazon press, Washington.
7. Goodwin TW and Mercer EI. (1983). Introduction of Plant Biochemistry 2nd Edition, Pergamon Press, Oxford.
8. Harbone JB. (1997). Plant Biochemistry, 5th Edition. Harcourt Asia (P) Ltd., India and Academic Press, Singapore.
9. Fundamentals of Ecology, MCDASH, (1993), Second Edition, TATA Mcgow Hill Publishing Company Limited, New Delhi

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1. Plummer D. (1989). Biochemistry–the Chemistry of life, 1st Edition, McGraw Hill Book Co., London, New York. New Delhi, Paris, Singapore, Tokyo.
2. Taiz L and Zeiger E. (2010). Plant Physiology. 5th Edition. Sinauer Associates, Inc. Publishers, USA.
3. Kumar A and Purohit S. (2003). Plant Physiology- Fundamentals and Applications, 2nd Edition, Agrobios Publishers, India.
4. Hopkins W Gad NPA. Höner. (2009). Introduction to Plant Physiology, 4th Edition, John Wiley & Sons Publishers, USA.
5. Steward FC. (1964). Plants at Work (A summary of Plant Physiology), 22nd Edition, Addison- Wesley Publishing Co., Inc. Reading, Massachusetts, Palo alto, London.
6. Dey PM and Harborne JB. (2000). Plant Biochemistry, 1st Edition, Harcourt Asia (P) Ltd., India & Academic Press, Singapore.
7. H.D.Kumar, (2008). Modern concepts of Ecology, Vikas Publishing House Pvt Ltd, 8th edition,
8. Dr. Biswarup Mukherjee, (2008). Fundamentals of Environment Biology, Silverline publications.
9. Pranav Kumar, Usha Mina (2022). Life Sciences: Fundamentals And Practice Part – II, 6th Edition, Pathfinder Publication - New Delhi.

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1. http://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf
2. https://ncert.nic.in/textbook/pdf/kebo112.pdf
3. https://www.ctahr.hawaii.edu/oc/freepubs/pdf/pnm3.pdf
4. https://ncert.nic.in/textbook/pdf/kebo113.pdf
5. https://byjus.com/biology/plant-growth-regulators/
6. https://icar.org.in/files/mAgMicro.pdfv
7. https://collegedunia.com/exams/calvin-cycle-c-3-cycle-definition-stages-diagram-roducts biology-articleid-1723
8. https://www.nios.ac.in/media/documents/SrSec314NewE/Lesson-10.pdf
9. https://testbook.com/biology/photosynthesis
10. https://ec.europa.eu/echo/files/evaluation/watsan2005/annex_files/WEDC/es/ES07CD.pdf

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