GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

REVISED MINUTES

of the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

Saturday, 30th July, 2022

Time

10.00 a.m.

Council Hall
Goa University

D 3.5	**Minutes of the Board of Studies in Environmental Science meeting held on 20.04.2022.** The Academic Council approved the minutes of the Board of Studies in Environmental Science meeting held on 20.04.2022 with the following suggestions: 1. The month and year mentioned in the heading of the Syllabus document to be corrected from September 2022 to August 2022. 2. The Course Codes for the PG programmes to be revised/changed. **(Action: Assistant Registrar Academic – PG)**
D 3.6	**Minutes of the Board of Studies in Sociology meeting held on 26.04.2022.** The Academic Council approved the minutes of the Board of Studies in Sociology meeting held on 26.04.2022 with the following suggestions: 1. The Course Codes for the PG programmes to be revised/changed. 2. The column indicating Lecture Hours per week in programme structure to be removed/deleted. **(Action: Assistant Registrar Academic – PG)**
D 3.7	**Minutes of the Board of Studies in Public Administration meeting held on 01.07.2022.** The Academic Council approved the minutes of the Board of Studies in Public Administration meeting held on 01.07.2022 with the following suggestions: 1. The duration for the internship to be specified. 2. The Course Codes for the PG programmes to be revised/changed. 3. Number of hours for the Course **PARSOC5 Community Engagement and Rural Development** to be corrected. 4. The proposed syllabus/structure for Semester III and Semester IV was deferred. **(Action: Assistant Registrar Academic – PG)**
D 3.8	**Minutes of the Board of Studies in Physics meeting held on 24.03.2022.** The Academic Council approved the minutes of the Board of Studies in Physics meeting held on 24.03.2022 with the suggestion to revise/change the Course Codes for the PG Programme. The discussion on the proposed syllabus/structure for Semester III and Semester IV was deferred. **(Action: Assistant Registrar Academic – PG)**
D 3.9	**Minutes of the Board of Studies in History meeting held on 25.04.2022.** The House did not consider the minutes of the Board of Studies in History as the Board had not recommended the syllabus for Semester II. The Chairperson expressed his displeasure on behalf of the House about the fact that in spite of the official intimation given almost four months in advance, the said Chairperson did not take up the matter in Board of Studies. The Chairperson, Board of Studies, was advised to hold a meeting of the Board of Studies and submit the Syllabus for Semesters I and II on an urgent basis. The Vice-Chancellor was authorized to approve the Syllabus on behalf of the Academic Council. **(Action: Assistant Registrar Academic – PG)**
D 3.10	**Minutes of the Board of Studies in Biochemistry meeting held on 22.04.2022.** The Academic Council approved the minutes of the Board of Studies in Biochemistry

	meeting held on 22.04.2022 with the following suggestions: 1. The Course Codes for the PG Programme to be revised/changed. 2. The Chairperson, Board of Studies was requested to indicate the number of hours unit wise for the courses in the syllabus. **(Action: Assistant Registrar Academic – PG)**
D 3.11	**Minutes of the Board of Studies in Political Science meeting held on 25.04.2022.** The Academic Council approved the minutes of the Board of Studies in Political Science meeting held on 25.04.2022 with the following suggestions: 1. The Course Codes for the PG Programme to be revised/changed. 2. The Chairperson, Board of Studies was requested to rework the number of hours in the proposed syllabus. 3. Course Code PSDSOC205 Politics in the Developing World, to be corrected. **(Action: Assistant Registrar Academic – PG)**
D 3.12	**Minutes of the Board of Studies in Philosophy in the School of Sanskrit, Philosophy and Indic Studies (SSPIS) meeting held on 29.04.2022.** The Academic Council approved the minutes of the Board of Studies in Philosophy in the School of Sanskrit, Philosophy and Indic Studies (SSPIS) meeting held on 29.04.2022 with the suggestion to revise/change the Course Codes for the PG Programme. **(Action: Assistant Registrar Academic – PG)**
D 3.13	**Minutes of the Board of Studies in Library and Information Science meeting held on 16.05.2022 and 30.05.2022.** The Academic Council deferred the minutes of the Board of Studies in Library and Information Science meeting held on 16.05.2022 and 30.05.2022. **(Action: Assistant Registrar Academic – PG)**
D 3.14	**Minutes of the Board of Studies in Commerce UG meeting held on 19.04.2022.** **(Item withdrawn)** **(Action: Assistant Registrar Academic – PG)**
D 3.15	**Minutes of the Board of Studies in International Studies meeting held on 22.04.2022.** The Academic Council approved the minutes of the Board of Studies in International Studies meeting held on 22.04.2022 with the following suggestions: 1. Prerequisites for the courses to be made as 'Graduate in any discipline'. 2. The Course Codes for the PG Programme to be revised/changed. **(Action: Assistant Registrar Academic – PG)**
D 3.16	**Minutes of the Board of Studies in English meeting held on 25.04.2022.** The Academic Council approved the minutes of the Board of Studies in English meeting held on 25.04.2022 with the following suggestions: 1. The Course Codes for the PG programmes to be revised/changed. 2. The proposed syllabus/structure for Semester III and Semester IV was deferred by the house. **(Action: Assistant Registrar Academic – PG)**
D 3.17	**Minutes of the Board of Studies in Chemistry PG meeting held on 26.04.2022.**

X AC- 9 (Special)
30.07.2022

GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

F I N A L U P D A T E D A G E N D A

For the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

30th July, 2022

Time

10.00 a.m.

Venue
Conference Hall
Administration Block

	ii. Recommendations of the text books for the course of study at post graduate level: Readings were suggested for the courses mentioned in **Annexure I**. **Part F** Important points for consideration/approval of Academic Council i) The important points/recommendations of BoS that require consideration/approval of Academic Council(points to be highlighted)as mentioned below: **The revised course structure with list of papers and syllabi as mentioned in Annexure I** ii) The declaration by the Chairperson that the minutes were read out by the Chairperson at the meeting itself. (Minutes were circulated to the members through email). The minutes were read out by the Chairperson at the meeting itself and were unanimously approved by the members (through email circulation). Date: 25.04.2022 Sd/- Place: Goa University, Taleigao Plateau Signature of the Chairperson Note: online approval of the members is enclosed. **Part G**. The Remarks of the Dean of the Faculty i. The minutes are in order. ii. The minutes may be placed before the Academic Council with remarks if any. iii. May be recommended for approval of Academic Council. iv. Special remarks if any. Date: 05.05.2022 Sd/- Place: Goa University Signature of the Dean **(Back to Index)**
D 3.10	**Minutes of the Board of Studies in Biochemistry meeting held on 22.04.2022.** **Part A**. i. Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level: NIL ii. Recommendations regarding courses of study in the subject or group of subjects at the postgraduate level: (Detailed minutes of the BOS meeting may please be seen). 1. **To discuss the revision of semester I & II syllabus of M.Sc. Biochemistry program** After due deliberations and incorporating the suggestions made by the members, the BOS unanimously resolved to approve the draft syllabus of semester I and II of M.Sc. Biochemistry program based on NEP. The approved syllabus of SEM. I & II of M.Sc.Biochemistry program is attached as **Annexure I** **(refer page no. 308)** **Part B**

i) Scheme of Examinations at undergraduate level: NIL
ii) Panel of examiners for different examinations at the undergraduate level: NIL
iii) Scheme of Examinations at postgraduate level: NIL
iv) Panel of examiners for different examinations at post-graduate level: NIL

Part C.

i. Recommendations regarding preparation and publication of selection of reading material in the subject or group of subjects and the names of the persons recommended for appointment to make the selection: NIL

Part D

i. Recommendations regarding general academic requirements in the Departments of University or affiliated colleges: NIL
ii. Recommendations of the Academic Audit Committee and status thereof: NIL

Part E.

i. Recommendations of the text books for the course of study at undergraduate level:NIL
ii. Recommendations of the text books for the course of study at post graduate level: NIL

Part F.

Important points for consideration/approval of Academic Council

i. The important points/recommendations of BoS that require consideration/approval of Academic Council as mentioned below
   a) **PART-A (ii)**

ii. The declaration by the Chairperson:
Hereby, it is declared that the minutes were readout by the Chairperson at the meeting itself.

Date: 22.04.2022 Sd/-
Place: Taleigao Plateau Prof. V. M. S. Verenkar
Signature of the Chairperson

Part G. The Remarks of the Dean of the Faculty

i. The minutes are in order.
ii. The following important points / recommendations of BOS may be considered / approved by the Academic Council.
Attention of the Academic Council is drawn to item Nos. PART-A (ii)
iii. May be recommended for approval of Academic Council.
iv. Special remarks if any: NIL

Date: 22.04.2022 Sd/-
Place: Taleigao Plateau Prof. V. M. S. Verenkar
Dean, School of Chemical Sciences

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D 3.10 Minutes of the Board of Studies in Biochemistry meeting held on 22.04.2022.

Annexure I

M.Sc. Biochemistry Part-I revised syllabus (SEM I and SEM II)

SEM I			
Sl. No.	**Course code**	**Course title**	**Credits**
1.	**BCC 411**	Biomolecules and Bioenergetics **(DSCC)**	4
2.	**BCC 412**	Analytical Biochemistry-I **(DSCC)**	4
3.	**BCC 413**	Molecular Biology **(DSCC)**	4
4.	**BCC414**	Cell and Developmental Biology **(DSCC)**	4
5.	**BCO 411**	Laboratory Course in Biochemistry-I **(DSOC)**	4
	BCO 412	Biochemical Methods of Analysis **(DSOC)**	4
SEM II			
1.	**BCC 415**	Enzymology **(DSCC)**	4
2.	**BCC 416**	Analytical Biochemistry-II**(DSCC)**	4
3.	**BCC 417**	Immunology and Immunotechniques**(DSCC)**	4
4.	**BCC 418**	Industrial Biochemistry **(DSCC)**	4
5.	**BCO 413**	Laboratory Techniques and Applications of Biochemistry **(DSOC)**	4
	BCO 414	Plant Biochemistry (**DSOC)**	4

Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 411**
Title of the course: **Biomolecules and Bioenergetics**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**
Programme: **M.Sc. Part-I (Biochemistry)**

Prerequisites for the course:	Students should have graduate level knowledge either in chemical or life sciences or should have qualified change of discipline test.
Course Objective:	1. To develop concepts about structures and functions of different biomolecules. 2. To understand the reactivity of biomolecules and their role in metabolic pathways. 3. To understand the metabolism of biomolecules and their regulation in living cells.
Course Outcome:	1. Students will be able to classify different biomolecules based on their structure and explain their 3-dimensional arrangement and biological functions. 2. Students will be able to write the metabolic pathways for major macromolecules and recognize the chemical changes occurring at each step based on the functional groups involved. 3. Students will be able to compute the energetics involved in metabolic pathways in terms of number of ATPs and describe the different regulatory mechanisms. 4. Students will be able to relate certain common diseases to the malfunctioning of respective metabolic pathways.

Content	*Hrs*
1. Introduction to Biomolecules a. Origin, aim and scope of Biochemistry. b. Introduction to various classes of major biomolecules.	1
2. Structure and properties of water a. Structure and physico-chemical properties of water, Ionic product of water. b. Importance of water in biological systems.	2
3. Chemical bonding, Stereochemistry and Reactions a. Properties of covalent bond, non-covalent bonds and their importance in biological systems. b. Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and syn& anti nomenclature with respect to biomolecules. c. Types of biochemical reactions: oxidation-reduction, condensation, rearrangement, addition, elimination, group-transfer, resonance bond, electrophilic and nucleophilic substitution reactions .	7
4. Structure and Biological functions of biomolecules a. Amino acids, Peptides and Proteins i. Amino acids: Structure, Classification, physico-chemical properties of amino acids	20

and role of non-protein amino acids. ii. Peptides: peptides of physiological significance, peptide bond. iii. Proteins: primary (importance of primary structure), secondary (alpha-helix, β – structure, β-helix, super secondary structure), tertiary (stabilizing forces, unfolding/ refolding) and quaternary structures (e.g.; Haemoglobin). b. Nucleotides and Nucleic acids i. Structure and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thymine, Uracil) bases. ii. Structural features of nucleic acids (DNA & RNA) and their biological functions. c. Carbohydrates i. Structure, stereochemistry, reactions and functions of monosaccharides, disaccharides, polysaccharides. ii. Complex carbohydrates; amino sugars, proteoglycans and glycoproteins. d. Lipids Classification, structure and function of major lipid subclasses - Triacylglycerols, Phospholipids, Sphingolipids, glycolipids, Lipoproteins, chylomicrons, LDL, HDL and VLDL, steroids, prostaglandins and bile acids, rancidity.	
5. **Bioenergetics and Oxidative Phosphorylation** a. Thermodynamics: laws of thermodynamics, mechanism of exergonic and endergonic reactions, redox potential, high energy compounds, ATP structure and significance. b. Aerobic electron transport and oxidative phosphorylation, redox enzymes of ETC, ATP synthase and mechanism.	6
6. Metabolism of Biomolecules: a. Carbohydrate metabolism Regulatory mechanisms, bioenergetics and significance of central pathways of carbohydrate metabolism: Glycolysis, TCA, Pentose phosphate pathway, Entner-Doudoroff pathway, glycolate cycle, Gluconeogenesis, gluconeogenesis from TCA intermediates/ amino acids / acetyl-CoA, glucuronic acid pathway, Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen. Biosynthesis of polysaccharides and sugar interconversions. b. Lipid metabolism Oxidation of fatty acids and its energetics: oxidation of saturated and unsaturated (mono and polyunsaturated fatty acids (PUFA), Peroxisomal oxidation of fatty acids (Phytanic acid), Refsum's disease, ketone body formation and their clinical significance, diabetic ketoacidosis, Biosynthesis of fatty acids and regulation, Biosynthesis of triglycerides, cholesterol and phospholipids. c. Amino acid metabolism	24

General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation. Overview of biosynthetic pathways of amino acids and their regulation; Assimilation of ammonia, biosynthesis of essential and non-essential amino acids, regulation of glutamine synthetase and aspartate family of amino acids. d. Nucleotides and nucleic acids metabolism Purine and pyrimidine nucleotides: biosynthesis and its regulation. Deoxyribonucleotides: biosynthesis and regulation. Biosynthesis of nucleotide coenzymes. Catabolism of purine and pyrimidine nucleotides.	
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Nelson, D. L.; Cox, M. M.; Lehninger Principles of Biochemistry, W.H. Freeman; 2017, 7th Edition. 2. Voet, D.; Voet, J. G.; Pratt, C. W.; Fundamentals of Biochemistry, John Wiley & Sons Inc., 2016, 5th Edition. 3. Berg, J. M.; Stryer, L.; Tymoczko, J. L.; Gatto, G. J.; Biochemistry; W.H Freeman; 2019, 9th Edition. 4. Kuchel, P.; Easterbrook-Smith, S.; Gysbers, V.; Guss, J. M.; Hancock, D.; Johnston, J.; Jones, A.; Matthews, J.; Schaum's Outline of Biochemistry, McGraw-Hill Book Co., 2009, 3rd Edition.

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Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 412**
Title of the course: **Analytical Biochemistry-I**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have graduate level knowledge either in chemical or life sciences or should have qualified change of discipline test.
Course Objective:	1. To introduce various bioanalytical techniques for separation and purification of biomolecules. 2. To develop concepts in techniques used for routine biochemical work such as chromatography, spectrophotometry, centrifugation, microscopy, electrophoresis. 3. To evaluate the utility of various analytical techniques as a qualitative and quantitative tool.
Course Outcome:	1. Students will be in a position to differentiate between various analytical techniques for separation and purification of biomolecules based on their principles

	2. Students will be able to explain the principles of various separation techniques and apply the knowledge of these techniques for designing various experiments in research and development

Content	*Hrs*
1. General principles of analytical biochemistry a. Selection of valid methods for analysis, Instrumental methods, physiological methods, assessment of analytical methods. b. Quality assurance in analytical biochemistry: quality control and quality assessment, c. Accreditation of laboratories: standard operating procedure and good laboratory practice, sampling for analysis, calibration and graphical representation of data.	4
2. Acid, bases and buffers a. Units used in quantitative biochemical measurements: molarity, normality, parts per million and percentage by weight/ volume, concept of pH using pH electrode and other ion selective electrodes., Eh, acid-base associations. b. Buffers, buffering capacity, measurement of pH, mechanism of dissociation of macromolecules, dissociation constants, pKa, pI, solvents (eluotropic series), peroxide values, solubility and affinity constants.	10
3. Colligative Properties a. Definitions, Factors affecting and Physiological Applications of Osmosis. b. Measurement of osmotic pressure, Osmoregulation, Adsorption, Colloids, Surface Tension and Viscosity. c. Numerical Problems based on above concepts.	4
4. **Centrifugation:** a. Principle of centrifugation, concepts of RCF, different types of instruments and rotors. b. Preparative, differential and density gradient centrifugation, analytical ultra-centrifugation. c. Determination of molecular weights and other applications, subcellular fractionation.	8
5. Electrophoretic techniques: a. Principles of electrophoretic separation, Types of electrophoresis including paper, cellulose, acetate/nitrate and gel (introduction to concepts of slab gel, tube, continuous and discontinuous, etc). b. Gel electrophoresis - types of gel, Agarose GE, Polyacrylamide gel electrophoresis PAGE, SDS- PAGE, Isoelectric Focusing and ampholytes, 2-D, native, gradient gels, PFGE, DGGE, TGGE. c. Capillary electrophoresis - instrumentation, sample introduction in CE, types of CE, electrophoretic mobility and electroosmotic mobility, total mobility, efficiency and resolution in CE column. d. Separation of neutral molecules by MEKC. e. Staining strategies and procedures: Coomassie Brilliant blue R/G 250, Silver, Fluorescent stains Flamingo, Oriole, SYPRO-Ruby; Stain-free gels. f. Examples of separation of biomolecules by electrophoresis.	10
6. Solvent extraction	5

a. Basic principle, types of extractions and application. b. Separations based on a partitioning between phases based on chemical nature and polarity of analyte. c. Introduction to Soxhlet apparatus, solid phase extraction, microwave assisted extraction, ultrasound assisted extraction, counter current extraction.	
7. Dialysis a. Principles and applications of equilibrium dialysis and ultrafiltration. b. Dialysis and Concentration, reverse dialysis. c. Artificial membranes, semi-permeable membranes, Donnan membrane equilibrium. d. Biological significance of osmosis and micelles.	5
8. Chromatographic techniques: a. Introduction to chromatography: definitions, theories, principle of chromatographic technique, terms and parameters used in chromatography, classification of chromatographic methods, concept of mobile phases; gradient elution (concave, convex and linear) and stationary phases. b. Basic principles, instrumentation and application of thin-layer, paper chromatography, column chromatography, HPLC, GC, ion-exchange chromatography, affinity chromatography, molecular exclusion chromatography and adsorption chromatography. c. Special chromatographic techniques for nucleic acids: DNA cellulose chromatography, MAK hydroxyl-apatite chromatography. d. Introduction to Supercritical-Fluid Chromatography and hyphenated techniques like LCMS, GCMS.	14
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments/ presentations /self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Wilson K., Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; 2010, 7th Edition. 2. Christian G. D., Dasgupta P. K, Schug K. A; Analytical Chemistry; John Wiley & Sons; 2013, 7th Edition. 3. Parakhia M. V., Tomar, R. S., Patel S., Golakiya B. A.: Molecular Biology and Biotechnology: Microbial Methods; New India; 2010. 4. Homes D. J., Peck H; Analytical Biochemistry; Pearson education Limited; 1998. 5. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis; Cengage Learning 2016, 7th Edition. 6. David. J. Holme., Hazel Peck.; Analytical Biochemistry; Prentice Hall 1998, 3rd Edition.

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Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 413**
Title of the course: **Molecular Biology**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have graduate level knowledge either in chemical or life sciences or should have qualified change of discipline test.
Course Objective:	1. To introduce the students to the structure of nucleic acids, their folding and packaging inside living cells and viruses. 2. To acquaint the students to concepts of damage to DNA, the repair mechanisms initiated by the cell and the expression and regulation of genes in prokaryotes and eukaryotes.
Course Outcome:	1. The student will be able to outline and explain the fundamental concepts of genetics like structure and packaging of nucleic material. 2. The student will be able to illustrate and explain the mechanisms of DNA damage, repair and recombination. 3. The student will be able to describe and discuss the process of expression of genes in prokaryotes and eukaryotes.

Content	*Hrs*
1. Mendelian Genetics a. Basic concepts of Mendelian genetics: Mendel's Principles, Mendel's experiment, allele, wild-type and mutant alleles, dominant and recessive allele, homozygous and heterozygous , genotype, phenotype. b. Laws of inheritance: Mendel's law of inheritance, Law of segregation, monohybrid cross, test cross, Law of independent assortment, incomplete dominance and codominance, multiple alleles. c. Prediction, expression and probability: predicting blood groups of progeny, lethal alleles, penetrance and expressivity, Probability: predicting outcome of genetic crosses.	10
2. Structure and properties Nucleic acids a. DNA as genetic material: Structure of DNA and RNA, Types of DNA based on their structure and their importance in cell (A-DNA, B-DNA, Z-DNA), Types of DNA based on the functionality and their importance in cell (Satellite DNA, Palindrome DNA, Repetitive DNA). b. RNA: Types of RNA (mRNA, antisense mRNA, rRNA, tRNA), their structure and functions. c. Functions and properties of DNA: Fundamental functions of DNA, Buoyant density, melting temperature (Tm), DNA reassociation kinetics (Cot curve analysis), DNA methylation and epigenetic effects(Agouti gene methylation, maternal diet and offspring coat colour).	12
3. Genome organization and Packaging a. Viruses (icosahedral capsid and helical capsids) b. Prokaryotes (supercoiling, nucleosomes and nonhistone proteins) c. Eukaryotes (supercoiling, nucleosomes, histones, chromatin and chromosome). d. Heterochromatin and euchromatin, Importance of structural features of chromosome (telomere, centromere and repetitive sequences), Functions of the chromosomes.	6
4. Model organisms and Mechanisms of gene transfer a. *Escherichia coli as* a model prokaryotic organism. b. Yeast as a model eukaryotic organism.	5

c. Mechanisms of Gene Transfer: transformation, transduction, conjugation, plasmids (natural, artificial), episomes.	
5. Mechanisms of DNA damage, repair and recombination a. Mutations and mutagenic agents: Types of mutations (point mutations, frameshift mutations, forward mutations, reverse mutations, suppressor mutations, transitions and transversions), Role of Mutagenic agents (spontaneous and induced mutagenic agents). b. DNA repair mechanisms/ pathways: (Base excision repair, Mismatch repair, SOS repair, Photoreactivation repair, recombination repair. c. Mechanisms of Genetic recombination: Homologous and site-specific recombination, Role of synaptonemal complex, lamp brush chromosomes, chi sequences, Rec BCD system, Role of Rec A, Ruv C, Holliday junctions.	12
6. Flow of genetic information and expression of genes in prokaryotes and eukaryotes, **Concept of Central Dogma** a. Replication: replication of DNA, Semi conservative nature of DNA replication. b. Transcription: transcription factors and machinery, formation of transcription initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation, and termination, RNA to proteins (reverse transcription). Post transcriptional modifications: attenuation, riboswitches, alternate splicing, RNA interference, RNA processing, RNA editing, and polyadenylation, RNA transport. c. Translation: structure of Ribosome (eukaryotes and prokaryotes), formation of translation initiation complex, initiation factors and their role in regulation of initiation of translation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post translational modification of proteins in prokaryotes and Eukaryotes.	11
6. Control of gene expression at transcription and translation level a. Regulation of gene the expression of phages, viruses, prokaryotic and eukaryotic genes. b. Role of chromatin in gene expression and gene silencing. c. Role of Recognition sequences or motifs of gene regulatory proteins, Genetic switches and their role in gene expression.	4
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipursky, L., & Darnell, J.;Molecular cell biology; W.H. Freeman; 2008, 5th Edition. 2. Watson, J. D., Molecular Biology of the Gene; Pearson/Benjamin Cummings; 2013, 7th Edition. 3. Craig, N., Cohen-fix, O., Green, R., Molecular Biology: Principles of Genome function, Oxford University Press, 2014, 2nd Edition. 4. Alberts B., Johnson, A., Molecular biology of cell, Garland Science, 2014, 6th Edition.

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Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 414**
Title of the course: **Cell and Developmental Biology**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have graduate level knowledge either in chemical or life sciences or should have qualified change of discipline test.
Course Objective:	1. The objective is to offer detailed knowledge about cell biology, various cellular organelles, the communication pathways associated with cellular processes. 2. Introduction of the fundamental concepts of organismal developmental biology. 3. The course aims to provide the students insights on basic cell culture techniques and their current applications.
Course Outcome:	1. Students will be able to describe the cell structure, cell division and cell cycle mechanisms, various cellular organelles and their functions. 2. Students will be able to explain the processes of transport across cell membranes, various cellular communication pathways along with their significance and understand the fundamentals of developmental biology. 3. The students will be able to apply the basic cell culture techniques needed to work in a biological research laboratory. 4. The students will be prepared for advanced courses in life science such as Cancer biology, Neurochemistry, etc.

Content	*Hrs*
1. Structural organization of the cell a. Prokaryotic and eukaryotic cells. b. Animal and plant cells. c. Structure and functions of cellular and subcellular organelles.	10
2. Biological membrane structure and function a. Structure and functions of membrane. b. Transport across cell membrane. i. Passive and active transport of molecules across biological membranes. c. membrane pumps.	5
3. Cell division and cell cycle a. Mitosis. b. Meiosis. c. Regulation of the cell cycle.	5
4. Cellular communication and Cell signalling a. Signal transduction pathway. b. Signaling molecules and their receptors. c. G-Protein Coupled receptors. d. Receptor Tyrosine Kinases. e. MAP kinase pathway and JAK-STAT pathway. f. Light signaling in plants. g. Bacterial chemotaxis and quorum sensing. h. Programmed cell death (Apoptosis).	10
5. Fundamentals of organismal development	6

a. Potency, commitment, specification, induction, competence. b. Determination and differentiation, morphogenetic gradients. c. Cell fate and cell lineages. d. Stem cells, genomic equivalence. e. Cytoplasmic determinants, imprinting and mutants.	
6. Early organismal development a. Gametogenesis. b. Cell surface molecules in sperm-egg recognition in animals. c. Embryo sac development and double fertilization in plants. d. Zygote formation, cleavage, blastula formation, embryonic fields gastrulation. e. Formation of germ layers in animals, embryogenesis. f. Establishment of symmetry in plants. g. Seed formation.	6
7. Plant tissue culture: techniques and applications a. Introduction to plant tissue culture and various requirements. b. Preparation for tissue culture. i. Surface sterilization of plant tissue material. ii. Basic procedure for aseptic tissue transfer. c. Tissue culture methodologies. i. Callus Culture. ii. Cell Suspension Culture, protoplast culture and hybridization. iii. Organogenesis. iv. Plant micropropagation. v. Somatic Embryogenesis. vi. Incubation and maintenance of culture. d. Applications of PTC.	6
8. Animal tissue culture: techniques and applications a. Introduction to animal tissue culture and various requirements. b. Typical cell lines, growing mammalian cells and general maintenance of cells. c. Applications of ATC.	6
9. Microbial culture techniques a. *In vitro* culture techniques. b. Nutrient requirements. c. Applications in industry.	6
Pedagogy	Mainly lectures and tutorials. Seminars /term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Karp, G.; Cell and Molecular Biology: Concepts and experiments; John Wiley and Sons Inc., 2015; 8th Edition. 2. Lodish, H.; Berk A.; Kaiser, C. A; Krieger, M.; Bretscher, A.; HiddePloegh, Amon A.; Martin, K. C.; Molecular Cell Biology; W.H. Freeman and Company; 2016; 8th Edition. 3. Freshney, I.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; 2016; 7th Edition. 4. DeRobertis, E.D.P.; DeRobertis Jr. E.M.F; Cell and Molecular Biology; Saunders; 2017; 8th Edition.

	5. Pelczar, M.; Reid, R.D.; Chan E.C.S.; Microbiology. MacGraw-Hill; 2001; 5th Edition. 6. Smith, R.H.; Plant tissue culture: technique and experiments; Academic Press; 2012; 3rd Edition. 7. Gilbert, S.F.; Barresi M. J.; Developmental Biology; Oxford University Press; 2020; 12th Edition.

Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCO 411**
Title of the course: **Laboratory course in Biochemistry-I**
Number of Credits: **04** Total Hours: **120** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have graduate level knowledge either in chemical or life sciences or should have qualified change of discipline test.
Course Objective:	1. To understand principles, theory and calculations of each experiment. 2. To gain hands on preparation of all the solutions and to standardize solutions individually. 3. To develop basic understanding and skills of various instruments and techniques used for analysing biomolecules.
Course Outcome:	1. After learning the biomolecules and bioenergetics unit of the practical students will be able to skilfully handle biomolecules. Students will be able to quantify biomolecules with appropriate methods. 2. With Analytical Biochemistry-I part of this practical, students will be able to choose between the separation techniques and carry out separation and purification of biomolecules. 3. Molecular Biology unit of the practical will train the students in techniques involved in genomic DNA isolation and PCR amplification for its use in molecular research. 4. In the Cell Biology part of the practical, the students will be able to demonstrate the various cell culture techniques needed to work in a biological research laboratory.

Content	*Hrs*
1. Biomolecules and Bioenergetics (Any six) a. Estimation of reducing sugars by DNSA method. b. Colorimetric methods for protein estimation by Biuret method. c. Colorimetric methods for protein estimation by Folin-Ciocalteau methods. d. Estimation of total sugars by anthrone method. e. Estimation of amino acids (ala, tyr, trp) and protein by UV-Vis spectroscopy. f. Estimation of nucleic acid by UV-Vis spectroscopy. g. Estimation of DNA by diphenylamine method. h. Estimation of RNA by orcinol reaction.	30
2. Analytical Biochemistry-I (Any six) a. Calibration of pH meter using standard buffer solutions and determination of pH of given unknown solution b. Preparation of acetate and phosphate buffer of different pH values using calibrated pH meter.	30

c. Separation of mixtures of compounds (organic compounds including biomolecules) based on their chemical nature using solvent extraction. d. Separation of lipids by thin layer chromatography. e. Separation of mixtures of compounds (organic compounds including biomolecules) by thin layer chromatography. f. Column chromatographic separation of mixtures of compounds (organic compounds including biomolecules). g. Separation of amino acids by paper chromatography. a. Separation of mixtures of compounds (organic compounds including biomolecules) by HPLC. b. Separation of amino acids by Ion Exchange chromatography. c. Separation and detection of plant pigments by using thin layer chromatography.	
3. Molecular Biology (Any six) a. Preparation and maintenance of microbial culture. b. Isolation of genomic DNA of bacterial cells. c. Estimation of quantity and purity of DNA by spectrophotometry. d. Agarose gel electrophoresis of bacterial DNA. e. PCR amplification of a specific gene using genomic DNA as a template. f. Agarose gel analysis of PCR product to determine amplicon size. g. Isolation of plasmid DNA from microbial cells. h. Agarose gel electrophoresis of plasmid DNA.	30
4. Cell Biology (Any six) a. Use of aseptic techniques of sterilization and disinfection in microbial culture. b. Isolation of microbial species from an environmental sample such as soil/water. c. Cell counting and viability of fungal/bacterial cells via spread plating. d. Primary identification and characterization of bacterial/ fungal cells via colony characterization on solid media. e. Determining the Gram character of a bacterial species via Gram's staining technique. f. Isolation of tissue, culturing and maintenance of cell lines. g. Microscopic examination and cell counting, viability testing using a haemocytometer. h. Surface sterilization of plant material, excision, aseptic tissue transfer i. Induction of callus using plant explant and micropropagation.	30
Pedagogy	Mainly lectures and tutorials. Seminars /term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; 2010; 7th Edition 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; 2005. 3. Freshney, I. R.; Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; 2016; 7th Edition. 4. Kumar, D. K.; Plant tissue culture; New Central Book Agency; 2008; 1st edition.

	NOTE: Apart from the references cited above, references given under respective theory courses (BCC 411, BCC 412, BCC 413, BCC414) may be referred.

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Programme: **M.Sc. Part-I (Chemistry)**
Course Code: **BCO 412**
Title of the course: **Biochemical Methods of Analysis**
Number of Credits: **04** Total Hours: **120** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have studied chemistry courses at graduate level or must have cleared the change of discipline entrance test.
Course Objective:	1. To provide basic knowledge of environmental pollution, effects of environmental pollutants and control measures. 2. To introduce various experimental techniques for analysis of environmental samples. 3. To impart skills in isolation and analysis of bioactive compounds in plants 4. To acquaint the students with various food adulterants, food safety and methods of their analysis.
Course Outcome:	1. Students will be able to extract a bioactive compound from plants and perform a quantitative analysis. 2. Students will be in position to use different techniques for qualitative and quantitative analysis of environmental samples. 3. Students will be able to identify adulterants and pathogens in food. 4. Students will be able to explain the origin and harmful effects of toxic chemicals in the environment.

Content	*Hrs*
1. Microbial Techniques (Any six) a. Laboratory safety protocols and Preparation of media and sterilization techniques. b. Isolation and enumeration of bacterial and fungal cultures from various environmental samples. c. Identification of microbial isolates: Morphological and biochemical identification technique d. Gram staining in bacteria. e. Determinations of total viable count. f. Determination of efficacy of cell disruption by sonication. g. Density gradient separation of cell biomolecules. h. Study of bacterial growth curve.	30
2. Analysis of bioactive compounds from plants (Any six) a. Extraction and estimation of betacarotene from fruits. b. Extraction and estimation of folic acids from vegetables. c. Extraction and estimation of lycopene from tomatoes. d. Extraction and estimation of astaxanthene from grapes. e. Separation of plant pigments using column chromatography. f. Steam distillation for extraction of essential oils.	30

g. Determination of starch in plant tissues. h. Estimation of mineral contents in pulses by ashing method.	
3. Environmental analysis (Any six) a. Estimation of acidity, alkalinity of environmental water samples using titrimetry. b. Estimation of nitrate and total organic carbon using UV-Vis spectrophotometry. c. Estimation of total dissolved solids (TDS) by gravimetric determination. d. Estimation of nitrate using cadmium reduction column method. e. Estimation of total phosphorus using spectrophotometric method. f. To estimate total suspended solids (TSS) using the filter paper method. g. Isolation of xenobiotic degrading bacteria by selective enrichment. h. Calcium analysis by ethylenediaminetetraacetic acid (EDTA) titration.	30
4. Food safety analysis. (Any six) a. Study of sterilization techniques used in food safety. b. Screening and enumeration of spoilage bacteria from food samples. c. Study of spoilage fungi isolated from fruit samples. d. Assessing the quality of raw milk *via* MBRT test. e. Determination of total viable count in prepared (ready to eat) food sample. f. Determination of adulterants in food (turmeric- metanil yellow/ chilli powder-congo red) g. Testing the adulteration/ rancidity in oils. h. Assessment of surface sterilization using swab and rinse Method	30

Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; 2010; 7th Edition. 2. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; 2005 3. SMT. B. Poornima B., Food Science & Quality Control, Centrum Press First ,2014, 1st Edition. 4. Sathe, A.Y., A first course in Food Analysis, New Age International Pvt. Ltd., 1999, 1st Edition.

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Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 415**
Title of the course: **Enzymology**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have studied biochemistry at M.Sc. semester I level. It is assumed that students have a basic knowledge of fundamentals in biochemistry.

Course Objective:	1. To introduce enzymes and the important role they play in metabolism 2. To develop knowledge regarding basic concepts of enzyme such as enzyme activity, kinetics and mechanism of action. 3. To develop understanding about techniques used for purification of enzymes.
Course Outcome:	1. The students will be able to classify and discuss enzymes, their mechanism of action, regulation and kinetics. 2. The students will be able to determine and choose biochemical techniques for purification of enzymes.

Content	*Hrs*
1. Introduction to enzymes a. Types of enzymes: Simple enzymes, conjugated enzymes. b. Cofactors and prosthetic groups: Coenzymes and cofactors and their role in enzyme activity, prosthetic group, metalloenzymes. c. Nomenclature and classification of enzymes. d. Structure and specific sites: Enzyme structure, enzyme-substrate complex, binding sites, concept of active site, stereo-specificity. e. Enzymes as catalysts: lock and key model, induced fit model, role of enzymes to increase reaction rates: transition state theory and activation energy.	10
2. Enzyme Kinetics and Enzyme-substrate interactions a. Enzyme activity, Enzyme Assay, specific activity (Definition and units). b. Enzyme kinetics: Michaelis-Menten Equation: formula and derivation, Line-Weaver Burk plot for one substrate reactions. c. Significance of Vmax and Km. d. Kinetics of bi- or multi reactant system. e. Effect of pH, temperature on enzymes. f. Enzyme inhibition: reversible (competitive, uncompetitive, mixed inhibition) and irreversible inhibition. g. Enzyme turnover: Ks, Kd and measurement of enzyme turnover. h. Correlation between the rates of enzyme turnover and structure and function of enzymes, significance of enzyme turnover. i. Mechanism of enzyme degradation.	16
3. Mechanism of Enzyme Action and Enzyme regulation a. Mechanism of Enzyme catalysis, Determination of active centre. b. Identification of functional groups, Factors affecting catalytic efficiency: proximity, orientation, strain, Enzyme catalytic strategies: covalent, acid - base catalysis, metal ion catalysis. c. Enzyme Regulation: control of enzyme activity, control of enzyme availability, inhibitor or enhancer molecules. d. Mechanisms of enzyme regulation and their significance in metabolism: i. Allosteric regulation (aspartate transcarbamylase). ii.Reversible covalent modification (glycogen phosphorylase,glutamine synthetase). iii.Feedback inhibition and feedback repression.	14
4. Enzyme systems a. Zymogens and Isozymes.	12

b. Multienzyme systems: disassociated system (catabolic enzymes), multienzyme complex (pyruvate dehydrogenase) membrane-bound system (electron carrying enzymes). c. Nucleic acid as catalysts: Ribozyme, DNAzyme; Abzyme. d. Mechanism of action of lysozyme, chymotrypsin, aspartate protease, RNase A.	
5. Enzyme purification techniques a. Isolation of intracellular and extracellular enzymes from plant and animal tissues and microbial cells. b. Separation and purification of enzymes by differential centrifugation, salt precipitation, dialysis, ultrafiltration, molecular exclusion chromatography, affinity chromatography, ion exchange chromatography. c. Determination of Enzyme activity, Specific activity and fold purification as criteria of purity of enzymes. d. Zymograms. e. Molecular weight determination by PAGE, SDS-PAGE.	8

Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Berg, J.M., Stryer, L., Tymoczko, J., Gatto, G., Biochemistry, WH Freeman, 2019, 9th edition. 2. Nelson, D. L. and Cox, M. M. Lehninger Principles of Biochemistry, WH Freeman 2017, 7th edition. 3. Price, N. and Stevens, L., Fundamentals of Enzymology, Oxford University Press, 1999, 3rd edition. 4. Plummer, D.T., An introduction to practical biochemistry, TATA McGraw Hill, 2006, 3rd edition. 5. Oktore R.O, Essentials of Enzymology, Xlibris-US, 2015. 6. Bugg T.D.H, Introduction to enzymes and coenzyme chemistry, Wiley, 2012, 3rd Edition.

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Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 416**
Title of the course: **Analytical Biochemistry-II**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have studied biochemistry at MSc. semester I level. It is assumed that students have a basic knowledge of fundamentals in biochemistry and certain basic techniques in routine laboratory analysis.
Course Objective:	1. To Introduce various electro-analytical, imaging and spectral characterisation techniques for analysis. 2. To evaluate the utility of various analytical techniques as a qualitative and quantitative tool. 3. To develop concepts in techniques and instruments required for macromolecule structure determination and other techniques such as tracers for metabolic pathways.
Course Outcome:	1. Students will be able to differentiate between various analytical techniques based on their theory and sensitivity achieved. 2. Students will be able to choose between various techniques of structure elucidation based on the information desired and interpret the data obtained to a fair level. 3. Students will be in a position to explain the principles of various techniques and apply the knowledge of these techniques for designing experiments in research and development.

Content	*Hrs*
1. Automation in biochemistry a. Definition and history. b. Discrete analysers and flow analysis. c. Advantages and disadvantages of automation.	4
2.Electroanalytical methods a. Introduction to ion selective and gas sensing electrodes and their applications. b. Introduction to potentiometry, conductometry, coulometry and voltammetry. c. Introductions to biosensors.	7
3. Optical methods of analysis a. Theory, instrumentation and application of nephelometry. b. Theory, instrumentation and application of turbidimetry. c. Theory, instrumentation and application of UV-visible spectrophotometry. d. Theory, instrumentation and application of fluorometric analysis. e. Theory, instrumentation and application of flame emission photometry and Atomic absorption spectrophotometry.	12
4. Microscopy and Bioimaging a. Imaging living cells and tissues and measuring cellular dynamics. Theory of microscopy, basic aspects of compound microscope. b. Light microscopy: Theory, instrumentation and applications of bright field, dark field,	11

phase-contrast, inverted microscopy. c. Principle and application of fluorescence microscopy, confocal scanning microscopy, epifluorescence and immuno-fluorescence microscopy. d. Electron microscopy: Theory, instrumentation and applications of atomic force microscopy (AFM), scanning electron microscopy (SEM), transmission electron microscopy (TEM). Optical tweezers, photography.	
5. Radioisotope techniques a. Nature of radioactivity and its detection, measurement of radioactivity, Disintegration kinetics. b. Radio-activity counters and radioanalysis – GM Counter, Scintillation Counter, Isotope dilution analysis. c. Theory and application of Autoradiography. d. Theory and application of radiorespirometry. e. Tracer techniques for metabolic pathways. f. Safety measures in handling radioisotopes.	8
6. Spectroscopic techniques for structure determination of biomolecules: a. Principles, application and profile analysis of: FTIR, NMR, ESR, Single crystal X-ray diffraction, optical rotatory dispersion, circular dichroism. b. Structure elucidation of metabolites using combined spectroscopic data.	12
7. Mass Spectrometry: a. Principle, components, working and applications of mass spectrometer. b. Different types of ionization methods used in mass spectrometer (CI, EI, ESI, FAB). c. Different types of mass analysers used in mass spectrometers (magnetic sector, quadrupole), MALDI-MS, MALDI-TOF-MS, ICP-MS. d. Structural information by tandem mass spectrometry.	6
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1.Wilson, K.; Walker, J.; Principles and Techniques of Practical Biochemistry; Cambridge University Press; 2010,7th Edition. 2. Christian, G. D.; Dasgupta, P. K.; Schug, K. A.; Analytical Chemistry; John Wiley & Sons; 2013, 7th Edition. 3. Skoog, D. A.; Holler, F. J.; Crouch, S. R. Principles of Instrumental Analysis; Cengage Learning; 2016,7th Edition. 4. Parakhia, M. V.; Tomar, R. S.; Patel, S.; Golakiya, B. A.; Molecular Biology and Biotechnology: Microbial Methods; New India, 2010. 5. Homes, D. J.; Peck, H.; Analytical Biochemistry; Pearson Education Limited; 1998, 3rd Edition. 6. de Hoffmann, E.; Stroobant, V.; Mass Spectrometry: Principles and Applications; John Wiley & Sons Ltd; 2007, 3rd Edition.

Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 417**
Title of the course: **Immunology and Immunotechniques**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have studied biochemistry at MSc.semester I level. It is assumed that students have a basic knowledge of fundamentals in biochemistry.
Course Objective:	1. The objective of the course is to provide an insight into the components of the immune system, their development, their functions and their mechanisms of action and various Immunological techniques. 2. This course will enable students to understand the role of the immune system in eliciting immune response.
Course Outcome:	1. Students will be able to visualize the importance of the immune system in the human body to fight pathogens. 2. Students will be able to schematize mechanisms of Immunological response. 3. Students will be able to illustrate the importance of antigen-antibody interactions and various serological techniques for immunological research. 4. Students will be able to devise strategies in designing immunological experiments based on their understanding about immunological processes.

Content	*Hrs*
1. Cells and Organs of the Immune system a. Cells of the immune systems. i. Hematopoiesis; Lymphocytes and Antigen presenting cells (APCs). ii. T cells: Maturation; Activation and Proliferation; T cell subsets and their functions; T cell receptor; structure and organization. iii. B cells: Maturation, Activation and Proliferation; Functions; T cell receptor, Structure and Organization. b. Organs of the immune systems. i. Primary and secondary lymphoid organs: Structure and function.	10
2.Innate Immune response a. Mechanical barriers to infection. b. Physiological factors contributing to innate immunity. c. Inflammatory response: Mechanism and mediators involved. d. Phagocytic system: Activation of macrophages and mechanism of phagocytosis. e. Complement system: Components; Properties; function; Activation of complement pathways (Classical, Alternative and lectin pathways); Consequences of complement activation; Complement fixation test.	8
3.Adaptive immune response a. Cell-mediated and Humoral immunity: primary and secondary immune response. b. Major Histocompatibility Complex: Molecular organization of MHC molecules (H-2, HLA); Structure of MHC molecules; Class I MHC-peptide and Class II MHC-Peptide interactions; self MHC restriction of T cells; Gene	8

organisation and concept of MHC polymorphism; MHC expression and its regulation. c. Antigen processing and presentation pathways: Cytosolic and Endocytic pathways.	
4.Antigens and Antibodies a. Antigens: Chemical complexity and molecular property of Antigens; Immunogens; Haptens; Epitopes; Antigenicity and Immunogenicity. b. Antibodies: i. Structure and function of various classes of immunoglobulins. ii. Antigenic determinants on immunoglobulins. iii. Monoclonal and Polyclonal antibodies: their production by hybridoma technology and clinical uses.	6
5. Immunogenetics a. Theories of antibody formation. b. Generation of antibody diversity. c. Class switching among constant-region genes.	4
6. Immune effector mechanisms a. Cytokines: properties; Receptors and Functions. b. Immunological tolerance. c. Hypersensitivity reactions: Classification and mechanisms. d. Autoimmunity: Pathogenesis; Classification (Organ-specific autoimmune disease and Systemic Autoimmune diseases).	6
7.Immune system in health and disease: a. Immunodeficiencies: Primary and secondary immunodeficiencies. b. Transplantation immunology: Definition; Immunologic Basis of Graft Rejection; Allograft rejection; Clinical features of graft rejection; Graft v/s host reaction; Immune tolerance to allograft; Immunosuppressive therapy for prevention of graft rejection. c. Concepts of vaccines: whole-organism vaccines; recombinant vaccines; DNA vaccine; synthetic peptide and multivalent subunit vaccines.	8
8. Immunotechniques: a. Antigen – antibody reactions: General features of Ag-Ab reactions, Stages of Ag-Ab reactions (primary and secondary). b. Principles and techniques: *in vitro* precipitation; agglutination; immunofluorescence; immunodiffusion; immunoelectrophoretic; ELISA; RIA; Avidin-Biotin complex (ABC) method; Western blotting; Immunohistochemistry; flow cytometry.	10
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Owen, J.; Punt,J.; Stranford, S.; Patricia, J.; Kuby Immunology, WH Freeman and Company, 2012, 8th Edition. 2. Martins, S.J.; Burton,D.R.; Roitt, I.M.;Delves,P.J.; Roitt's Essential Immunology;Wiley Blackwell; 2017; 13th Edition. 3. Abbas,A.; Lichtman, A.; Pillai, S.; Cellular and Molecular Immunology; Ed. Saunders; Elsevier; 2014; 8th Edition. 4. Parija, S.C.; Textbook of Microbiology and Immunology; Elsevier; 2012; 2nd Edition.

	5. Hay, F.C.; Westwood, O.M.R; Practical Immunology; Cold spring Harbour; 2002; 4th Edition.

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Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCC 418**
Title of the course: **Industrial Biochemistry**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have studied biochemistry at M.Sc. semester I level. It is assumed that students have a basic knowledge of fundamentals in biochemistry.
Course Objective:	To develop the concepts and principles for handling, pr ocessing and managing biomolecules at commercial scale.
Course Outcome:	1.Students will be able to understand and apply the principles of tools and techniques of biochemistry in various settings of industrial processes. 2. Students will be able to develop strategies for production of various types of biomolecules.

Content	*Hrs*
1. Fermentation and bioreactors a. Introduction to Fermentation: Industrial fermentation and its range, advantages of industrial fermentations over chemical manufacturing process, types of fermentation processes: submerged and solid-state fermentation, modes of fermentation: batch, fed-batch and continuous, microbial growth curve and its use in designing modes of fermentation. b. Fermenters: Basic components of a fermenter, types of fermenters with their advantages and disadvantages, solid state fermentation, anaerobic fermentation. c. Significance and control of various fermentation parameters: Maintenance of aseptic conditions, methods of sterilisation, aeration and agitation, Industrial media and the nutrition of industrial organisms, Scale up and scale down of a fermentation process, rheological properties of fermenter, Online and offline monitoring, computerization of fermenter operation. D. Downstream processing: Steps of downstream processing: Details of removal of insolubles, disruption of cell, isolation/extraction/purification, recovery and final product isolation of fermentation products.	16
2. Food technology a. Characteristics of industrial microorganisms; strain improvement; use of auxotrophic mutants; cultivation of microorganisms. b. Introduction to processed foods: Introduction about different food industries, general properties and microorganisms involved in it	16

c. Industrial production of few food products; i. Production of foods made from milk: Cheese, Probiotics – yoghurt/ curd. ii. Production of alcohol-based fermentation products: wine, beer, vinegar. iii. Production of oriental fermented foods: Soy sauce, tofu, tempeh. iv. Production of Indian fermented foods: Idli, dosa, dokhla. v. Production of ethnic fermented foods and beverages of Goa.	
3.Industrial production of biochemically important products a. Production of industrially important proteins. i. Industrially important enzymes - amylase / protease / pectinase / lipase. b. Production of industrially important carbohydrates. i. Manufacturing and refining of cane sugar, pectin/cellulose ii. Manufacturing of polysaccharides. Plant polysaccharide (Gum Arabic), microbial polysaccharides, modified carbohydrates – modified starches, modified celluloses c. Production of industrially important lipids. i. Extraction and refining of vegetable oils and animal fats in general. ii. Extraction and applications of chlorophyll, carotene, lycopene, curcumin, and essential oils.	9
4.Production of pharmaceuticals, nutraceuticals and biochemicals a. Production of Antibiotics: penicillins/streptomycins. b. Production of Vitamins: B12/ascorbic acid. c . Production of Amino acids: lysine/glutamine. d. Production of Alcohol: ethanol. e. Production of Organic acid: citric acid/ lactic acid.	9
5.Microbial cells as fermentation products: a. Production of Baker's yeast. b. Single cell proteins/Spirulina. c. Bacterial insecticides. d. Mushrooms.	5
6. Immobilized Biocatalysts: Enzymes and Cells a. Rationale for immobilizing enzymes and whole cells. b. Methods for enzyme and whole cell immobilization, supports and their selection. c. Properties of immobilized biocatalysts. d. Industrial applications of immobilized biocatalysts.	5
Pedagogy	Lectures/ tutorials/ seminars/ term papers/assignments/ presentations. Sessions shall be interactive in nature to enable peer group learning. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.

Text Books/ References / Readings	1. Okafor N.,*Modern* Industrial Microbiology and Biotechnology,Science Publishers, 2007, 4th Edition. 2. Frazier W. C. and Westhoff D. C., Food Microbiology –Tata McGraw Hill Publishers, 1995. 3. Stanbury P. F., Whitakar A. and Hall S.; Principles of fermentation technology, Butterworth-Heinemann, 1995, 2nd Edition. 4. Casida, JR L. E.; Industrial Microbiology, New Age International Publishers, 2019, 2nd Edition. 5. Clarke, W.; Biotechnology: Industrial Microbiology a Textbook, CBS Publishers and distributers, 2016. 6. Kuila, A., Sharma, V.; Principles and Applications of Fermentation Technology, Wiley-Scrivener Publishing, 2019, 1st Edition. 7. Tamang J P., Ethnic Fermented Foods and Beverages of India: Science History and Culture. Springer Nature,2020.

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Programme: **M.Sc. Part-I (Biochemistry)**
Course Code: **BCO 413**
Title of the course: **Laboratory techniques and Applications of Biochemistry**
Number of Credits: **04** Total Hours:**120** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have studied biochemistry at MSc.semester I level. It is assumed that students have a basic knowledge of fundamentals in biochemistry.
Course Objective:	This course develops basic understanding and skills of various techniques and instruments in biochemistry research, Immunology and Environmental science.
Course Outcome:	1. Enzymology part of this practical will impart skills on isolation of enzymes from living cells, their purification and understanding their substrate interactions. 2. From the Analytical Biochemistry-II part of this practical, students will be able to explain the principle and working of basic instruments in analytical laboratories and interpret spectral data to elucidate structures of certain secondary metabolites. 3. From the Industrial Biochemistry part of this course, students will develop the skills required for production and analysis of various industrially important metabolites. 4. From the Immunology and Immunotechniques unit of this practical students will be able to evaluate and design various techniques in Immunological research.
Content	*Hrs*

1. Enzymology (Any six) a. Assay of enzyme activity, rate of reaction. b. Optimization of parameters for enzyme activity. c. Determination of specific activity of enzyme. d. Determination of Km, Vmax. e. Screening of microbes for production of enzymes (amylases, cellulases). f. Purification of enzyme by salting-out using ammonium sulphate. g. Dialysis of the precipitated enzyme. h. Purification of enzyme by Gel filtration. i. Determination of fold purification, percentage recovery of protein. j. Molecular weight determination of the enzyme by SDS-PAGE.	30
2. Analytical Biochemistry – II (Any six) a. Visualization of cells by Light microscopy. b. Visualization of cells by Phase contrast microscopy. c. Verification ofBeer lambert law using biomolecules or organic compounds. d. Qualitative analysis of any one of the given amino acids or organic compounds using calorimetry. e. To perform UV-Visible spectroscopic studies to determine extinction coefficient of different organic compounds including biomolecules. (Tryptophan, Tyrosine, Methionine, Proline, Arginine, Cysteine, Cystine, Histidine). f. Calibration ofspectrofluorometer using quinine sulphate. g. Analysis of biomolecule/ organic molecule using GC. h. Analysis of biomolecule/ organic molecule using IR. i. Analysis of biomolecule/ organic molecule NMR. j. Analysis of biomolecule/ organic molecule LC-MS. k. Elucidation of structure of cellular metabolites using IR, NMR and Mass profiles.	30
3. Immunology and Immunotechniques (Any six) a. Agglutination assays. i. Haemagglutination: Determination of ABO and Rh blood group. ii. Latex bead agglutination: Rheumatoid Arthritis factor determination. b. Immunodiffusion assays. i. Single Immunodiffusion. ii. Double Immunodiffusion: Ag-Ab pattern and Antibody titration. c. VDRL test. d. Widal test: Slide and tube method. e. Rapid tests. i. Malarial antigens Pv/Pf. ii. Dengue IgM and IgG antibodies. iii. Hepatitis HBsAg. f. ELISA: Dot-ELISA method. g. Immunoelectrophoresis. h. Determination of Immunoglobulins. i. Precipitation of antibodies with $(NH_4)_2 SO_4$. ii. Determination of antibody concentration. iii. Separation and visualization of immunoglobulins by SDS-PAGE.	30

4. Industrial biochemistry (Any six) a. Production of wine and monitoring of sugar reduction during the fermentation b. Production of wine and monitoring of alcohol production during fermentation c. Production of vinegar and estimation of acetic acid d. Isolation and screening of probiotics e. Study of fermentation process of milk to curd by microscopic observation and monitoring of pH. f. Study fermentation of dosa batter and monitor pH and microbial load in given dosa batter samples g. To perform comparative study of rheology of substrate solutions and fermentation broth (any Indian fermentation productsIdli/ dosa)	30
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Berg, J.M., Stryer, L., Tymoczko, J., Gatto, G., Biochemistry, WH Freeman, 2019, 9th Edition. 2. Prescott, H. Laboratory exercise in Microbiology, MacGraw-Hill Companies, 2002, 5th Edition. 3. Vogel's Text book of Quantitative Inorganic Analysis, Pearson Education, Asia, 2000, 6th Edition. 4. Owen, J.; Punt,J.; Stranford, S.; Patricia, J.; Kuby Immunology, WH Freeman and Company, 2012, 8th Edition. NOTE: Apart from the references cited above references given under respective theory courses (BCC 415, BCC 416, BCC 417, BCC 418) may be referred.

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Programme: **M.Sc. Part-I (Chemistry)**
Course Code: **BCO 414**
Title of the course: **Plant Biochemistry**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2022-23**

Prerequisites for the course:	Students should have studied chemistry courses at graduate level or must have cleared the change of discipline entrance test.
Course Objective:	1. To acquaint students with biochemistry of plants and the mechanisms of photosynthesis. 2. To introduce to students the details of pigment production, toxin production, antioxidative and stress tolerance mechanisms in plants.
Course Outcome:	1. The students will be able to describe and outline the mechanisms of plant photophosphorylation, photosynthesis and functions of plant pigments. 2. The students will be able to explain mechanisms of pigment production, stress tolerance and antioxidant production by plants.

Content	*Hrs*
1. Electron transport system in plants a. Oxidative phosphorylation in plants (cyclic and non-cyclic photo-phosphorylations) b. Mitochondrial respiratory complexes c. Order and organization of electron carriers d. Electrochemical gradient e. Chemiosmotic theory f. ATP synthase and mechanism of ATP synthesis g. Generation of NADPH	10
2. Nitrate assimilation a. Structural features of nitrate reductase and nitrite reductase b. Incorporation of ammonia into organic compounds c. Regulation of nitrate assimilation d. Nitrogen fixing plants	8
3. Photosynthesis a. Photosynthetic apparatus, pigments of photosynthesis, the role of carotenoids b. Photosystems I and II, their location c. Hill reaction, complexes associated with thylakoid membranes d. Light-harvesting complexes, e. Path of carbon in photosynthesis: C3 and C4 pathway of carbon, reduction and its regulation, Photorespiration.	10
4. Special features of secondary plant metabolism a. Terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids, b. Biosynthesis of nicotine c. Functions of alkaloids, d. Cell wall components.	8
5. Toxins of plant origin a. Phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, glycosides, proteinaceous toxins, tannins, oxalates, anti-vitamins, volatile oils, furocoumarins, lectins, solanins and chaconines b. Mechanism of toxin action c. Toxicological effects of plant toxin	8
6. Stress metabolism in plants a. Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavy metals, radiations and their impact on plant growth and metabolism b. Criteria of stress tolerance.	10
7.Antioxidative defence system in plants a. Reactive oxygen species and their generation b. Enzymic and non-enzymic components of antioxidative defence mechanism.	6

Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Text Books/ References / Readings	1. Taiz, L. and Zeiger, E. 2010. Plant Physiology. 5th edition. Sinauer Associates Inc., U.S.A. 2. Hopkins, W.G. and Huner, N.P. 2009. Introduction to Plant Physiology. 4th edition. John Wiley & Sons, U.S.A. 3. Campbell, M.K. 2012. Biochemistry. 7 th edition. Cengage Learning, Boston. 4. Campbell, P.N. and Smith, A.D. 2011. Biochemistry Illustrated. 4 th edition. Churchill Livingstone, London. 5. Berg, J.M., Tymoczko, J.L. and Stryer, L. 2011. Biochemistry. W.H. Freeman and Company, New York. 6. Nelson, D.L. and Cox, M.M. 2008. Lehninger Principles of Biochemistry. 5th edition. W. H. Freeman and Company, New York.

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