DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

FACULTY OF SCIENCE & TECHNOLOGY

2/1 Year P.G. Programme in Science

(M.Sc.)

As per National Education Policy-2020

(To be implemented from Academic Year-2024-25)

Course Structure and Curriculum

(Outcome Based Credit System)

Subject: Biochemistry

(Effective from 2024-25)

INDEX

PREFACE

Outcome Based Education (OBE) is the educational approach which focuses on student centric education in the context of development of personal, social, professional and knowledge (KSA) requirements in one's career and life. It is the decade ago curriculum development methodology. The educational triangle of *LEARNING-ASSESSMENT-TEACHING* is the unique nature of the OBE approach. The curriculum practices such as Competency Based Curriculum, Taylor's Model of Curriculum Development, Spadys' Curriculum principles, Blooms taxonomy and further use of assessment methodologies like, Norm-reference testing and Criterion reference testing, etc is being practiced since decades. It is also interesting to know that, globally, different countries and universities adopts the curriculum development models/approaches such as, CDIO (Conceive-Design-Implement-Operate), Evidenced Based Education, Systems' Approach, etc as the scientific and systematic approaches in curriculum design.

The authorities of Dr. BabasahebAmbedkarMarathwada University, Aurangabad (M.S.) in-lieu of accreditation standards of National Assessment and Accreditation Council, decided to opt for Outcomes Based Education (OBE). As the part of the decision, different meetings, workshops and presentations were held at the campus of university.

This document is the outcome of different meetings and workshops held at university level and department level. The detailed document is designed and the existing curriculum of the department is transformed in to the framework of OBE. This is the first step towards the implementation of OBE in the department. The document will serve all stakeholders in the effective implementation of the curriculum. The OBE is continuous process for quality enhancement and it will go a long way in order to enhance the competencies and employability of the graduates/Post-graduates of the university department.

Head of Department

OUTCOME BASED EDUCATION

Faculty of Science & Technology

Department of BIOCHEMISTRY

1. **Mission:**

   Mission Statement

   - To provide quality education to the students through state of art and education in biochemistry.
   - To provide a learning environment that helps the students to enhance problem solving skills, be successful in their profession and to prepare students to be lifelong learner by offering solid theoretical & practical foundation in various discipline of biochemistry and educating them about their professional and ethical responsibilities.
   - To provide exposure to students to the latest tools and technologies in the area of biochemistry.
   - To provide research based projects activities in the emerging area of biochemical technology.
   - To develop the man resource with sound knowledge theory & practical in the disciple of biochemistry and the ability to apply knowledge to the benefit of the society at large.

2. **Vision:**

   Vision Statement

- Producing quality students trained in the latest tools and technologies and striving to make university a world leader in the area of biochemistry.
- To achieve academic excellence in biochemistry of imparting in-depth knowledge to the students, facilitating research activities and cater to the ever changing industrial demand & societal needs.
- To be a centre of excellence in the discipline of biochemistry.
- The mission and vision of the organization help in preparation of strategic plan.

3. **Title of the Program (s):**
   a. **Master of Science in Biochemistry**

4. **Program Educational Objectives:**

   The program educational objectives (PEO) are the statement that describes the career and professional achievement after the program of studies (graduation/ post-graduation). The PEO s are driven form question no. (ii) of the Mission statement (What is the purpose of organization). The PEOs can be minimum three and maximum five.

PEO1: To have advance knowledge of biochemistry domain.

PEO2: To provide the professional services to industry, research organization, institutes.

PEO3: To provide the professional consultancy and research support for the relevant organization in the domain of super specialization.

PEO4: To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.

PEO5: To provide, value based and ethical leadership in the professional and social life.

5. Program Outcomes:

The program outcomes (PO) are the statement of competencies/ abilities. POs are the statement that describes the knowledge and the abilities the graduate/ post-graduate will have by the end of program studies.

a. In-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of Biochemistry.
b. Apply/implement interface between, on the one hand, the history of Biochemistry and natural science and, on the other hand, issues pertaining to the areas of modern technology, health, and environment.
c. Skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.
d. Skill in examining specific phenomena theoretically and/or experimentally,
e. Generation of new scientific insights or to the innovation of new applications of Biochemistry research.

6. Course- Program outcome Matrix:

The Program Outcomes are developed through the curriculum (curricular/co-curricular-extra-curricular activities). The program outcomes are attained through the course implementation. As an educator, one must know, ***"to which POs his/her course in contributing?"***. So that one can design the learning experiences, select teaching method and design the tool for assessment. Hence, establishing the Corse-PO matrix is essential step in the OBE. The course-program outcomes matrix indicates the co-relation between the courses and program outcomes. The CO-PO matrix is the map of list of courses contributing to the development of respective POs.

COURSE-PO MATRIX

Course Title	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
Biomolecules	*	*	*				
Molecular Biology	*	*	*				
Cell-Biology Physiology	*	*	*				
Bioenergetics and Metabolism	*	*	*				
Fermentation Technology	*	*	*				

Skill Advance Technique	*	*	*				
Bio-analytical Chemistry			*	*	*		
Advance Molecular Biology			*	*	*		
Enzymology	*		*	*	*		
Skill Advance Technique			*	*	*		
Plant Biochemistry			*	*	*		
Biochemical and Environmental Toxicology			*	*	*		
Field Project or On Job Training			*	*	*		
Biostatics and Research Methodology			*	*	*		
Methods in Molecular Biology	*	*	*	*	*		
Nutritional Biochemistry			*	*	*		
Review of Literature	*	*	*	*	*		
Microbial Biochemistry							
Genetics for Biologist							
Frontier Technologies in Bioscience							
RP-1							
Immunochemistry							
Microbial Biochemistry							
Clinical Biochemistry							
Muscle Biochemistry and Biomembrane							
Plant Biotechnology							
Neurobiochemistry							
Major Research Project							

7. Course Outcomes (for all courses):

The course outcomes are the statement that describes the knowledge & abilities developed in the student by the end of course (subject) teaching. The focus is on development of abilities rather than mere content. There can be 5 to 7 course outcomes of any course. These are to be written in the specific terms and not in general. The list of Course Outcomes is the part of ***Annexure-B*** attached herewith.

8. Set Target levels for Attainment of Course Outcomes:

The course outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment are measured/calculated. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

9. Set Target level for Attainment of Program Outcomes:

The program outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment and program outcome attainment is measured/calculated. The program outcome attainment is governed by curricular, co-curricular and extra-curricular activities including the stakeholders' participation. The direct method and indirect method is adopted to calculate the PO attainment. The direct method implies the attainment by course outcomes contributing to respective program outcomes. And indirect method is the satisfaction/feed-back survey of stakeholders. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

The set target level is the set benchmark to ensure the continuous improvements in the learners/ graduates' performance.

10. Course Attainment Levels:

a. CO attainment is defined/set at three levels;
b. The CO attainment is based on end term examination assessment and internal assessment;
c. The Co attainment is defined at three levels in ascending order-
    i. e.g. For end term and internal examination;
    ii. Level-1: 40% students scored more than class average
    iii. Level-2: 50% students score more than class average;
    iv. Level-3: 60% students score more than class average.
d. The target level is set (e.g. Level-2). It indicates that, the current target is level-2; 50% students score more than class average. The CO attainment is measured and the results are obtained. Based on the results of attainment, the corrective measures/remedial action are taken.
e. CO Attainment= 80% (Attainment level in end term examination) + 20% (Attainment level in internal examination).

11. Program attainment Level:

a. PO attainment is defined at five levels in ascending order;
b. The PO attainment is based on the average attainment level of corresponding courses (Direct Method) and feed-back survey (Indirect method);
c. The PO attainment levels are defined / set as stated below;
    i. Level-1: Greater than 0.5 and less than 1.0 (0.5>1)- Poor
    ii. Level-2: 1.0>1.5-Average
    iii. Level-3: 1.5>2.0-Good
    iv. Level-4: 2.0>2.5-Very Good
    v. Level-5: 2.5>3.0 -Excellent
d. The PO attainment target level is set/defined (say, Level-4). It implies that, the department is aiming at minimum level-4 (very good) in the performance of

abilities by the graduates. Based upon the results of attainment, the remedial measures are taken;

e. PO Attainment= 80% (Average attainment level by direct method) + 20% (Average attainment level by indirect method).

1. **Planned Actions for Course Attainment: NA**
2. **Planned Actions for Program Outcome Attainment: NA**

Dr.BabasahebAmbedkarMarathwada University, Aurangabad

Two Years Post Graduate Program

Course and Credits Distribution of two years/Master's Degree Program with Entry and Exit Option

Eligibility

M.Sc. Biochemistry Program

The student joining M. Sc. Biochemistry should have studied the following subjects at B.Sc. level

1. Biochemistry
2. Chemistry and Any one of the following subject

Botany / Zoology / Microbiology/ Biotechnology/ Environmental Science/ Molecular Biology/ Food Technology/Dairy Science/Home Science/Fishery with background in basic genetics

Students with non-biochemistry background at B.Sc. level should have studied Chemistry as one of the subject.

The optional courses to be offered will be decided by the department depending upon the faculty / expertise available.

Two-Year Post- Graduate Program
Course and credit Distribution of Two years/One YearPG/Master's Degree program with Entry and Exit Option

Year/Level	Sem	Major Subject		RM	OJT/FP	RP	Credits	Degree
		DSC Core Mandatory	DSE (Elective)					
First Year 6.0	I	3(4)+2=14	4	4	--	--	22	PG Diploma (after 3 Years of Degree)
	II	3(4)+2=14	4	--	4 Complete during summer break	--	22	
Cum.Cr.for PG Diploma		28	8	4	4	--	44	
Exit Option with Post-graduate Diploma (44 Credits) after first year or two semester with completion of course equivalent to 44 credits								
Year/Level	Sem	Major Subject		RM	OJT/FP/LC	RP	Credits	Degree
		DSC Core Mandatory	DSE (Elective)					
Second Year 6.5	III	3(4)+2=14	4	--		4 Minor	22	PG Degree after 3 Years UG or PG Degree after 4 Years UG
	IV	2(4)+2=10	4	--	--	6 Major	22	
Cum.Cr.for 1 Year PG Degree		22	8	4	4	10	44	
Cum.Cr.for 2 Year PG Degree		50	16	4	4	10	88	
2 years (4 Sem.) PG Degree 92 (Credits) after three year UG Degree or 1 Year (2 Sem.) PG Degree (44 Credits) after 4 year UG degree								
8.0		Course work min.12 credits 3(4)	Training in Teaching/education/pedogogy:4	16+Ph.D. Work				Ph.D. in subject

Note: DSC is based on Specialization

Abbrevation:

Major: Comprising Mandatory- is based on Specialization

DSE: Discipline Specific Elective

OJT: On the Job Training

FP: Field Project (Corresponding to the Major (Core) Subject

RP: Research Project (Corresponding to the Major (Core) Subject

Internship/Apprenticeship: Corresponding to the Major (Core) Subject

AS PER NEP 2020

Illustrative Credit distribution structure for Two Years Programme with Multiple Entry and Exit options –

(Discipline Specific Core in Biochemistry

Class: M.Sc. First Year
Semester: Ist Semester
Subject: Biochemistry

Course and Credit Distributions Structure for Two Years Post Graduate Programme with Multiple Entry Exit Options

Class: M.Sc. First Year, Semester: First Semester, Subject: Biochemistry

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Discipline Specific Core Course (DSC) Mandatory	BIC/MJ/500	Bimolecules	2	-	2	-	14
	BIC/MJ/501	Molecular Biology	2	-	2	-	
	BIC/MJ/502	Bioenergetics and Metabolism	2	-	2	-	
	BIC/MJ/503	Practical Based on BIC/MJ/500	-	4	-	2	
		Practical Based on BIC/MJ/501	-	4	-	2	
		Practical Based on BIC/MJ/502	-	4	-	2	
	BIC/MJ/504 BIC/MJ/504P	Skill/ Advance Technique Practical Based on BIC/MJ/504P	2	2	1	1	
DSE (Choose any one from pool of Course)							4
	BIC/DSE/505 BIC/DSE/505P	Cell Biology and Physiology Practical Based on BIC/DSE/505	2	4	2	2	
	OR						
	BIC/DSE/506 BIC/DSE/506P	Fermentation Technology Practical Based on BIC/DSE/506	2	4	2	2	
RM	BIC/RM/507	RM	4	-	4	-	4
			14	**18**	**13**	**09**	**22**

Class: M.Sc. First Year: Biochemistry

First Semester: Major Mandatory - *DSC-Based on specialisation

1. DSC-1: BIC/MJ/500-Biomolecules

   DSC-2: BIC/MJ/501-Molecular Biology

   DSC-3: BIC/MJ/502-Bioenergetics and Metabolism

   DSC-4: BIC/MJ/503-Practical Based on BIC/MJ/500, 501 and 502.

   DSC-5: BIC/MJ/504- Skill/Advance Technique.

   DSC-5: BIC/MJ/504- Practical Based on BIC/MJ/504P

2. DSE—: (Choose any one from Pool /Basket)
   1. : BIC/DSE/505-Cell Biology and Physiology
   2. BIC/DSE/505- Practical Based on BIC/DSE/505P
   3. BIC/DSE/506–Fermentation Technology
   4. BIC/DSE/506- Practical Based on BIC/DSE/506P

3. RM-1: ----- BIC/RM/507- Research Methodology

Class: M.Sc. First Year
Semester: II Semester
Subject: Biochemistry

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Discipline Specific Core Course (DSC) Mandatory	BIC/MJ/508	Bioanalytical Chemistry	2	-	2	-	14
	BIC/MJ/509	Advance Molecular Biology	2	-	2	-	
	BIC/MJ/510	Enzymology	2	-	2	-	
	BIC/MJ/511	Practical Based on BIC/MJ/508	-	4	-	2	
		Practical Based on BIC/MJ/509	-	4	-	2	
		Practical Based on BIC/MJ/510	-	4	-	2	
	BIC/MJ/512 BIC/MJ/512P	Skill/ Advance Technique Practical Based on BIC/MJ/512P	2	2	1	1	
DSE (Choose any one from pool of Course)	BIC/DSE/513 BIC/DSE/513P	Plant Biochemistry Practical Based on BIC/DSE/513P	2	4	2	2	4
	OR						
	BIC/DSE/514 BIC/DSE/514P	Biochemical and Environmental Toxicology Practical Based on BIC/DSE/514P	2	4	2	2	
OJT/Field Project	BIC/RM/515	Field Project or On Job Training	-	8	-	4	4
			10	**26**	**9**	**13**	**22**

Class: M.Sc. First Year: Biochemistry

Second Semester:

1. DSC-6: :BIC/MJ/508-Bioanalytical Chemistry.
   DSC-7: - BIC/MJ/509-Advanced Molecular Biology.
   DSC-8:- BIC/MJ/510-Enzymology.
   DSC-9:- BIC/MJ/511- Practical Based on BIC/MJ/508, 509 and 510
   DSC-10: - BIC/MJ/512- Skill/Advance Technique.
   DSC-10: BIC/MJ/512- Practical Based on BIC/MJ/512P

2. DSE- 3&4 (T/P): (Choose any one from Pool /Basket)
   1. - BIC/DSE/513-Plant Biochemistry.
   2. BIC/DSE/513- Practical Based on BIC/DSE/513P
   3. - BIC/DSE/514-Biochemical and Environmental Toxicology.
   4. BIC/DSE/514- Practical Based on BIC/DSE/514P

5. BIC/OJT/FP/515: Field Project or On Job Training.

Class: M.Sc. Second Year
Semester: III Semester
Subject: Biochemistry

Course type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Discipline Specific Core Course (DSC) Mandatory	BIC/MJ/ 516	Biostatics and Research Methodology	2	-	2	-	14
	BIC/MJ/ 517	Methods in Molecular Biology	2	-	2	-	
	BIC/MJ/ 518	Nutritional Biochemistry	2	-	2	-	
	BIC/MJ/ 519	Practical based on BIC/MJ/516	-	4	-	2	
		Practical based on BIC/MJ/ 517	-	4	-	2	
		Practical based on BIC/MJ/518	-	4	-	2	
	BIC/MJ/ 520	Review of Literature	-	4	-	2	
							4
DSE (Choose any one from pool of courses)	BIC/DSE/ 521 BIC/DSE/ 521P	Genetics for Biologists Practical Based on BIC/DSE/521P	2	4	2	2	
		OR					
	BIC/DSE/ 522 BIC/DSE/ 522P	Frontier Technologies in Bioscience Practical Based on BIC/DSE/522P	2	4	2	2	
RP/Field Project	BIC/RP/ 523	**RP-1**	-	8	-	4	04
			08	**28**	**08**	**14**	**22 credits**

Class: M.Sc. Second Year: Biochemistry

III Semester:

1. DSC-11: :BIC/MJ/516-Biostastics and Research Methodology.
   DSC-12: - BIC/MJ/517-Methods in Molecular Biology.
   DSC-13:- BIC/MJ/518-Nutritional Biochemistry.
   DSC-14: - BIC/MJ/519- Practical based on BIC/MJ/516, 517 and 518.

2. DSE—5/6(T/P): (Choose any one from Pool /Basket)
   1: -BIC/DSE/520- Review Of Literature
   2 : BIC/DSE/521 Genetics for Biologists.
   3 :BIC/DSE/521P Practical Based on BIC/DSE/521P
   4: BIC/DSE/522 Frontier Technologies in Bioscience
   5: BIC/DSE/522P Practical Based on BIC/DSE/522P

3. BIC/RP/523: -- RP-1

Class: M.Sc. Second Year
Semester: IV Semester
Subject: Biochemistry

Course type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Discipline Specific Core Course (DSC) Mandatory	BIC/MJ/524	Immunochemistry	2	-	2	-	12
	BIC/MJ/525	Microbial Biochemistry	2	-	2	-	
	BIC/DSE/526	Clinical Biochemistry	2	-	2	-	
	BIC/MJ/527	Practical Based on BIC/MJ/524	-	4	-	2	
		Practical Based on BIC/MJ/525	-	4	-	2	
		Practical Based on BIC/MJ/526	-	4	-	2	
DSE (Choose any one from pool of courses)	BIC/DSE/528 BIC/DSE/528P	Muscle Biochemistry and Biomembrane Practical Based on BIC/DSE/528P	2	4	2	2	04
	OR						
	BIC/DSE/529 BIC/DSE/529P	Plant Biotechnology Practical Based on BIC/DSE/529P	2	4	2	2	
	OR						
	BIC/DSE/530 BIC/DSE/530 P	Neurobiochemistry Practical Based on BIC/DSE/530P	2	4	2	2	
RP/Field Project	BIC/RP/531-2	Major Research Project	-	12	-	6	06
			8	**28**	**8**	**14**	**22 credits**

Class: M.Sc. Second Year: Biochemistry

Forth Semester:

1. DSC-15: **:** **-** BIC/MJ/522-Immunochemistry.

   DSC-16:: **-** BIC/MJ/523-Microbial Biochemistry.

   DSC-17::- BIC/DSE/526 Clinical Biochemistry

   DSC-18::- BIC/MJ/527 Practical Based on BIC/MJ/524, 525, 526

2. DSE—7&8 (T/P): (Choose any one from Pool /Basket)
   1: - BIC/DSE/528**-** Muscle Biochemistry and Biomembrane
   2. BIC/DSE/528P- Practical Based on BIC/DSE/528P
   3. BIC/DSE/529- Plant Biotechnology
   4. BIC/DSE/529P - Practical Based on BIC/DSE/529P
   5. BIC/DSE/530- Neurobiochemistry
   6. BIC/DSE/530P- Practical Based on BIC/DSE/530P

3. BIC/RP/531-2: Major Research Project

M. Sc. Biochemistry Program Contents

SEMESTER I
Foundation Courses

Course Code: BIC/MJ/500
Course Name: Biomolecules **Total Credit : 02**
Unit I Credit: 0.5
Carbohydrates and their derivatives
Monosaccharides and related compounds, glycosidic bond, disaccharides, polysaccharides, heteropolysaccharides.

Lipids
Fatty acids, Phospholipids, Cholesterol and related steroids, other biological lipids.Glycerolipids, sphingolipids, the eicosanoids.

Unit II Credit: 0.5
Nucleotides and nucleic acids
Genetic significance of nucleic acids, structural properties of DNA, chemical synthesis of DNA, conformational behavior of RNA, nucleoproteins.

Analysis of nucleic acids
Isolation of nucleic acids, radioactive labeling of nucleic acids, restriction endonucleases, plasmids, purification of complementary DNA strands, hybridization by blotting, determining base sequence of DNA, preparation of DNA complementary to RNA.

Unit III Credit: 0.5
Amino acids, peptides and polypeptides
Amino acids, peptides and polypeptides, determination of amino acid composition of proteins, determination of amino acid sequence of proteins, chemical synthesis of peptides and polypeptides.

Unit IV Credit: 0.5
3-D structure of proteins
Information for folding, forces that determine folding, hierarchy of structural organization, functional diversification of proteins.

Characterization and purification of proteins
Methods of protein characterization, methods of protein purification.
Centrifugation, Dialysis, Lyophilization, Ultrafilteration, Chromatography, Electrophoresis,

Course Code: BIC/MJ/501
Course Name: Molecular Biology **Total Credit : 02**
Unit I Credit: 0.5
DNA replication
Semiconservative replication of DNA, DNA synthesis in prokaryotes, replication of a viral chromosome, replication of the E. coli chromosome, DNA synthesis and chromosomal replication in eukaryotes, control of DNA replication, specific inhibitors of DNA replication, DNA degradation, DNA repair, DNA recombination.

Unit II Credit: 0.5

RNA synthesis

Different classes of RNA, DNA dependent synthesis of RNA, eukaryotic transcription, other RNA synthesis, posttranscriptional modification and processing of RNA, Degradation of RNA by ribonucleases, inhibitors of RNA metabolism.

Unit III Credit: 0.5

Protein synthesis

The cellular machinery of protein synthesis, steps in translation, deciphering the genetic code, code word assignments, inhibitors of protein synthesis, posttranslational modifications of proteins, intracellular protein degradation, lysosomes and protein degradation.

Unit IV Credit: 0.5

Regulation of gene expression in prokaryotes

Regulation of gene expression in *E. coli*, regulation of gene expression in bacterial viruses.

Regulation of gene expression in eukaryotes

Gene regulation in unicellular eukaryotes, gene regulation in multicellular eukaryotes, regulatory phenomena associated with development.

Course Code: BIC/MJ/502

Course Name: Bioenergetics and Metabolism Total Credits: 02

Unit I Credit: 0.5

Bioenergetics:

Energy transformation, Laws of thermodynamics, Biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes. Gibbs energy, free energy changes and redox potentials, phosphate potential, ion electrochemical potentials, proton electrochemical potential, membrane potentials, photons energy interconversions. Chemo-taxis and chemoreceptors chemo-osmotic theory, ion transport across energy transducing membranes.Influx and efflux mechanisms.Proton circuit and electrochemical gradient, the transport and distribution of actions, anions and ionophores.Uniport, antiport and symport mechanisms, shuffle systems.

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization.The Q cycle and the stoichiometry of proton extrusion and uptake; P/0 and H/P ratios.Reversed electron transfer, respiratory controls and oxidative phosphorylation, uncouplers and inhibitors of energy transfer.Fractionation and reconstitution of respiratory chain complexes.

ATP - synthetase complex.Microsomal electron transport, partial reduction of oxygen, superoxides.

Intermediary metabolism: Approaches for studying metabolism.

Unit II Credit: 0.5

Carbohydrates:

Glycolysis, citric acid cycle its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway and its regulation. Alternate pathways of carbohydrate metabolism.Gluconeogensis, interconversions of sugars. Biosynthesis of glycogen, starch and oligosaccharides.Regulation of blood glucose homeostasis.Hormonal regulation of carbohydrate metabolism.

Unit III Credit: 0.5

Lipids

Fatty acid biosynthesis: Acetyl CoA carboxylase, Fatty acid synthase, desaturase and elongase. Fatty acid oxidation: (x, 0, w oxidation and lipoxidation. Lipid Biosynthesis: Biosynthesis of triacyglycerols, phosphoglycerides and sphingolipids, Biosynthetic pathways for terpenes, steroids and Prostaglandins. Ketone bodies: Formation and utilisation. Metabolism of Circulating lipids: chylomicrons, LDL, HDL and VLDL. Free fatty acids. Lipid levels in pathological conditions.

Unit IV Credit: 0.5

Amino Acids

Biosynthesis and degradation of amino acids and their regulation.Specific aspects of amino acid metabolism.Urea cycle and its regulation, In-born errors of amino acid metabolism.

Nucleic Acids

Biosynthesis or purines and pyrimidines, Degradation if purines and pyrimidines
Regulation of purine and pyrimidine biosynthesis, Structure and regulation of ribonucleotidereductase. Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis

Course Code: BIC/MJ/503
Course Name: Practical Based on BIC/MJ/500, 501, 502.

Total Credits: 06

BIC/MJ/500
500: BIOCHEMICAL PREPARATIONS AND ANALYSIS-PRACTICALS

1. General reactions of carbohydrates. Specific reactions of different sugars: arabinose, xylose, fructose, galactose, sucrose, maltose and lactose.
2. General reactions of proteins and amino acids. Precipitation reactions of albumins and globulins.
3. General reactions of lipids and cholesterol.
4. Isolation and estimation of cholesterol from brain.
5. Isolation and estimation of glycogen/starch.
6. Preparation of Casein from milk.
7. Crystallization of albumin.
8. Estimation of proteins in biological samples:
    a. Biuret method.
    b. Folin-Lowry method.
    c. UV method.
    d. Bradford's dye binding method.
9. Titration curve of amino acid and calculation of PK and PI value.
10. Estimation of amino acids by formal titration.
11. Estimation of amino acid by Ninhydrin method.
12. Estimation of tyrosine by Million's –reaction.
13. Identification of N-terminal group of proteins by Sanger's method.
14. Estimation of fructose in Fruit-juice.

Course Name: Practical Based on BIC/MJ/501

1. Specific Reactions for Individual Amino Acids:
    a) Xanthoproteic Test
    b) Millon's Test

c) Hopkin's Cole Test
d) Lead-Sulfide Test
e) Ehrlich Test
f) Sakaguchi Test
g) Nitroprusside Test
h) Biuret Test
i) Ninhydrin Test

2. TESTS ON AMINO ACIDS:
3. QUALITATIVE TESTS FOR LIPIDS:

Physical Test:

a) Grease spot test.
b) Test for free fatty acids
c) Emulsification
d) Saponification test
e) Tests for unsaturation of fatty acids
f) Isolation of free fatty acids from soap
g) Tests for Glycerol:Acrolein test, Dichromate Test

4. QUANTATIVE TESTS FOR LIPIDS:
   a) Determination of Iodine Number
   b) Qualitative Test of Cholesterol
   c) Enzymatic Methods

Other Tests for Cholesterol:

Salkowski's Test (H2SO4 Test)

Formaldehyde-H2SO4 Test

5. Estimation total sugar concentration by
   a. Phenol-H_2SO_4 method
   b. Anthrone method
6. Estimation of glucose concentration by Glucose oxidase method.
7. Determination of fructose concentration by resorcinol method.
8. Estimation of vitamin C concentration by DCPIP method.

Course Name: Practical Based on BIC/MJ/502

502: BIOCHEMICAL & BIOPHYSICAL METHODS

1. Effect of solvent system on the Rf value of two solutes using TLC.
2. Separation of purines and pyrimidines by Paper Chromatography.
3. Separation of amino acids by Paper Chromatography.
4. Separation of sugars by TLC.
5. Isolation & Characterization of Brain Lipids by Solid phase extraction and TLC.
6. Separation of amino acids by Paper Electrophoresis (Demonstration).
7. Separation of amino acids by Ion-exchange Chromatography (Demonstration).
8. Separation of Serum proteins by Paper Electrophoresis.
9. Measurement of pH of a biological fluid using pH meter.
10. Absorption spectra of phenol red, amino acids and nucleic acid.
11. Verification of Beer's law and determination of molar extinction coefficient using p-nitro phenol.
12. Isolation and spectrophotometric characterization of plant pigments.
13. Isolation of Mitochondria from Rat liver by density gradient centrifugation (Demonstration).
14. Viscosity measurement of Bovine serum albumin.

15. Measurement of inversion of sucrose by Polarimetry.
16. Measurement of refractive index of biological sample.
17. Dialysis.

Recommended Books:

1. Hawk's Physiological chemistry
2. Practical Biochemistry by T Plummer
3. Practical Biochemistry by J Jayaraman
4. Klemir and others: practical Biologicalchemistry.
5. Practical Biochemistry – Koch and Hank Dunn and Drell.
6. Practical Biochemistry-Sawhney (2000)
7. Varley's Practical clinical Biochemistry-Ed.AlanW. Gowenlock (Heinemann Medical Books).

Course Code: BIC/MJ/504

Course Name: Skill/Advance Technique. Total Credits: 01

Unit I: Microscopy Principles and Applications. Credit: 0.5

Overview of current microscopy techniques, Fundamentals of Optics, Light-matter interactions, Confocal Microscopy, Multiphoton Microscopy, Labeling and Sample Preparation, Advanced Microscopy Techniques - Forster resonance energy transfer (FRET), fluorescence lifetime imaging (FLIM), super resolution techniques (STED, STORM, PALM, SIM), single-molecule techniques, Microscopy Applications.

Unit II: Spectroscopy Credit: 0.5

Principle of spectroscopy. Concept of absorptions, transmission, scattering, phosphorescence, fluorescence, luminescence, diffraction spectra. Principle, instrumentation, working and application of – UV, visible and IR spectroscopy, spectro-fluorimetry, luminometry. Principle, instrumentation, working and application of- Nuclear Magnetic Resonance (NMR), electron spin resonance (ESR), matrix assisted LASER desorption/ionizationtime of flight-mass spectroscopy (MALDI-TOF MS). X-ray crystallography.

Course Code: BIC/MJ/504P

Course Name: Practical Based on BIC/MJ/504P Total Credits: 01

1. Microscopy Techniques
2. Separation of amino acids by thin layer chromatography
3. Separation of sugars by paper chromatography
4. Identification of lipids by thin layer chromatography
5. Affinity chromatography,
6. Ion exchange chromatography
7. Gel filtration chromatography
8. Gasliquid chromatography (GLC)
9. High Pressure liquid chromatography (HPLC)
10. PCR
11. Amplification of an unknown target –inverse PCR

Course Code: BIC/DSE/505

Course Name: Cell Biology, Physiology Total Credits: 02

Cell Biology

Unit I Credit: 0.5

Cell classification: Cell variability (size, shape, complexity, functions).

Structural Organisation of prokaryotic and eukaryotic cells.The ultra structure of nucleus, mitochondria, endoplasmic reticulum, rough and smooth, Golgi apparatus, lysosomes and peroxisomes and their functions. Plant and animal cells: variation in structure and function.

The cytoskelton - microtubules and microfilaments.

Types of tissues, epithelium - types, epithelial apices - glycocalyx, microvilli.The basement membrane - structural features and characteristics.The extracellular matrix-collagen, elastin, fibrillin, fibronectin, laminin and protroglycans.

Unit II Credit: 0.5

Culture techniques to study cell division - cell division by mitosis and meiosis.Cell cycle.

Cell differentiation - organogenesis, morphological, functional and biochemical maturation of tissues.

Biochemistry of cancer - carcinogenesis, characteristics of cancer cell, agents promoting carcinogenesis.

Physiology

Unit III Credit: 0.5

Blood**:** Composition and functions of plasma, erythrocytes including Hb, leukocytes and thrombocytes plasma proteins in health and diseases.

Blood coagulation - mechanism and regulation. Fibrinolysis, transfers of blood gases oxygen and carbon dioxide. Role of2,3 DPG, Bohr effect and chloride shift.

Hydrogen ion homeostasis- Factors regulating blood pH - buffers, respiratory and renal regulation. Acid-base balance - metabolic and respiratory acidosis and alkalosis.

Unit IV Credit: 0.5

Digestive system: Composition, functions and regulation of saliva, Gastric, pancreatic, intestinal and bile secretions - digestion and absorption of carbohydrates, lipids, proteins, nucleic acids, minerals and vitamins.

Excretory system: Structure of nephron, formation of urine, glomerular filtration, tubular re-absorption of glucose, water and electrolytes - tubular secretion.

Regulation of water and electrolyte balance, role of kidneys and hormones in their maintenance.

The endocrine glands: secretion and function - reproduction, pregnancy and lactation. Biochemistry of vision.

Course Code: BIC/DSE/505P

Course Name: Practical Based on BIC/MJ/505P Total Credits: 02

1. Isolation of mitochondria
2. Determination of starch in plant tissues
3. Isolation of casein from milk
4. Estimation of chlorophyll concentration in the chloroplast suspension

Course Code: BIC/DSE/506

Course Name: Fermentation Technology Total Credits: 02

Fermentation Technology

Unit I: Credit:0.5

Bioreactors: Design of a basic fermenter: Design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices. Calculations for designing a bioreactor. Instrumentation and control of bioprocesses (Physical and chemical sensors for the medium and gases., online sensors for cell properties, off-line analytical methods Biosensors , computer control of fermentation process) Different Bioreactor configurations: (Basic construction and types for distribution of gases): Tube reactors, Packed bed reactors, Fluidized bed reactors, cyclone reactors, Trickle flow reactors, Reactors for specialized applications: Alcohol fermentation.

Unit II Credit: 0.75

Fermentation process: Development of Fermentation Process: Screening and Isolation of microorganisms, Strain improvement of the selected organisms ,designing of fermentation media for lab scale experiments, inoculum development and production; inoculum development strategies and procedure; storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentations (Economic considerations) Growth of cultures in the fermenter: Kinetics of growth in Batch culture, continuous culture w.r.t. substrate utilization, specific growth rate, substrate utilization kinetics; steady state in a chemostat; Fed batch fermentations; yield of biomass, product; calculations for productivity.

Unit III Credit: 0.75

Industrial fermentation: Study of industrial fermentation processes with respect to: Microorganism, strain improvement (if any), media, production parameters, type of reactor and type process, downstream processing (involving separation,purification packaging etc.) Citric acid, penicillin, amylases, ethanol Novel fermentation processes:Xanthan, PHB Downstream processing :Separation of insoluble products (sedimentation, filtration, centrifugation, coagulation and flocculation) Cell Disruption (Mechanical methods, Nonmechanical methods) Separation of soluble products(Liquid-liquid extraction, aqueous two-phase extraction, precipitation, adsorption, Dialysis, electro-dialysis, ultra-filtration and micro-filtration, cross-flow ultra-filtration and micro-filtration.)Extraction: Solvent extraction,two phase liquid extraction, whole broth extraction Aqueous multiphase extraction. Purification – crystallization and significance.

Course Code: BIC/DSE/506P

Course Name: Practical Based on BIC/MJ/506P Total Credits: 02

1. Random and strategic screening for a metabolite (screening for citric acid producing organisms)
2. Screening, enrichment and isolation for a secondary metabolite producer from the environment crowded plate technique for antibiotic producing organisms
3. Determination of TDP & TDT of E .coli for designing of a sterilizer
4. Determination of Growth curve of yeast and compute growth rate & growth yield
5. Strain improvement of the industrially important isolate (A.niger / yeast) using EtBr for Higher yield of the product

6. Media balancing experiments: carbon and nitrogen as variables (in alcohol fermentation)
7. Alcohol Fermentation: using different substrates and its downstream processing.
8. Production of Organic acid /s by fermentation
9. Antibiotic fermentations Penicillin (up to bioassay)
10. Microbial Enzyme production and its characterization-Amylase
11. Bio insecticide / Bio fertilizers: isolation production purification and assay
12. Microbial leaching-using Thiobacillus thiooxidanse (NCIM strain)
13. Effluent treatment –
    A] Dye degradation by microbial cultures
    B] Reduction in COD/BOD physical, chemical and biological treatments

Course Code: BIC/RM/507
Course Name: Research Methodology Total Credits: 4

UNIT I- Research Methodology

Meaning of research, Objectives of research, Types of research, Research approaches, Significance of research, Research methods versus methodology, Research and scientific methods, Research processes, Criteria for good research problem, Selecting the problem, Necessity of defining the problem, Techniques involved in defining a problem
systematic review of literature, preparation of research proposal/ synopsis, Research Ethics (Issues relating to referencing and documentation, copyrights, plagiarism), Impact Factor, H-Index, Citation Index, references/bibliography, structuring the thesis, use of software in thesis writing

UNIT II – Data Collection and Processing

Measurements in Research, Measurement Scales, Sources of errors in measurement
Collection of primary data: Observation Method, Interview Method, through questionnaires, through schedules, difference between questionnaire and schedule,
Collection of secondary data: Selection of appropriate methods for data collection, Case study method
Data processing: processing operations - editing, coding, classification, tabulation, graphical representation, types of analysis, Statistics in research, Dispersion and Asymmetry, Measures of Relationship, Regression Analysis

UNIT III- Testing of Hypothesis

Basic Concepts Concerning Testing of Hypotheses, Procedure and Flow diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses, Hypothesis Testing of Correlation Coefficients and Limitations of the Tests of Hypotheses
Chi-Square Test, Steps Involved in Applying Chi-square Test, Important Characteristics of Chi-Square Test, t-test, p-value; use of software in statistical analysis, Analysis of Variance (ANOVA), Analysis of Co-Variance (ANOCOVA)

UNIT IV- Research Funding

Funding Agency (National and International), Fellowships at national and international levels, conferences and symposium, testimonial, reference letter, preparation of manuscript and its submission, writing of innovative project proposal and its submission.

SEMESTER II

Course Code: BIC/MJ/508
Course Name: Bio-analytical Chemistry Total Credits: 2

Unit I Credit: 0.5

Isomerism: Structural isomerism, Stereoisomerism, geometrical isomerism (E & Z nomenclature)

Free radicals in **biological systems:** Oxygen as a free radical in the autooxidation of fats. Antioxidants (Free radical inhibitors in the cell such as vitamin A, vitamin E, vitamin C, Se etc.)

Stereochemistry: Optical isomerism, optical activity, meso-compounds, specific rotation, chirality, chiral center, enantiomers, diastereoisomers, D L, R S, threoerythro notations, conformation and configuration, dihedral angles, conformational analysis of ethane, n-butane, cyclohexane, monoand di-substituted cyclohexane, monosaccharides, boat and chair forms, eclipsed, gauche and staggered conformations, axial and equatorial bonds. Anomers and mutarotation, glycoside, epimers, glucopyranose, fructopyranose, periodic acid oxidation of sugars.

Unit II Credit: 0.5

Water: Physical properties and structure of water, hydrogen bonding, ionization of water, pH scale, acids-bases, Handerson-Hasselbalch equation, buffers, ionization behaviour of amino acids and proteins, titration curve, buffer solutions and their action.

Radioisotope techniques: Nature of radioactivity, properties of (α, β and λ-rays, measurement of radioactivity, use of radioisotopes in research. *In vivo and in vitro* labelling techniques, double labelling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography.

Unit III Credit: 0.5

Viscosity: Its measurement, viscosity of macromolecules, molecular weights of biomolecules. Sedimentation of macromolecules, centrifugation techniques and their applications, differential centrifugation, density gradient 'and ultracentrifugation techniques. Subcellular fractionation.

Electrophoretic techniques: Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing.

Unit IV Credit: 0.5

Chromatography: Paper, TLC, Adsorption, partition, ion-exchange, reverse phase, gel filtration, affinity, gas chromatography, HPLC (High Pressure Liquid Chromatography).

Spectroscopy: Basic concepts and applications of X-ray diffraction, NMR, ESR, UV, IR, fluorescence, Raman, mass spectroscopy in structure determination of organic and biomolecules, CD and ORD.

Microscopy: Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, freeze-fracture techniques, specific staining of organelles or marker enzymes.

Course Code: BIC/MJ/509
Course Name: Advanced Molecular Biology Total Credits: 2

Unit I Credit: 0.75
Recombinant DNA Technology

Methods of creating recombinant DNA molecule, splicing, properties of restriction endonucleases and their mode of action, selection/screening, construction of DNA library, genomic VscDNA library, chemical synthesis of gene, cloning vectors (X-phage, plasmid, M-13 phage, cosmid) shuttle vectors, yeast and viral vectors, expression vectors, uses of cloned gene, subcloning, sequencing by Sanger's method, proteins production in bacteria, site directed mutagenesis, RFLP, PCR, DNA finger printing, antisense-RNA technology, chromosomal walking.

Unit II Credit: 0.50
Hybridoma Technology

Monoclonal antibodies, mycelium cell fusion, selection of hybrids, hybridomas, protoplast fusion and HAT-medium, screening assays, purification and application of monoclonal antibodies.

Unit III Credit: 0.75
Plant and Animal Cell Culture
Micropropagation, somatic cell culture, somaclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and vectorless methods), production of transgenic plants and animals, production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture, applications.

Course Code: BIC/MJ/510
Course Name: Enzymology Total Credits: 2
Unit I Credit: 0.5
Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. Michaelis pH functions and their significance.
Classification of multisubstrate reactions with examples of each class.Kinetics of multisubstrate reactions.Derivation of the rate of expression for Ping Pong and ordered Bi Bi reaction mechanism. Use of initial velocity, inhibition and exchange studies to differentiate between multisubstratereaction mechanisms.
Concept of Convergent and Divergent evolution of enzymes.

Unit II Credit: 0.5
Methods of examining enzyme-substrate complexes.
Flexibility and conformational mobility of enzymes.
Methods for measuring kinetic and rate constants of enzymic reactions and their magnitudes.
Enzymes Turnover and methods employed to measure Turnover of enzymes. Significance of enzymes Turnover.

Unit III Credit: 0.5

Protein - Ligand binding, including measurement, analysis of binding isotherms.Co-operativity phenomenon.Hill and Scatchard Plots.

Allosteric enzymes, Sigmoidal kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance.

Immobilized enzymes and their industrial applications.Effect of partition on kinetics and performance with particular emphasis on changes in pH and hydrophobicity.

Unit IV Credit: 0.5

Multienzymesystem : Occurrence, isolation and their properties. Polygenic nature of multienzyme systems.Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complexes.Immobilized Multienzyme Systems and their applications.

Structure and function of coenzymes

Thiamine pyrophosphate, Pyridoxal phosphate, Nicotinamide, flavins, phosphopentetheine, alfa-lipoic acid, biotin, folate, vitamin B12, Iron containing coenzymes, coenzymes in methanogenesis.

Porphyrines

Porphyrin nucleus and classification, important metalloporphyrinsoccuring in nature, detection of porphyrins Spectrophotometry, bile pigments, chemical and physiological significance by and fluoroscence.

Mechanisms of enzyme catalysis

Enzyme catalyst and other chemical catalyst, unique features of enzyme catalysts, trypsin family of enzymes, chymotrypsin catalytic mechanism, carboxipeptidaseA, pancreatic RNAase A, lysozyme, lactate dehydrogenase.

Course Code: BIC/MJ/511

Course Name: Practical Based on BIC/MJ/508,509,510 Total Credits: 6

Practical Based on BIC/MJ/508

1. **Chromatography:**
   a] Separation and identification of amino acid mixture by
      i] Paper chromatography technique.
      ii] Electrophoresis technique
   b] Thin layer chromatographic separation of sugars, amino acids and membrane lipids
2. **Colum Chromatography:** Extraction, Purification and Isolation of metabolic plant products.
3. **Polyacrylamide gel:** Separation and identification of serum proteins by polyacrylamide/agarose gel electrophoresis.
4. **High Pressure liquid Chromatography:** Separation of protein by gel filtration. Separation of metabolic products using HPLC, Separation of proteins by ion exchange chromatography.
5. **Laboratory Solution Preparation:** Basic concepts of preparing solutions, Preparation

of simple inorganic salt solutions, Preparations of acid and base solutions. Normality, Saturated, Solution, Solute, Solvent, Standard Solution, Supersaturated Solution, Distilled or Deionized Water-Which Do I Need, Prepare Buffer Solutions.

6. **Set up a Practical Lab. Room:** Safety Essentials • Eyewash/Body Drench • Spill Control and Clean-up Materials • Fire Extinguisher • Chemical-resistant Gloves and Aprons • Chemical Splash Goggles • Telephone Available for Emergency Use • Chemical First Aid Kit • Good Ventilation Equipment • Electronic Balance • Magnetic Stirrers • Volumetric Flasks • Graduated Cylinders • Water Purification System • Bottles • Labels

Practical Based on BIC/MJ/509

1. Isolation of DNA from bacterial, plant and animal cells.
2. Estimation of DNA by Diphenylamine method.
3. Isolation RNA from yeast cells.
4. Estimation of RNA BY Orcinol method.
5. Estimation of DNA and purity determination by UV absorption method.
6. Determination of melting temperature (Tm).
7. Isolation of plasmid DNA from E. coli.
8. Detection and differentiation of open circular, linear and closed covalent circular plasmid DNA by submarine gel electrophoresis.
9. Transformation of E. coli with ampicillin resistant plasmid.
10. Trasfection of M13 DNA into E. coliJM103.
11. Isolation of phageM13.
12. Isolation of single and double standard M13DNA.
13. Conjugation: Use of broad host range plasmid RP in demonstrating conjugation transfer of plasmid bacteria.
14. Catabolite repression: Evidence of B-Galactosidase isduction in presence of lactose in E. coli lac strains.

Practical Based on BIC/MJ/510

1. Identification and puantitation of activity of amylase/ amylase/ cellulose/amyloglucosidase/invertase/alkaline phosphatase/Urease (salivary/microbial/animal/plant source). Trypsin
2. Determination of specific activity.
3. Determination of activity in presence of activators.
4. Determination of activity in presence of inhibitors.
5. Determination of optimum temperature.
6. Determination of Km.
7. Determination of Competitive, non-competitive inhibitors.
8. Immobilization of enzymes (demonstration only).

Course Code: BIC/MJ/512-
Course Name: Skill/Advance Technique Total Credits: 1
Unit I: Chromatography Credit: 0.5

Basic Principles, Instrumentation, working and applications of partition chromatography (Paper), absorption chromatography (TLC, HPTLC, Coloumn), affinity chromatography, ion exchange chromatography, gel filtration chromatography, gasliquid chromatography (GLC), high Pressure liquid chromatography (HPLC). Applications: GC-MS, HPLC-MS and LC-MS/MS.

Unit II- Polymerase Chain Reaction (PCR) and Sequencing Polymerase Chain Reaction (PCR) Credit: 0.5

A. PCR –Primer design, standard PCR/ optimization of PCR conditions, basic principle, enzymes used with respect to their properties, amplification on various types of Double Stranded template DNA.

B. Conventional PCR, Principle, Potential and Limitations

C. Types of PCR ----------

a. PCR with degenerate primer

b. Amplification of an unknown target –inverse PCR

c. Amplification assuming authenticity of amplified amplicon –Nested PCR,

d. Combination of complementary oligostrands a specific primer to identify insertion of an unknown in a known DNA –Ligation Mediated PCR

e. Introduction of small, insertion, small deletion, mismatches PCR for mutagenesis –site directed mutagenesis

f. Error prone PCR –to identify catalytic domain, active site and essential region of an enzyme

g. Quantification of mRNA –Reverse Transcriptase PCR, Real –Time RT PCR

Course Code: BIC/MJ/512P

Course Name: Practical Based on BIC/MJ/512P Total Credits: 1

1. Advanced Microscopy
2. Thin layer chromatography
3. Polyacrylamide gel electrophoresis (PAGE)
4. Native PAGE
5. SDS-PAGE
6. Gas liquid chromatography (GLC)
7. High Pressure liquid chromatography (HPLC)
8. PCR
9. Amplification of an unknown target –inverse PCR

Course Code BIC/DSE/513

Course Name: Plant Biochemistry Total Credits: 2

Unit I Credit: 0.5

Structure and functions of plant cell (including cell wall, plasmodesmata, meristematic cells, vacuoles, secretary systems and root quiescent zone), Isolation of cell organelles, absorption, adsorption and transport of water and ions in plants. Evapotranspiration.

Unit II Credit: 0.5

Photosynthesis - structure of organelles involved in photosynthesis in plants and bacteria. Proton gradients and electron transfer in chloroplasts of plants and in purple bacteria - differences from mitochondria. Light receptors - chlorophyll, light harvesting complexes, bacteriorhodopsin, rhodopsin as ion pump.
Photosystems I and II, their location, mechanism of quantum capture and energy transfer between photosystems - ferridoxin, plastocyanin, plastoquinone, carotenoids.

Unit III Credit: 0.5
The Hill reaction, photophosphorylation and reduction of CO2.
C_3 C^4 and CAM metabolism, light and dark reactions. Light activation of enzymes, regulation of photosynthesis. Photorespiration.
Biological nitrogen fixation and ammonia assimilation.
Nitrate and sulphate reduction and their incorporation into amino acids.
Translocation of inorganic and organic substances.

Unit IV Credit: 0.5
Special features of secondary plant metabolism, formation of phenolic acids, tannins, lignins, lignans, pigments, terpenes, terpenoids, plant phenolics, alkaloids and surface waxes - their biosynthesis and functions, cell wall components.
Plant hormones - Growth regulating substances and their mode of action.Molecular effects of auxin in regulation of cell extension and of gibberellic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development, and embryogenesis.
Biochemistry of seed development and fruit ripening.
Defence system in plants.
Tissue culture and transgeneic plants.

Course Code BIC/DSE/513P
Course Name: Practical Based on BIC/DSE/513P

Total Credits: 2

1. PHYTOCHEMICAL ANALYSIS:
   A. Qualitative Analysis of Primary Metabolites such as Carbohydrates, Proteins, Amino acids, free fatty acids, Test of resins, Test of fixed oils and fats etc.
   B. Qualitative Analysis of Secondary Metabolites:
      Test for alkaloids
      1. Mayer's test
      2. Wagner's test (iodine – potassium iodine reagent): To about an ml of extract few drops of Wagner's reagent were added. Reddish – brown precipitate indicates presence of alkaloids. 3. To 5ml of extract 2ml of HCl was added. Then 1 ml of Dragendroff‟s reagent was added an orange or red precipitate shows a positive result for alkaloids.
      Test for glycosides:
1. Borntrager's test
2. Test for cardiac glycosides (Keller-Killani test)
      Test for phenol
      Test for tannins
      Test for Flavonoids
      Test for phytosterols
      Test for phlobatannins

Test for xanthoproteins
Test for triterpenoids
Test for anthocyanins
Test for Leucoanthocyanins
Test for Coumarins
Test for emodins
Qualitative Analysis of Vitamins: Vit.A, Vit.C, Vit.D and Vit.E.

Course Code: BIC/DSE/514
Course Name: Biochemical & Environmental Toxicology

Total Credits: 2

Unit I Credit: 0.5

Definition and scope of toxicology: Eco-toxicology and its environmental significance. Toxic effects: Basis for general classification & nature. Dose - Response relationship: Synergism and Antagonism, Determination of ED 50 & LD 50' Acute and Chronic exposures. Factors influencing Toxicity.Pharmacodynamics &Chemodynamics.
Principles & procedures of testing for acute toxic effects: Regulatory guidelines, Mammalian systems affected & the clinical signs of Systemic Toxicity. Factors affecting acute Toxicity studies.

Unit II Credit: 0.5

Xenobiotic metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase 11 reactions/Conjugation: Methylation, Glutathione and amino acid conjugations. Detoxification.
Biochemical basis of toxicity: Mechanisms of Toxicity : Disturbance of Excitable membrane function. Altered calcium Homeostasis.Covalent binding to cellular macromol-ecules &Genotoxicity.Tissue specificity of Toxicity.
Toxicity testing: Test Protocol, Genetic toxicity testing & Mutagenesis assays: In vitro Test systems - Bacteria[Mutation Tests: Reversion Test, Ames Test, Fluctuation Tests and Eukaryotic Mutation Tests. In vivo Mammalian Mutation tests - Host mediated assay & Dominant Lethal Test. Use of Drosophila in Toxicity testing. DNA repair assays. Chromosome damage test.Toxicological evaluation of Recombinant DNA - derived proteins.

Unit III Credit: 0.5

Pesticide toxicity: Insecticides: Organochlorines, Anti-cholinesterases - Organophosphates and Carbamates. Fungicides.Herbicides.Environmental consequences of pesticide toxicity.Biopesticides.
Food toxicology: Role of diet in cardiovascular diseases and cancer. Toxi(iology of food additives.
Metal toxicity: Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity - effect of light, temperature &pH.

Unit IV Credit: 0.5

Diagnosis of toxic changes in liver and kidneys: Metabolism of Haloaklkanes, Haloalkenes&Paracetamol with their toxic effects on tissues.
Air pollution: Common air Pollutants & their sources. Air pollution & ozone.Air pollution due to chloroflurocarbons (CFCS) and asbestos.
Occupational toxicology & assessment of occupational hazards: Industrial effluent toxicology & Environmental health.

An overview of regulatory agencies: Responsibilities of regulatory agencies. Management of Toxicological risk. Regulatory approaches. Regulatory systems & organizations.

Course Code BIC/DSE/514P
Course Name: Practical Based on BIC/DSE/514P

Total Credits: 2

2. Bacterial and chemical analysis of domestic and industrial effluents
2. Isolation and identification of Naphthalene, Xylene, Camphor and Petrol degrading microorganism
3. Bioremediation of textile dyes by bacteria/fungi/plants, calculation of percentage decolorization.
4. Measurement of Biological and Chemical Oxygen Demand (BOD/COD)
5. Enrichment,Isolation and Characterization of bacteria from Waste Water.
6. Isolation of coliphages from sewage water
7. Effect of UV radiation on *E.coli*
8. Fluctuation Test
9. DNA repair meachnism
10. Ames Test

Course Code: BIC/OJT/FP/515-
Course Name: On Job training/Field Project Total Credits: 4

SEMESTER III
Core and Research Component

Course Code: BIC/MJ/516
Course Name: Biostatistics & Research Methodology Total Credits: 2

Unit I Credit: 0.5

Population, Sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis
Sample space, events, equally likely events. Definition of probability (frequency approach), independent events.Addition and multiplication rules, conditional probability, Examples Bernoulli, Binomial, Poisson and Normal distributions.Mean and variance of these distributions (without proof).Sketching of p.m.f. and p.d.f, Use of these distributions to describe in biological models. Model sampling and Simulation study.

Unit II Credit: 0.5

Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination.

Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.
Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence.P-value of the statistic. Confidence limits, Introduction to one way and two-way analysis of variance.

Unit III Credit: 0.5

Patent and Intellectual Property
Intellectual Property Areas: Patents, Trademarks and Copyrights
Parts of a Patient; The process of obtaining a patent; who can obtain a why obtain a patent?;
Recent changes in IPR and patent policies.

Unit IV Credit: 0.5

Methodology of scientific research
The nature of scientific methods; Design of experiment,
Significance of statistical methods.

Course Code: BIC/MJ/517
Course Name: Methods In Molecular Biology Total Credits:2

Unit I Credit: 0.5
Physical properties of RNA: Classes of RNA, rRNA, tRNA, mRNA, HnRNA etc. Structure and methods of isolation and fractionation, gel electrophoresis and DNases, RNases, Phosphodiesterases.
Satellite DNA: C-value paradox, possible functions o satellite DNA, Mechanical strength, gene library, supppressor mutation, centromeric DNA, split genes.
Chromatin: Histone and non-histone proteins, general properties of histones, packing density. Nucleosomes, size variable linker, role of H 1.Selenoid structure.Transcriptionally active chromatin.

Unit II Credit: 0.5
Classes of DNA sequences: Zero-order bending, highly repetitive, unique. Methods of distinguishing double and single stranded DNA.
Re-association kinetics: Cot values, experimental procedure, qualitative significance, use of Ag* cesium sulphate.
Rapid DNA sequencing techniques and strategies details of a range of methodologies, e.g. plus and minus, dideoxynecleotide, partial ribosubstitution, Maxam and Gilbert.Use of thin gels, resolution etc. Interpretation of DNA sequences.
Role of counterions, deep and narrow grooves, single stranded DNA, A, B and Z DNA etc. Chirality of the helix, syn/antiparallel complementary stands.
Rapid RNA sequencing techniques: plus and minus, dideoxy-nucleotide, Zimmern and Kaesberg, Peattie, Simoncsits et al., method etc. Interpretation of RNA sequence.

Unit III Credit: 0.5

Movable genes: transposons and associated inverted repeats. The cassette model.Transforming DNA and plant genes.Retrovirus life cycle.
Strategies for cloning in plasmid vectors, features of commonly used vectors, their purification and characterization. Identification of bacterial colonies that contain recombinant plasmids. Bacteriophage λ vectors, growth, purification. Cloning in Bacteriophage λ vectors. Cloning in cosmid vectors.Construction of Genomic DNA libraries in cosmid vectors. Enzymes used in molecular cloning, restriction enzymes, DNA-Polymerases, ligases, kinases, phosphatases, and nucleases. DNA binding proteins.

Unit IV Credit: 0.5
Agarose gel and polyacrylamide gel electrophoresis, detection and extraction of DNA from gels.Construction and analysis of c-DNA; protocols and strategies for C-DNA cloning.Analysis of Genomic DNA by Southern Hybridization.Amplification of DNA by the polymerase chain reaction. Preparation of radiolabelled DNA and RNA probes. Synthetic oligonucleotides probes. Expression of cloned Genes in cultured cells.Screening expression with antibodies and oligonucleotides.Microarray chips and their applications.

Course Code: BIC/MJ/518
Course Name: Nutritional Biochemistry Total Credits 2

Unit I Credit: 0.5
Basic Concepts: Composition of human body. Energy content of foods. Measurement of energy expenditure: Direct & indirect calorimetry. Definition of BMR and SDA and factors affecting these.Thermogenic effects of foods. Energy requirements of man and woman and factors affecting energy requirements.
Carbohydrates: Dietary requirements and sources of available and unavailable carbohydrates. Physico-chemical properties and physiological actions of unavailable carbohydrates (dietary fibre).
Proteins: Protein reserves of human body. Nitrogen balance studies and factors influencing nitrogen balance. Essential amino acids for man and concept of protein quality Cereal proteins and their limiting amino acids.Protein requirement at different stages of development.
Lipids: Major classes of dietary lipids. Properties and composition of plasma lipo- proteins. Dietary needs of lipids. Essential fatty acids and their physiological functions.

Unit II Credit: 0.5

Electrolytes and water balance: Electrolyte concentrations of body fluids. Acid base regulation by the human body.Concept of metabolic and respiratory acidosis and alkalosis.
Minerals: Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
Vitamins: Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water-soluble vitamins. Hypervitaminosis symptoms of fat- soluble vitamins.
Nutritional requirements during pregnancy, lactation and of infants and children.

Unit III Credit: 0.5

Processed Food: Food processing and loss of nutrients during processing and cooking

Anti-nutrients: Naturally occurring food born toxicants: Protease inhibitors, Hemagglutins, Hepatotoxins, Allergens, Oxalates, Toxins from Mushrooms, Animal food stuffs and sea foods.

Protein energy malnutrition (PEM): Aetiology, clinical features, metabolic disorders and management of Marsmus and Kwashiorkar diseases.

Starvation: Techniques for the study of starvation. Protein metabolism in prolonged fasting.Protein sparing treatments during fasting.Basic concept of High protein, low caloric weight reduction diets.

Unit IV Credit: 0.5

Obesity: Definition and classification. Genetic and environmental factors leading to obesity Obesity related diseases and management of obesity. Role of leptin in regulation of body mass.

Clinical nutrition: Role of diet & nutrition in the prevention and treatment of diseases: Dental caries, Fluorosis, Renal failure, Hyperlipidemia, Atherosclerosis & Rheumatic disorders, Inherited metabolic disorders: Phenyl ketonuria, Maple syrup disease. Hemocystinuria, Galactosemia, Gout, Diabetes Insipidus and Diabetes Mellitus.

Food allergy: Definition, Role of antigen, host and environment. Types of Hypersensitivities. Diagnosis and management of allergy.

Course Code: BIC/MJ/519

Course Name: Practical Based on BIC/MJ/516, 517, 518 **Total Marks:100,**
Total Credits: 02

Course Name: Practical Based on BIC/MJ/516

1) Use of graphical modes to represent biological data.
2) Developing understanding for linear equation analysis (regression analysis).
3) To study normal distribution curve.
4) To carry out Hypothesis testing using Z-test and t-test.
5) To develop scientific abstract writing skills.
6) To develop scientific reports writing skill.
7) Formation of frequency distribution and calculation of descriptive measures-mean, median, mode, variance, standard deviation and standard error.

Course Name: Practical Based on BIC/MJ/517

8) Isolation of Genomic DNA from bacterial cell/plant cell/animal cell
9) Isolation of total RNA
10) Isolation of Plasmid DNA
11) Agarose Gel Electrophoresis of DNA/RNA
12) Restriction Digestion
13) Isolation of total Proteins from bacterial cell/plant cell/animal cell
14) Detection of Proteins by PAGE/ SDS PAGE
15) Dot Blot method
16) Blue White screening method for gene expression
17) Amplification of DNA by PCR
18) Western Blotting
19) Southern Blotting

Course Name: Practical Based on BIC/MJ/518

1. Bioassay for vitamin B12/B1.

2. Homocystiene estimation.
3. Serum/ urine MMA estimation.
4. Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
5. Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
6. Vitamin A/E estimation in serum.
7. Bone densitometry /bone ultrasound test demonstration (visit to a nearby clinic)

Course Code: BIC/DSE/520
Course Name: Review Of Literature Total Credits:02

This course focuses on the skills that students need to locate, identify, and select relevant sources of literature to compile an annotated bibliography and a structured literature review, Students will write a formal research paper designed to broaden students' perspectives and to provide an opportunity for the integration of course concepts. Emphasis will be placed on methods of interpretation, writing, and critical thinking related Biochemistry.

Unit I- Review of Literature

a. Writing a literature review: Structure and Components
b. Description of Types of Documents included in review of literature
    I. Articles
    II. Monographs
    III. Reviews
    IV. Manuscript
    V. Critical studies
    VI. Understanding Types of Sources: Journal Articles, Books, Magazines and Newspapers, Reports, Websites and Reference Material.
    VII. Strategies for evaluating sources. Relevance, Currency, Bias and Credibility.

Unit II- Summary of original or significant literature related to identified issue/ research problem/ topics with reference to its:

I. Background
II. Objective
III. Approach
IV. Chronology
V. Impact in the field
VI. Conclusion

Unit III- Comparison and Critical evaluation of Research articles related to the research problem analyzing the following aspects:

I. Research Problem evaluation
II. Methodology
III. Arguments
IV. Changing Perspective and reception
V. Conclusion and questions for further research.

Unit IV- Writing, submission and presentation of literature review on the tentative research problem related to the field of Biochemistry.

Course Code: BIC/DSE/521
Course Name: Genetics for Biologist Total Credits: 02

Unit I Credit: 0.5

Genetic Counseling

Possible approaches for tackling genetic disorders; Diagnosis of genetic defects; Positive eugenics; Negative eugenics; genetic counseling (antenatal diagnosis, fetus sexing).

Restriction Maps and Molecular Genetic Maps

Restriction Mapping. Restriction fragment length polymorphisms (RFLPs); Linkage and recombination between molecular and phenotypic markers; Random amplified polymorphic DNA (RAPDS) using PCR. Chromosome walking; reverse genetics and chromosome jumping

Unit II Credit: 0.5

Applied Genetics : Scope and Importance

What is applied genetics; Achievements of applied genetics; Need for future development.

Cloning and Amplification of DNA

Restriction enzymes in cloning; Techniques used in recombinant DNA technology (Polyacrylamide gel electrophoresis, Southern, Northern and Western blotting); Cloning vectors for recombinant DNA; cloning in bacteria, Molecular probes, Construction and screening of genomic and CDNA libraries; PCR and its applications.

Unit III Credit: 0.5

Isolation, Sequencing and Synthesis of Genes

Isolation of genes (genes with Tissue specific expression; mutant complementation, transpose tagging); Sequencing of genes (Maxam-Gitbert's method); Synthesis of genes (organochemical synthesis of TRNA gene and interferon gene).

Unit IV Credit: 0.5

Gene Transfer Methods and Transgenic Organisms

Gene transfers methods for animals and plants; Agro-bacterium mediated gene transfer, electroporation and particle gun. Transgenic animals (mouse and rabbit); Transgenic plants (Herbicide insect and virus resistance).

Course Code: BIC/DSE/521
Course Name: Practical Based on BIC/DSE/521P Total Credits: 02

1. Plasmid DNA Extraction and Agarose Gel Electrophoresis

2. Polyacrylamide gel electrophoresis (PAGE)
3. Native PAGE
4. SDS-PAGE
5. Amplification of an unknown target –inverse PCR
6. Isoelectric focusing
7. Two-dimensional (2D) electrophoresis
8. Gel Staining methods
9. Specific protein detection methods: Western blot
10. Specific protein detection methods: In-gel method based on enzyme activity

Course Code: BIC/DSE/522
Course Name: Frontier Technologies in Bioscience Total Credits: 02

Unit I Credit : 0.5
Stem cell technology
Stem cell, definition, types of stem cells, scientific terms
Manipulations of stem cells
factors governing manipulations of stem cells
The future of stem cell technology using pluripotent stem cells
Culture of stem cells
Study of microenvironmental factors governing stem cell propogation
Tissue engineering using stem cell technology
Reprogramming of genome function through epigenic inheritance
Ethical, social considerations of stem cell technology.

Unit II Credit : 0.5
Functional Proteomics
What is proteome
Mass spectroscopy of various protein complexes
Organization of proteome in an organism and its systematic study
Protein chips
Computation
Nanobiotechnology
Definitions and terms
Molecular Motors
DNA hybridization control using metal ion crystal antenae

Unit III Credit : 0.5
Microarray chips,
Microarray probes / chips, array fabrication, targets, assays, read out, image analysis, uses and examples.

SNPs
Identification and uses, DNA variations, SNP detection, data bases, study design, uses, genotyping.

Unit IV Credit : 0.5
Bioremediation and Phytoremediation

The interaction of soils and groundwater with organic and synthetic contaminants
The role of soils in pollution control
The physical, chemical, and microbiological properties of soil and water
Conventional remediation and bioremediation techniques
Regional pollution problems
Agricultural runoff, landfill leachates, leaking underground storage tanks.

Course Code: BIC/DSE/522
Course Name: Practical Based on BIC/DSE/522P Total Credits: 02

1) Western Blotting
2) Southern Hybridisation method
3) GCMS/LCMS analysis and data interpretation of biomolecules
4) 2-D PAGE
5) Image analysis of 2-DE gels
6) Protein sequencing method (Edman degradation, MALDI TOF/TOF)
7) Microarray Technology in Treating Disease

Course Code: BIC/RP/523 -1
Course Name: Research Project (Minor) Total Credits: 04

Research Project (Corresponding to the Major (Core) Subject

SEMESTER IV

Course Code: BIC/MJ/524
Course Name: Immunochemistry **Total Credits:02**

Unit I Credit: 0.5

Natural and acquired immunity, nature of immune response, cells and tissues of immune system. Components of natural immunity - complement system - classical and alternative pathway, opsonization and phagocytosis by macrophages.
Antigens, haptens and antibodies.Fine structure and subclasses of antibodies. Clonal selection theory and genetic basis of antibody diversity, immunoglobulin class switching. Antigen-antibody interactions.

Unit II Credit: 0.5

T and B lymphocyte classes.Major histocompatibility complex I and II. Processing and presentation of antigen by MHC, molecular basis of recognition, activation and maturation of T lymphocytes. Activation of B lymphocytes.Humoral immune response and its regulation. Cell mediated immunity - cytolytic and natural killer T lymphocytes.

Unit III Credit: 0.5

Cytokines, biogenic amines, interleukins and other effector components.
Cytokine signaling – JAK-STAT pathway
Programmed cell death – Apoptosis, Casapases and their role in cell death, Fas ligand signaling, TNF signaling
Immunodiffusion, immunoelectrophoresis, RIA, EIA, ELISA, fluroscent labelling and fluroscent cell sorter. Monospecific and bispecific antibodies.Hybridoma technology and monoclonal antibodies, catalytic antibodies.Western blotting.

Unit IV Credit: 0.5

Allergy and hypersensitivity, immunodeficiency - inherent and aquired, HIV, autoimmune disorders, mechanism of immunosuppression, graft rejection, organ transplantation and tumor immunology.
Interaction of microbes with immune system. Strategies adopted by viruses, bacteria and parasites to escape immune surveillance. PAMPS and Toll like receptors in microbe interaction

Course Code: BIC/MJ/525
Course Name: Microbial Biochemistry Total Credits:02

Microbiology
Unit I Credit: 0.5
Types of microorganisms: Mycoplasma, Protozoa, archea and yeast, fungi, general characteristics of main groups of microorganisms. Criteria used in the classification of microorganisms - cytology, genetics, host specialization, serology, different phases of growth.
Nutrition, physiology and growth of microbial cells. Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture

Unit II Credit: 0.5
Gram positive and gram-negative organisms.Structure and functions of peptidoglycan in gram-positive and gram-negative organisms.Functions of polymeric components in outer membrane and acidic polymers in gram-negative organisms.

Special features of bacterial metabolism.Food spoilage, fermentation, food-borne infection.
Role of microorganisms in domestic and industrial sewage. Microbiological standards

Virology
Unit III Credit: 0.5
Virus structure, virus proteins, virus classification schemes
methods of assay: culture methods, serological detection, complement fixation, plaque reduction assay, neutralization tests
Replication of RNA viruses - negative strand (VSV), positive strand (polio), retroviruses (to include all events in the infectious cycle).

Unit IV Credit: 0.5

Replication of DNA viruses (Adenovirus or SV40). Herpes simplex virus, cytomegalovirus
Virus-host interaction
Vaccines and prevention – smallpox, polio, AIDS, rotavirus vaccine, influenza

Course Code: BIC/MJ/526
Course Name: Clinical Biochemistry Total Credits: **2**

Unit I Credit: 0.5
Introduction to laboratory principles and instrumentation in Clinical Biochemistry.
Automation in the Clinical Biochemistry
Instrumental concepts
Chemical reaction phase
Measurement approaches
Selection of instruments.
Quality Assurance
Control of Pre-analytical variables
Control of analytical variables
External and internal quality control measurements.

Unit II Credit: 0.5
Disorders of Carbohydrate Metabolism
Diabetes mellitus
Glycohemoglobins.
Hypoglycemia's.
Ketone bodies
Various types of glucose tolerance tests. Glycogen storage diseases
Galactosemia
Lipids, Lipoproteins and Apolipoproteins
Physiology of lipids/lipoproteins, lipidosis
Clinical inter-relationships of lipids (sphingolipidosis, multipisclerosis), Lipoproteins and apolipoproteins.
Diagnostic tests for apolipoproteins, HDL-cholesterol, LDL-cholesterol and triglycerides disorders.

Unit III Credit: 0.5
Disorders of Amino Acid Metabolism
Phenylalaninemia, homocystineuria, tyrosinemia and related disorders, aminoacidurias.
Evaluation of Organ Function Tests
Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions, bilirubin metabolism.
Clinical presentation and diagnosis of various organ diseases.
Diagnostic Enzymes: Aspartate aminotransferase, Alanine aminotransferase, Creatine kinase Aidolase, Lactate dehydrogenase
Enzyme tests in determination of myocardial infarction, pancreatitis, biliary diseases

Unit IV Credit: 0.5
Hormonal Disturbances
Protein hormones, anterior pituitary hormones, posterior pituitary hormones, steroid hormones, adrenocortical steroids, reproductive endocrinology, thyroid function.
Disorders of Mineral Metabolism

Hypercalcemia, hypocalcemia, normocalcemia, hypophosphatemia, hyperphosphatemia.

Detoxification Mechanism in the Body

Enzymes of detoxification - polymorphism in drug metabolizing enzymes.

Detection of toxic substances by specific procedures.

Course Code: BIC/MJ/527

Course Name: Practical Based on BIC/MJ/524, 525, 526 **Total Marks:100,**

Total Credits: 02

BIC/MJ/524

1. RBC count.
2. Total WBC count.
3. WBC Differential count.
4. Erythrocyte Sedimentation Rate (ESR).
5. Packed Cell Volume (PCV).
6. Estimation of Haemoglobin (Hb).
7. Mean Cell Haemoglobin and Mean Cell RBC volume.
8. Colour Index and Volume Index of RBC.
9. Osmotic fragility of RBC.
10. Raising of antibodies to soluble antigen in rabbits.
11. Immunodiffusion.
12. Single Radial Immunodiffusion.
13. Rocket immune electrophoresis.
14. Cross over Immunoelectrophoresis.
15. Graber and Williams Immunoelectrophoresis
16. Detection of HCG by latex agglutination inhibition test.
17. Haemeagglutination tests for identification of human blood groups.
18. Detection by viral fever by slide agglutinationtests.

Practical Based on BIC/MJ/525,

1. Handling of Microscopes: Calibration of Microscopes.
2. Sterilization techniques: Autoclaving (Moistened-heat), Oven sterilization (dry-heat), Filtration.
3. UV irradiation and Chemical.
4. Preparation of media: For Bacteria and Fungi.
5. Isolation and cultivation of pure cultures: Serial dilution, Pour plate method, Spread plate method and streak plate method.
6. Method for the estimation of Growth (Growth rate and generation time in bacteria).
7. Staining techniques for bacteria and yeast: Gram Staining and Spore staining for bacteria; Methylene blue staining for Yeast. Antibiotic sensitivity test.
8. Starch hydrolysis assay for the identification amylase-producing microorganisms.
9. Gelatin hydrolysis assay for the identification protease-producing microorganisms.
10. Preparation of wine from Grapes.
11. Production of Alcohol from molasses and its estimation by specific gravity method.
12. Production of Citric acid and its estimation by Marrier and Boulet method.
13. Production of Lactic acid and its estimation by Barker and Summerson method.
14. Induction of mutation in bacteria using physical and chemical mutagens.
15. Water analysis for bacteria and determination of BOD and COD of water.

16. Observation of Rizobium from root nodules of ground nut plant.
17. Isolation of phages from sewage and quantification by plaque assay.

Practical Based on BIC/DSE/526

1. Determination of Blood Glucose by Enzymatic methods
2. Glucose Tolerance test (G.T.T)
3. Determination of Lipid Profile: Total Cholesterol, -Lipoproteins analyses:High-density lipoproteins HDL, Low-density lipoproteins LDL
4. Kidney function tests-Determination of the non-protein nitrogen compounds:Determination of Blood Urea,Determination of Serum Creatinine,Determination of Uric acid
5. Liver function tests:Determination of Serum transaminase enzyme activities,Determination of Serum Bilirubin,Determination of Serum total proteins,Determination of Serum Albumin and Globulin,Determination of Serum alkaline phosphatase ALP
6. Serum acid phosphatase:Determination of: Serum acid phosphatase:Bessey, Lowry and Brock (BLB) method.
7. Pancreatic function test:Determination of: Serum amylase activity-1. Enzymatic method.2. Caraway method.
8. Determination of: Serum Calcium by Calorimetric method
9. Determination of: Serum Inorganic phosphate
10. Estimation of Serum cholesterol.
11. Determination of SGOT.
12. Determination of SGPT.
13. Estimation of serum calcium.
14. Estimation of serum bilirubin.
15. Determination of urine ascorbic acid.
16. Tests for abnormal constituents in urine.
17. Use of diagnostic kits.

Course Code: BIC/MJ/528
Course Name: Muscle Biochemistry and Biomembrane Total Credits: **2**

Unit I

Muscle cell components-definition myofibril, miofillament, sarcomere, sarcolema, sarcoplasm.

Structure and function of actin , tropomyosin, troponin,

Structural organization of sarcomere, properties and function of muscles

Type of muscles in body-structure and function of skeleton muscles, cardiac muscles and smooth muscles.

Unit II

Mechanism of muscle contraction and relaxation, Sliding filament model, function of Titin, nebulin, dystrophin.

Regulation of muscle contraction and relaxation.

Muscles disorders-muscular dystrophy, paralysis, Rigor mortix.

Unit III

Biological membrane, structure and assembly: constituents, asymmetry, membrane fluidity, flip-flop, lipid-lipid, lipid-protein interactions, factors affecting physical properties of membranes.

Membrane models: singer and Nicolson- fluid mosaic model

Classification of membrane lipid -structure and composition of phosphoglycerides, spingolipids, cholesterol, phospholipids and, glycolipids.

Membrane proteins-integral membrane protein, peripheral protein, lipid anchored protein. Topology of membrane proteins.role of transport protein and flippases . Membrane associated diseases. Membrane junctions.

Unit IV

Membrane transport-

Active transport-primary active transport: P-type, V-type ,F-type of pumps and ABC Transporter. secondary active transport: Na/glucose symporters, Na/ca+ antiporter.

Passive transport-simple and facilated diffusion.

Receptor mediated endocytosis, osmoregulation and ATP-ADP Exchanger .Role of Na+,K+ ATPase and passive permeability of the plasma membrane to Na+ ,K+,cl-,votage and Ligand gated ion channels and propagation of nerve impulse ,action potential, Na+ and K +channels.

Course Code: BIC/DSE/528P
Course Name: Practical Based on BIC/DSE/528P Total Credits: 02

1. Isolation and Characterization of Sphingolipids from wheat grains.
2. Isolation of phospholipid from egg yolk.
3. Isolation of cholesterol from egg yolk.
4. Investigation into the effect of a temperature on the permeability of cell membrane.
5. Investigate the main effect of monovalent salt concentration on a phospholipid membrane
6. Separation of phospholipid by thin layer chromatography.
7. Estimation of serum cholesterol by using zak's method.

Course Code: BIC/DSE/529
Course Name: Plant Biotechnology Total Credits: 02
Plant defence:

Unit I Credit: 0.5
Plant pathogens and integrated defense response to infection
Gene silencing as an adaptive defense
Natural products and plant disease resistance

Unit II Credit: 0.5
Programmed cell death
Hypersensitive response of plants and mitochondrial function
Biochemistry of airborne signals during plant defense
Co-evolution and plant resistance to natural enemies

Engineering pest and disease resistant plants
Unit III Credit: 0.5

Production of transgenic organisms: microbes
Producing proteins in bacteria and fungi
Methods to produce transgenic plants
Herbicides, manipulating herbicide tolerance in plants
benefits and problems of herbicide tolerance in plants

Unit IV Credit: 0.5
Plants with increased resistance to insects
Biotechnology and tomato, genetic modifications of foods, oils and starches
Improving plant tolerance to environmental stress
Production of transgenic animals
Release of transgenic organisms in the environment
Safety and regulation of genetically engineered food

Course Code: BIC/DSE/529P
Course Name: Practical Based on BIC/DSE/529P Total Credits: 02

1. Agrobacterium tumefaciens-mediated plant transformation and transient reporter gene expression assay
2. Analysis of free radical scavengers and antioxidant enzymes (Assay of any one - SOD, peroxidase, catalase, phenol oxidase, ascorbic acid oxidase,)
3. Measurement of free radicals by spectrophotometric method (Total phenolics, DPPH assay, ABTS assay, FRAP assay)
4. Proline content in normal and stressed plants.
5. Extraction of inhibitor proteins from plant and their inhibition assay
6. Extraction of plant pigments from spinach and separation by column chromatography
7. Spectrophotometric estimation of Indole acetic acid in plant tissues.
8. Estimation of carotene, ascorbic acid, phenols and tannins in fruits and vegetables.
9. Measurement of activity of plant nitrate assimilation enzymes
10. Isolation of chloroplast and mitochondria from plant tissue
11. Demonstration of Hill's reaction

Course Code: BIC/DSE/530
Course Name: Neurobiochemistry Total Credits: 02

Unit I Credit: 0.5

Neuromorphology and Neurocellular Anatomy. Central Nervous system - General features of Neurons. Cellular Organisation of neurons, Dendrites and Axons, neurotubules, neurofilaments, synapse neuralgia, astrocytes, oligodendrocyte, ependymal cells, schwa cells.
Peripheral Nervous System (PNS): Muscle, nerve endings, sensory receptors and effector endings; peripheral nerves, spinal and cranial nerves; plexuses ganglia, afferent pathways and sense organs.
Spinal Cord. Topographical anatomy, spinal nerves, spinal meninges, joint reflexes, gray and white matter of spinal cord.
Role of the Nervous System in Homeostasis: Cellular organization of specific regions such as cerebellum, cerebral cortex, hippocampus, retina, evolution of the nervous system - a comparative aspect.

Unit II Credit: 0.5

Neurophysiology, Neuronal membrane, excitability, ion channels and transport of ions.
Nerve and Synapse Structures: Structure function correlation at the synapse. Transmission across the synapse: membrane potential in the steady state, action potential generation and propagation.
Presynaptic Events at the Neuromuscular Junction: Cholinergic and non-cholinergic synapses.
Postsynaptic Events at the Neuromuscular Junction. Electrophysiology of Channels: EEG patterns.
Chemical Composition of Brain: Formation, structure and biochemistry of myelin, chemistry of major brain lipids, developmental changes, lipid composition, biosynthesis and catabolism of major lipids, characteristics of brain lipids, regional variations.

Unit III Credit: 0.5
Neurotransmitter: Chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neuronal integration.
Blood Brain CSF Barriers: Special transport systems, characteristics of BBB - morphology, diffusion, mediated transport, enzymatic barriers in capillary endothelium. Characteristics of blood CSF barrier, composition of CSF, formation of CSF, active transport from CSF to brain. CSF brain interface, similarities of BBB to blood CSF barrier.
Synaptic Transmission: Structure of the synapse, correlation of structure and function at the synapse, transmission across the synapse, pre and post synaptic events, membrane potential in the steady state action, action potential and propagation of nerve impulse. CAMP in hormone action. Cyclic nucleotide and synaptic transmission - CAMP and neuronal function, neurotransmitter sensitive adenylate cyclases and their role in neuronal function, mechanism of action of CAMP in synaptic transmission, CAMP and cell growth with differentiation, CAMP and microtubule function.

Unit IV Credit: 0.5
Endocrine Effects on the Brain and their Relationship to Behaviour. Behavioral control of hormone secretion, biochemical aspects of activational hormones effects, steroid receptor sites in brain, integration of behavioral and neuroendocrine effects, organizational effects of hormones on developing brain, thyroid hormone and brain development.
Sphingolipidosis and other Lipid Disorders: Diseases involving myelin classification, and biochemistry of demyelinating diseases.
Biochemical Pathology of Vitamin and Nutritional Deficiencies: Neurotoxic agents and diseases related to them.
Psychopharmacologyand Biochemical theories of Mental Disorders: Chemistry of neuroleptics and anxiolytics, antidepressants, hallucinogenic agents, biochemical theories of mental disorders.
Neurodegenerative Disorders: Parkinson's, Alzheimer's disease, amyotrophic lateral sclerosis, senile dementia.

Course Code: BIC/DSE/530P
Course Name: Practical Based on BIC/DSE/530P Total Credits: 02

Neurochemical studies:

1. TLC,
2. Silica gel chromatography,
3. DBH analysis.
4. Analysis of Genotype and allele frequency and assessment of risk towards disease predisposition using statistical analysis.
5. Isolation of neurotransmitters
6. Analysis of neurotransmitters by fluorometry, HPLC.
7. Behavioural studies using animal model (Zebra Fish, Mouse)
8. Testing motor functions
9. Grip Strength Test,
10. Testing Cognitive Functions – Learning and memory related test (Any-arm Maze, Water Maze, etc.).
11. Study of the electrical or chemical stimulation of the brain and its different parts.

Course Code: BIC/RP/531-2
Course Name: Major Research Project Total Credits: 06

Major Research Project (Corresponding to the Major (Core) Subject

Reference Books and literature for M. Sc. BIOCHEMISTRY Program

Bioanalytical Chemistry

Stereo chemistry of organic compounds (1994) by E L Eliel& SHW Awley., Inter Science Pub.30, Wiley and Sons.Inc.
Organic Chemistry (6th Ed. 2000) by R T Morrison & R N Boyd, Prentice Hall of India, New Delhi.
Organic Chemistry Vol.1 Fundamental Principles (6th Ed. 1985) by IL Finar, ELBS.
Vol.2 Stereo Chemistry and the Chemistry of Natural Products.(5th Ed. 1985) by I L Finar, ELBS.
Lehninger's Principles of Biochemistry (2nd Ed 2000) D L Nelson and M M Cox, Macmillan Worth Pub.Inc NY.
Physical Biochemistry by Kansal Edward Van Holde (1971) Prentice Hall Inc. New Jersey.
Physical Biochemistry 2nd Ed (1 982) by David Friefelder, W H Freeman and Co. NY.
Principles and Techniques of Practical Biochemistry (4th Ed 1999) by K Wilson and J Walker (eds.) Cambridge Univ. Press.

CELL BIOLOGY AND PHYSIOLOGY

Molecular Biology of the Cells (3rd Ed 1994) by Alberts et al., Garland Publications Inc NY and London.
Cell Biology (1993) by E S Sedava, Jones and Barlett Publishers Boston, London.
Cell and Molecular Biology (8th Ed. 2001) by E D P de Robertis& E M F de Robertis (Jr) Lippincott Williams & Wilkins, Philadelphia.
Principles of Cell Biology (1988) by Klein Smith and M. Kish, Harper-Cellins Pub.Inc. New Delhi.

Text book of Medical Physiology (10th Ed. 2001) by A C Guyton & J E Hall, Harcourt Asia.

BIOENERGETICS AND METABOLISM

Lehninger's Principles of Biochemistry (2nd edn. 2000) by D L Nelson and M M Cox, Macmillan, Worth Pub Inc., NY.
Biochemistry (4th Ed. 1992) by LubertStryer W H Freeman & Co., NY
Harper's Biochemistry (25th Ed.) by R K Murray and others. Appleton and Lange, Stanford.

PLANT BIOCHEMISTRY

Handbook of photosynthesis (Ed.) Mohammad Pesarakle, Marcel Dekkar, Inc. NY. Basel. Hong Kong 1997.
Introduction to plant biochemistry (1983) T W Goodwin and E I Mercer.Pergaman Press, Oxford, NY, Toronto, Sydney, Paris, Frankfurt.
Seed: physiology of development and germination (2nd Ed. 1994) J D Bewley and M Black Plenum Press NY.
Biochemistry of energy utilization in plants D T dennis Blackie, Glasgow and London 1987.
Plant Biochemistry by P M Dey and J B Harborne. Harcourt Asia PTE Ltd., Singapore.

ENZYMOLOGY

The chemical kinetics of enzyme action by K J Laidler and P S Bunting, Oxford University Press, London.
Enzymes by M Dixon, E C Webb, CJR Thorne and K F Tipton, Longmans, London.
Enzyme structure and mechanism (1977) by Alan Fersht, Reading, USA.
Enzymatic reaction mechanism (1979) by Christopher Walsh, Freeman Pub., San Francisco.
Immobilized enzymes (1978) by lchiroChibata, Halsted Press Book.
Enzyme structure and function by S Blackburn (1976) Marcel Dekker, Inc., NY.

ADVANCED MOLECULAR BIOLOGY

Biochemistry (2nd Ed 1995) by Donald Voet and Judith Voet.
Molecular Biology of the gene (IV Ed 1987) J Watson NH Hopkin J W Roberts J P StertzA MWeiner, Freeman Pub., San Francisco.
Genes Vil Benjamin Lewin (2000) Oxford Univ Press. London.

IMMUNOCHEMISTRY

Immunology (4th Ed. 1998) by Ivan Roitt, J Brostoff and David Mole (4th edn) Mosby Times Mirror Int. Pub.Ltd.
Essential lmmunlogy (9th Ed. 1997) by Ivan Roift Blackwell Science Ltd.
Immunology (1992) by Janis Kuby W H Freeman and Co. Ltd. USA.
Immunology (2nd Ed. 991) by Edwards S Golub, Sinauer Associate, Sunderland.

METHODS IN MOLECULAR BIOLOGY

Molecular cloning: a laboratory manual (Vol.1, 2 & 3) (1989) by T.Maniatis, E.F.Fritsch, J.Sambrook. Cold Spring Harbor Laboratory Publications

RNA Isolation and Analysis by P Jones, J. Qiu, D.Rickwood(1st Ed. 1994) Bios Scientific Publishers.
Gene and Probes: A Practical Approach Series (1995) by B D Hames and S J Higgins. Oxford University Press.
Gel Electrophoresis of Nuclei Acids: A Practical Approach (1990) by D.Rickwood and B.D.Hames. Oxford University Press.

NUTRITION BIOCHEMISTRY

Nutrition- An integrated approach (3rd Ed. 1984) R L Pike and M L Brown, Wiley & Sons Inc., NY.
Text Book of Biochemistry and Human Biology G P Talwar, Prentice Hall.
Mechanism and Theory in Food Chemistry (1996) DWS Wong, CBS, New Delhi.
Text Book of Human Nutrition (1996) M S Bamji N PralhadRao and V Reddy, Oxford & IBH Publishers.
Nutritional Biochemistry and Metabolism Linten.
Principles of Food Science -1 (Food Chemistry) Fennemona D R.
Human Nutrition and Dietetics (8th Ed. 1982) by Davidson and Passmore ELBS.
Modern Nutrition in Health and Diseases (7th Ed. 1988) by Maurice E Skills and V R Young K M Varghese Co. Bombay.

BIOSTATISTICS

Biostatistics: A foundation for analysis in the health. (7th Ed. 1999) by W W Daniel John Wiley and Sons Inc., New York.

BIOCHEMICAL AND ENVIRONMENTAL TOXICOLOGY

General and Applied Toxicology 1995 by Marrs and Turner, Macmillan Press Ltd.
Basic Environmental Toxicology (1994) by LorrisG.Corkerhem and Barbara S S Shane CRP Press Inc.
Introduction to Food Technology by TakayurkiShibamato& Leonard F. Bzeldanes.
Molecular Biotechnology 2nd Ed 1994 by Barnard R Glick & J J Pasternak.

BIOMEMBRANES AND CYTOSKELETON

Molecular Cell Biology by H. Lodish, David Baltimore, et al W. H. Freeman Publication, 1996
Biological Membranes Findlay and Evans
Biochemistry of Tissues by Banks
Cell by Cooper

MUSCLE BIOCHEMISTRY

Biochemistry by LubertStryer, Freeman & Co., NY.
Principles of Biochemistry -Smith, Lehman, Lefkowtz, Handler and Smith.
Lehninger's Principles of Biochemistry - D L Nelson and M M Cox, Macmi.lian/Worth Pub Inc., NY.
Biochemistry of Lipids, Lipoproteins and Membranes (1991) - D E Vance and J E Vance, Elsevier Sci.

MICROBIAL BIOCHEMISTRY

Microbial World (5th Ed. 1987) R Y Stanier, Hampshire-Macmillan Press.
Medical Microbiology (12th Ed. 1973) Cruckishank R and others, ELBS Press, London.
Microbiology (1967) B D Davis, R Delbecco, H M Eisent H S Ginsberg, Hoeber Med Divn NY.
Microbiology (5th Ed. 2000) Michael J Peiczar (Jr) ESC Chan, N R Kreig, Tata McGraw Hill.

CLINICAL BIOCHEMISTRY

Tietz Fundamentals of Clinical Chemistry - (5th Ed.)C A Burtis, E R Ashwood (eds.) Saunders WB Co.
Notes on Clinical Chemistry - Whitby L G, A F Smith, G J Beckett, S M Walker, Blackwell Sci Inc.
Principles of Internal Medicine (1983) Harrison T R, McGraw Hill, NY.

MEDICAL AND ENVIRONMENTAL BIOCHEMISTRY

Clinical Chemistry by Kaplan L.A. and Pesce A. J. C. V. Mosby, 1989
Clinical Biochemistry by W. J. Marshall and S. K. Bangert, Churchill Livinston N.Y. 1995
Practical Clinical Biochemistry (Varley) by Gowenlock
Biochemical Aspects of Human Diseases by Elkeles and Tavill
Biodiversity by Hawksworth

NEURO BIOCHEMISTRY

Basic Neurochemistry by Siegel.
Elements of Molecular Neurotoxicology by CUM Smith.
Neuroanatomy by Grossman &Neavy.

GENETICS FOR BIOLOGISTS

General Genetics Sub Owen and Edger.
Genes VII (2000) Benjamin Lewin, Oxford Univ Press.
Molecular Biology of Gene (4th Ed. 1987) Watson *et al* Freeman Pub. San Francisco.