GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

REVISED MINUTES

of the 7th Meeting of the

X ACADEMIC COUNCIL

Day & Date

25th February, 2022

Time

10.00 a.m.

Conference Hall, Goa University

D 3.5 **Minutes of the meeting of the Board of Studies in English held on 15.12.2021.**

The Academic Council approved the minutes of the Board of Studies in English held on 15.12.2021 with the following suggestions:

1. Entire content of syllabus under American Literature to be shown in the proper format having clear details of Course contents, Credits, hours of Credits, Exam Pattern, etc.
2. Number of hours of credits to be re-checked for Environment and Literature.
3. More references to be added to the Environmental studies.
4. Pedagogy to be added for all the Courses.
5. Repetition of topics under Environment and Literature to be checked and deleted by the Chairperson, BoS.

(Action: Assistant Registrar Academic - PG)

D 3.6 **Minutes of the meeting of the Board of Studies in Biochemistry held on 11.01.2022.**

The Academic Council approved the minutes of the Board of Studies in Biochemistry held on 11.01.2022.

The House also approved the change of Course Codes of the M.Sc. Part-I (Biochemistry) Courses and the revision of Semester III and IV Syllabus of M.Sc. Biochemistry Programme.

(Action: Assistant Registrar Academic - PG)

D 3.7 **Minutes of the meeting of Board of Studies in Allied Health Science Courses held on 21.01.2022.**

The Academic Council approved the minutes of the Board of Studies in Allied Health Science Courses held on 21.01.2022.

The Academic Council partly approved the amendment to Clause 5 of the Ordinance OC-76.11 regarding Dissertation.

1. The proposed amendment to clause 5 OC-76.11.5 shall be read as:

Existing Clause	**Proposed Clause**
OC-76.11 Dissertation 5. A Guide shall be appointed by **the RC**, for a Candidate, based on the Clinical Speciality of the Dissertation. There shall be not more than four Candidates assigned to a Guide.	**OC-76.11 Dissertation** 5. A Guide shall be appointed by **the RC**, for a Candidate, based on the Clinical Speciality of the Dissertation. There shall be not more than four Candidates assigned to a Guide **in one academic year.**

(Action: Assistant Registrar Academic - PG)

D 3.8 **Minutes of the meeting of the Board of Studies in Civil Engineering held on 04.02.2022.**

The Academic Council approved the minutes of the Boards of Studies in Civil Engineering held on 04.02.2022 with the following minor modification (as underlined) to the OCS note under the revised Scheme of examination for Civil Engineering:

X AC- 7
25.02.2022

GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

A G E N D A

For the 7th Meeting of the

X ACADEMIC COUNCIL

Day & Date

25th February, 2022

Time

10.00 a.m.

	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 (points to be highlighted) as mentioned below : **NIL** ii. The declaration by the Chairperson that the minutes were readout by the Chairperson at the meeting itself. Date: 15.12.2021 Place: Goa University Sd/- Signature of the Chairperson **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: 23.12.2021 Sd/- Place: Goa University Signature of the Dean **(Back to Index)**
D 3.6	**Minutes of the meeting of the Board of Studies in Biochemistry held on 11.01.2022.** **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 approve the change of course codes of the M.Sc. Part-I (Biochemistry) papers** M.Sc. Part-I Biochemistry syllabus which was approved in the BOS held on 14th June 2021 and implemented in this academic year 2021-22 was having some of the paper codes of the old syllabus papers. This created problems for the students during the filling of the examination forms. To sort out this problem, the BOS approved the fresh codes starting from 401 onwards for these papers. (Syllabus of M.Sc Part-I with new codes is attached at **Annexure-IA** **(refer page no.72)** while the table with Biochemistry old & new paper codes is attached at

Annexure-IB (refer page no.94)

2. **To discuss the revision of semester III & IV 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 III and IV of M.Sc. Biochemistry program. The approved syllabus of SEM. III & IV of M.Sc. Biochemistry programme along with the justification for the change is attached as **Annexure II (refer page no. 96)** and **Annexure III (refer page no. 128)** respectively.

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: 18.01.2022 Sd/-
Place: Taleigao Plateau 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 No PART-A (ii)

iii. May be recommended for approval of Academic Council.

iv. Special remarks if any: **NIL**

Date: 18.01.2022

Place: Taleigao Plateau

Sd/-
Dean, School of Chemical Sciences

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D 3.7 **Minutes of the meeting of Board of Studies in Allied Health Science Courses held on 21.01.2022.**

Part A

1. Recommendations regarding course of study in the subject or group of subjects at the under-Graduate level- **NIL**
2. Recommendations regarding course of study in the subject or group of subjects at the Post-graduate level- **NIL**

Part B

1. Scheme of Examination at Under-Graduate level- **NIL**
2. Panel of Examiners at different Under-Graduate levels- **NIL**
3. Scheme of Examination at Post-Graduate level-**NIL**
4. Panel of examiners at different Post-Graduate levels-**NIL**
5. Question paper formats at Under-Graduate level- **NIL**
6. Question paper format at Post-Graduate level-**NIL**

Part C

1. Recommendations regarding preparing and publications of selection of reading material in any subject or group of subjects and the names of the persons recommended for appointment to make the selection-**NIL**

Part D

1. Miscellaneous recommendations regarding the general academic requirement in the department of university or affiliated college-**NIL**

Part E

1. Recommendations of text books for the courses of study at Under-Graduate level **NIL**
2. Recommendations of text books for the courses of study at Post-Graduate level-**NIL**

Part F

1. The amendments in existing AHSC Ordinance 76 for postgraduate degree courses in Allied Health Science were discussed and approved. **OC-76.2.2 Admission Procedure-Clause 2** and **OC-76.11 Dissertation-Clause 5** were discussed and approved.The approved changes with justification in 3 column format are enclosed as **Annexure I** **(refer page no. 135).**
2. The declaration by the Chairman that the minutes of the meeting were read out at

D 3.6 Minutes of the meeting of the Board of Studies in Biochemistry held on 11/01/2022.

Annexure IA

M.Sc. Biochemistry Part-I revised syllabus

Core Papers			
Sl. No.	**Subject code**	**Paper title**	**Credits**
1.	**BCC 401**	Fundamentals of Biomolecules	3
2.	**BCC 402**	Analytical Biochemistry-I	3
3.	**BCC 404**	Bioenergetics and metabolism	3
4.	**BCC403**	Molecular Biology	3
5.	**BCC405**	Laboratory course in Biochemistry-I	4
Optional Papers			
1.	**BCO 401**	Immunology and Immunotechniques	3
2.	**BCO 402**	Biochemistry of Environmental Pollution and Remediation	3
3.	**BCO 403**	Cell biology	3
4.	**BCO 404**	Analytical Biochemistry-II	3
5.	**BCO 405**	Laboratory techniques and Applications of Biochemistry	4

PART -I PAPERS CORE

Programme: M. Sc. (Biochemistry)

Course Code: BCC 401 **Title of the Course:** Fundamentals of Biomolecules

Number of Credits: 3

Effective from AY: 2021-22

Prerequisites for the course:	Students should have basic knowledge of organic and biomolecules and some of the functional groups and stereochemistry.	
Course Objectives	1. To develop concepts about structures and functions of different biomolecules. 2. To understand the reactivity of biomolecules and their role in metabolic pathways.	
Course Outcomes:	Students will acquire insights into the structure and functions of various biomolecules and their 3-dimensional arrangements. Students will be able to understand the reactivity of biomolecules which will help them in better understanding of the metabolic pathways.	
Content:	**1. Introduction:** Origin, aim and scope of Biochemistry **Properties of water**: Structure and properties of water, importance of water in biological systems, Ionic product of water. **2. Chemical bonding, Stereochemistry and Reactions:** Properties of covalent bond, non-covalent bonds and their importance in biological systems. Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and syn & anti nomenclature with respect to biomolecules. Types of biochemical reactions: oxidation-reduction, condensation, rearrangement, cleavage, group- transfer, Resonance bond, electrophilic and nucleophilic substitution reactions. **3. Amino acids and Protein:** Amino acids: Structure, Classification, and physico-chemical properties of amino acids, role of non-protein amino acids, peptides, peptides of physiological significance, peptide bond. Proteins: Structural features of proteins and their biological functions a. Primary Structure: Peptide bond, importance of primary structure. b. Secondary structure: alpha-helix, β - structure, β-helix, super secondary structure. c. Tertiary Structure: Forces stabilizing, unfolding/ refolding d. Quaternary structure – Haemoglobin. **4. Nucleotides and Nucleic acids:** Structure and properties of	**3 h** **6 h** **7 h**

	nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thiamine, Uracil) bases. Structural features of nucleic acids (DNA & RNA) and their biological functions. **5. Carbohydrates:** Structure, stereochemistry, reactions and functions of monosaccharides, disaccharides polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins. **6. 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. Formation of micelles, monolayers, bilayer, liposomes. **7. Vitamins**: Structure and Classification, water soluble and fat soluble vitamins.	**5 h** **6 h** **6 h** **3 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning/ self-study	
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. (Biochemistry)

Course Code: **BCC 402** **Title of the Course:** Analytical Biochemistry-I

Number of Credits: 3

Effective from AY: 2020-21

Prerequisites for the course:	Students should have studied the theory/ instrumentation and application of some of the basic analytical techniques. It is assumed that students have a basic knowledge of fundamentals in biochemistry.	
Course Objectives:	1. Introduction of various bioanalytical techniques for analysis. 2. Evaluate the utility of various analytical techniques as a qualitative and quantitative tool. 3. This course develops concepts in techniques used for routine biochemical work such as chromatography, spectrophotometry, centrifugation, microscopy, electrophoresis.	
Course Outcomes:	1. Students should be in a position to differentiate between various analytical techniques based on their theory and sensitivity achieved. 2. Explain the principles of various techniques and apply the knowledge of the techniques for designing various experiments in research and development.	
Content:	1. **Acid, bases and buffers:** concept of ph, eh, acid-base associations, buffers, buffering capacity, mechanism of dissociation of macromolecules, dissociation constants, pka, pi, solvents (eluotropic series), peroxide values, solubility and affinity constants. 2. **Centrifugation:** Principle of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation. 3. **Electrophoretic techniques:** Principles of electrophoretic separation. Types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Slab gel, tube, Continuous and discontinuous, etc; 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. Capillary electrophoresis-instrumentation, sample introduction in CE, types of CE methodology, electrophoretic mobility and electroosmatic mobility, total mobility, efficiency and resolution in CE column. Separation of neutral molecule by MEKC. Staining strategies and procedures: Coomassie Brilliant blue R/G 250, Silver, Fluorescent stains Flamingo, Oriole, SYPRO-Ruby; Stain-free gels. **4. Separation techniques:** Solvent extraction: Basic principle, types of extractions and application. Separations based on a partitioning between phases based on chemical	**6 h** **5 h** **8 h** **7 h**

	nature and polarity of analyte. Dialysis: Principles, and applications of equilibrium dialysis and ultrafiltration. Artificial membranes, semi-permeable membranes, Donnan membrane equilibrium, and biological significance of osmosis and micelles. 5. **Chromatographic techniques:** Basic principles and application of thin-layer, paper chromatography, column chromatography, HPLC, GC, separation matrixes - Ion-exchange, Affinity, Molecular exclusion and Adsorbtion (hydrophobic interaction chromatography, DNA cellulose chromatography, MAK hydroxyl-apatite chromatography). Concept of mobile phases; gradient elution (concave, convex and linear) and stationary phases	**10h**
Pedagogy:	Lectures (online or physical)/ tutorials/ seminars/ term papers/assignments/ presentations/ self-study or a combination of some of these. Sessions shall 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. Norris J. R., Ribbons D.W.; In Methods in Microbiology; Academic Press; 1971/1st 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. 6. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis; Cengage Learning 2016/ 7th Edition.	

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Programme: M. Sc. Biochemistry

Course Code: BCC 403 **Title of the Course:** Molecular Biology

Number of Credits: 3

Effective from AY: 2021-22

Prerequisites for the course:	Should have studied the courses in gene structure and Hereditary genetics at F Y B.Sc, S Y B.Sc and T Y B.Sc levels.	
Course Objective:	1. To acquaint students on the basic concepts of molecular biology. It explains the structure of nucleic acids, their packaging inside living cells and viruses, damages caused to DNA, the repair mechanisms initiated by the cell, the expression and regulation of genes in prokaryotes and eukaryotes.	
Course Outcome	1. The student will be able to understand the fundamental concepts of genetics and will gain an understanding on the flow of genetic information in viruses, prokaryotes and eukaryotes.	
Content:	**1. Structure of nucleic acid** 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),Types of RNA (mRNA, antisense mRNA, rRNA, tRNA), Fundamental functions of DNA. **2. Packaging of nucleic material:** Packaging of nucleic material in viruses (icosahedral capsid and helical capsids), Packaging of nucleic acids in prokaryotes (supercoiling, nucleosomes and nonhistone proteins), *Escherischia coli as* a model prokaryotic organism, Packaging of nucleic acids in eukaryotes to form chromosomes (supercoiling, nucleosomes, histones, chromatin and chromosome), Yeast as a model eukaryotic organism, Importance of structural features of chromosome (telomere, centromere and repetitive sequences), Functions of the chromosomes. **3. DNA damage by mutations, repair and recombination mechanisms** 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), DNA repair mechanisms/ pathways: (Base excision repair, Mismatch repair, SOS repair, Photoreactivation repair, recombination repair, 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 and heterologous chromosomes in homologous recombination.	**6h** **6h** **12 h**

	4. **Flow of genetic information and expression of genes in prokaryotes and eukaryotes:** Central Dogma of flow of genetic information, replication of DNA, Transcription of RNA, synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA to proteins (reverse transcription). Post transcriptional attenuation, riboswitches, alternate splicing, RNA interference, RNA processing, RNA editing, and polyadenylation, structure and function of different types of RNA, RNA transport. Translation of mRNA to proteins: Structure of Ribosome (eukaryotes and prokaryotes), formation of initiation complex, initiation factors and their regulation, 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. Control of gene expression at transcription and translation level: regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing. Role of Recognition sequences or motifs of gene regulatory proteins; Genetic switches and their role in gene expression.	**12 h**
Pedagogy:	Lectures (online or physical)/ tutorials/laboratory work/ field work/ project work/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
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. Davis, L. G., Dibner, M. D. and Battey, J. F., Basic Methods in Molecular Biology, Elsevier; 1986. 4. Gardner, E. J., Simmons, M. J. and Snustad, D. P. Principles of Genetics, John Wiley & Sons, 1981, 6th Edition	

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Programme: M. Sc. (Biochemistry)
Course Code: **BCC 404** **Title of the Course:** Bioenergetics and Metabolism
Number of Credits: 3
Effective from AY: 2021-22

Prerequisites for the course:	Students should have studied some of the basic knowledge of biomolecules.	
Course Objectives:	To understand the metabolism of biomolecules and their regulation in living cells.	
Course Outcomes:	Students will be able to understand the pathways associated with the degradation and biosynthesis of major macromolecules in living beings.	
Content:	1. **Bioenergetics** Thermodynamics: laws of thermodynamics, mechanism of exergonic and endergonic reactions, redox potential, high energy compounds, ATP structure and significance. 2. **Oxidative Phosphorylation** Redox enzymes, aerobic electron transport and oxidative phosphorylation, ATP synthase and mechanism. 3. **Carbohydrate breakdown metabolism** Regulatory mechanisms, bioenergetics and significance of central pathways of carbohydrate metabolism – Glycolysis and Gluconeogenesis Citric acid cycle, gluconeogenesis from TCA intermediates / amino acids / acetyl-CoA. Pentose phosphate pathway, glyoxalate cycle, glucuronic acid pathway, Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen. Biosynthesis of polysaccharides and sugar interconversions. 4. **Lipid metabolism** Oxidation of fatty acids and its energetics: oxidation of saturated and unsaturated (mono and poly unsaturated fatty acids (PUFA), Peroxisomal oxidation of fatty acids (Phytanic acid), Refsum's disease, ketone body formation and their clinical significance, diabetic keto acidosis, Biosynthesis of fatty acids and regulation, Biosynthesis of triglycerides, cholesterol and phospholipids. 5. **Nucleotides and Nucleic Acids** Purine and pyrimidine nucleotides: biosynthesis and its	**4 h** **2 h** **10 h** **8 h** **5 h**

	regulation. Deoxyribo nucleotides: biosynthesis and regulation. Biosynthesis of nucleotide coenzymes. Catabolism of purine and pyrimidine nucleotides. 6. **Amino acids** 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 biosynthethic 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.	**7 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning/ self-study.	
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. (Biochemistry)

Course Code: **BCC 405** **Title of the Course:** Laboratory course in Biochemistry-I

Number of Credits: 4

Effective from AY: 2021-22

Prerequisites for the course:	Should have basic knowledge on Biochemistry.	
Course Objectives	1. This course develops basic understanding and skills of various instruments and techniques in biochemistry, analysing biomolecules, Analytical biochemistry, Cell biology and Molecular biology.	
Course Outcomes	1. The Biomolecules unit of the practical will train the students with skilful handling and estimating biomolecules and other metabolic products. 2. Analytical Biochemistry-I part of this practical will eexplain the principle and working of basic instruments in analytical laboratory that will train the students in handling various instruments in Analysis. 3. Molecular Biology unit of the practical will teach the students techniques involved in genomic DNA isolation and PCR amplification for it's use in molecular research. 4. Field trip/study tour unit of this course will help the students to understand the working of industries and research institutions and provide them an insight of the prospects available to them. The students will understand the activities and research being carried out in industries and research institutes which reflects the applications of biochemical principles.	
Content		
	I. Biomolecules 1. Standard curve for glucose by DNSA and quantitative estimation of test sample. 2. Colorimetric methods for protein estimation – Biuret method 3. Colorimetric methods for protein estimation –Folin-Ciocalteau methods. 4. Estimation of total sugar by anthrone method. 5. Estimation of amino acids (ala, tyr, trp) and protein by direct spectroscopy. 6. Estimation of nucleic acid by direct spectroscopy.	**24 h**
	II. Analytical Biochemistry-I 1. Calibration of pH meter/weighing balance. Preparation of buffers using pH meter and determination of pH of given sample	**24h**

	2. Separation of compounds based on their chemical nature by solvent extraction. 3. Separation of lipids by thin layer chromatography 4. Separation of organic compounds by thin layer chromatography 5. Column chromatographic separation of organic molecule. 6. Separation of alpha amino acids by paper chromatography. 7. Separation of molecules by HPLC.	
	III. Molecular Biology 1. Preparation and maintenance of microbial culture 2. Isolation of genomic DNA of bacterial cells 3. Estimation of quantity and purity of DNA by spectrophotometry, 4. Agarose gel electrophoresis of bacterial DNA 5. PCR amplification of a specific gene using genomic DNA as a template. 6. Agarose gel analysis of PCR product to determine amplicon size.	**24**
	IV. Field trip/Study tour 1. **Visit to Research/Academic Institutes:** National Centre for Antarctic and Ocean Research [NCAOR], National Institute of Oceanography [NIO], BITS-Pilani, K.K. Birla, Goa campus and ICAR-Central Coastal Agricultural Research Institute (ICAR-CCARI). 2. **Visits to Industries:** Pharmaceutical industry, Agricultural farming, Food and beverage. 3**. Report writing:** Students are supposed to submit report highlighting the following points: i. Instrumental facility and their applications ii. Industrial processes and products iii. Quality checking parameters iv. Ongoing research work. 4**. Evaluation:** i. Every student is supposed to present his/ her report in Departmental council. Evaluation will be based on report writings, oral presentation and viva.	**24 h**
Pedagogy:	Lectures/ tutorials/ laboratory work/ field work/ project work/ viva/ seminars/ assignments/ term papers.	
Text Books/ References / Readings:	References given under respective theory courses (BCC 401, BCC 402, BCC 403) may be referred.	

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PART-I OPTIONAL PAPERS

Programme: M. Sc. (Biochemistry)

Course Code: BCO 401 **Title of the Course:** Immunology and Immunotechniques

Number of Credits: 3

Effective from AY: 2021-22

Prerequisites for the course:	Basic understanding of pathogens, blood cells, and human physiology studied at B.Sc level.	
Course Objectives	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.	
Course Outcomes	1. This course will enlighten the students on the importance of immune system in human body to fight pathogens. 2. Students will be able to understand mechanisms of Immunological response. 3. Students will develop an understanding of antigen-antibody interactions and various serological techniques for immunological research.	
Content	1. **Cells and organs of the immune system** 2. **Innate immune response:** Mechanical barriers to infection, Physiological factors contributing to innate immunity, Inflammatory response and Phagocytic system, Complement system. 3. **Adaptive immune response:** Cell-mediated and Humoral immunity-primary and secondary immune response, 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. Antigen presenting cells (APCs), Antigen processing and presentation pathways. **4. Antigens and Antibodies:** Antigens: Chemical complexity and molecular property of Antigens, Immunogens, Haptens, Epitopes. Antibodies: Structure and function of various, classes of immunoglobulins, Antigenic determinants on immunoglobulins, monoclonal and polyclonal antibodies and their production by hybridoma technology. 5. **Immunogenetics:** Generation of antibody diversity, class switching	**5h** **5 h** **5h** **4h**

	among constant-region genes 6. **Immune effector mechanisms** – Cytokines (properties, receptors and functions), Immunological tolerance, Hypersensitivity reactions and Autoimmunity. 7. **Immune system in health and disease**: Immunodeficiencies, AIDS, Transplantation immunology, Concepts of vaccines. 8. **Immunotechniques:** Antigen – antibody reactions: Principles and techniques- *in vitro* precipitation, agglutination, immunofluorescence, immunodiffusion, immunoprecipitation, immunoelectrophoresis, ELISA, RIA, Western blotting, Immunohistochemistry, flow cytometry.	**2h** **5h** **4h** **6h**
Pedagogy:	Lectures (online or physical)/ tutorials/ laboratory work/ viva/ seminars/ term papers/assignments/ presentations.	
Text Books/ References / Readings:	1. J. Owen, J. Punt, S. Stranford. J. Patricia. Kuby Immunology, WH Freeman and Company, USA. 8th Edition (2012) 2. S.J. Martins, D.R. Burton, I.M. Roitt, P.J. Delves. Roitt's Essential Immunology. Wiley Blackwell. 13th edition (2017). 3. A. Abbas, A. Lichtman, S. Pillai. Cellular and Molecular Immunology. Saunders, Elsevier, USA. 8th edition (2014). 4. S.C. Parija. Textbook of Microbiology and Immunology. Elsevier. 2nd edition (2012). 5. F.C. Hay and O.M.R. Westwood. Practical Immunology. Cold spring Harbour. 4th edition (2002).	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 402

Title of the Course: Biochemistry of environmental pollution and remediation

Number of Credits: 3

Effective from AY: 2021-22

Prerequisites for the course:	It is assumed that the students have a basic knowledge of environment pollutants and biogeochemical cycles (water, O, C, N, S, P).	
Course Objectives:	1. This course develops concepts in Environmental Pollution (Impact on air, water and soil), role of microorganisms in biogeochemical cycles and bioremediation of pollutants	
Course Outcomes:	1. Learning of impact of various environmental pollutants on air, water and soil, role of microorganisms in biogeochemical cycles and bioremediation of pollutants. 2. Learning the biochemistry of remediation mechanisms for developing further abatement strategies	
Content:	**1. Environment and Pollutants:** Environment and its component; Atmosphere, soil, aquatic – fresh water, marine systems; biogeochemical cycles. Pollutants: classification, toxicity, synergistic or antagonistic action. Eco-toxicology: concept of permissible limits, ED50 & LD50; acute and chronic exposures; biochemical effects and genotoxicity. Monitoring of pollution using indicator microorganisms, biosensors: genetically modified organisms and enzymes. Significance of dissolved oxygen, BOD, COD. Environment protection regulations, impact assessment and standards. **2. Impact of environmental pollution:** Atmosphere Greenhouse gases and CFCs – sources and effect on the ozone layer; consequences; concept of carbon credit. Atmospheric particulate matter and smog – effect on respiratory system Elements such as asbestos, lead – toxicity and occupational hazards. Soil Xenobiotics, agricultural chemicals, improper waste disposal Hydrocarbons: petroleum and polynuclear aromatics such as naphthalene, benzo-pyrene, solvents, pesticides, lead and other heavy metals – significance on health. Aquatic – fresh water, marine systems. Discharge of industrial effluents such as mining, metals, pesticides, textiles, thermal waters, aquaculture, sewage; oil spills – impact on aquatic life and the food chain; consequences on human health **3. Remediation of waste:** Treatment of waste Concepts of Reuse, Recycle, Recovery. Introduction: Waste water/ sewage treatment, Solid waste management, Hospital waste management. Bioremediation: Concept and technologies. Biological systems – plants, bacteria and fungi; microbial consortia. Microbial processes –	**14 h** **14 h** **8h**

	enzymic transformations, co-metabolism, microbial adhesion, biofilms, production of extracellular polymers and emulsifiers. Removal of metal pollutants through sedimentation, sorption, precipitation, speciation conversion Emerging eco-friendly alternatives for chemical industry –Green chemistry and Green Technology.	
Pedagogy:	Lectures (online or physical)/ tutorials/laboratory work/ outreach activities/ project work/ viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Text Books/ References / Readings	1. Manahan S. E; Environmental Chemistry; Lewis Publishers, 2000/7 th edition. 2. Salker A. V; Environmental Chemistry; Narosa Nublishing; 2017/ 1st edition 3. De A. k; Environmental Chemistry; New Age International Publishers; 2005/ 3 rd Ed 4. Dara, S.S., Mishra D. D; A text book of Environmental Chemistry and Pollution Control; S. Chand Publishers; 2004. 5. Enger E. D., Smith B. E.; Environmental Science: A study of Interrelationships; WCB Publication, McGraw-Hill Higher Education.; 2019/ 15 th edition. 6. Khopkar S. M., Environmental Pollution Analysis. New Age International Pvt. Ltd.; 2005/ 1 st edition. 7. Mitchell R., Cu J. D.; Environmental Microbiology; Wiley-Blackwell Publication; 2009. 8. Moore J. W., Moore, E. A.; Environmental Chemistry; Academic Press; 1976/ 1 st edition 9.Maier R., Pepper I., Gerba, C., Gentry T.; Environmental Microbiology; Academic Press; 2008/ 2 nd edition	

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Programme: M. Sc. (Biochemistry)

Course Code: **BCO 403** **Title of the Course:** Cell Biology

Number of Credits: 3

Effective from AY: 2021-22

Prerequisites for the course:	Should have basic knowledge on animal and plant cells studied at B.Sc levels.	
Course Objective	1. The objective is to offer detailed knowledge about cell biology, various cellular organelles and the cell communication pathways associated with the cellular processes of the cells. The course aims to provide insights of basic cell culture techniques.	
Course Outcomes	1. Students will learn about cell structure, cell division and cell cycle mechanisms, various cellular organelles and their functions. 2. Students will acquire insight into the processes of transport across cell membranes, 3. Students will gain knowledge about the concepts of various cellular communication pathway and their importance. 4. This course will give them understanding of basic Cell culture techniques needed to work in a Biological research laboratory. 5. This course will provide the students with the base for various courses in life science including Cancer biology, Neurochemistry, etc.	
Content	1. **Structural organizations, structure and functions of cellular and sub-cellular organelles:** prokaryotic and eukaryotic cells, Animal and plant cells 2. **Biological membrane structure and function:** Structure and functions of membrane, Transport across cell membrane- Passive and active transport of molecules across biological molecules, membrane pumps. 3. **Cell division and cell cycle:** Mitosis and Meiosis, their regulation 4. **Cellular communication and Cell signalling:** Signal transduction pathway, Signaling molecules and their receptor- G-Protein Coupled Receptors, Receptor Tyrosine Kinases, MAP kinase pathway, JAK-STAT pathway; light signaling in plants, bacterial chemotaxis and quorum sensing Programmed cell death: Apoptosis 5. **Plant tissue culture: techniques and applications-** Introduction to plant tissue culture and various requirements, preparation steps for tissue culture, surface sterilization of plant tissue material, basic procedure for aseptic tissue transfer, tissure culture methodologies- Callus Culture, Cell Suspension Culture, Protoplast culture and hybridization, Organogenesis, plant micro propagation, Somatic	**6h** **4h** **4h** **10h** **4h**

	Embryogenesis; incubation and maintenance of culture; Applications of PTC. 6. **Animal tissue culture: techniques and applications**- Introduction to animal tissue culture and various requirements, Stem cells, typical cell lines, Growing mammalian cells and general maintenance of cells; Application of ATC. 7. **Microbial culture techniques:** *In vitro* culture techniques, nutrient requirements.	**4h** **4h**
Pedagogy:	Lectures (online or physical)/ tutorials/ laboratory work/ viva/ seminars/ term papers/assignments/ presentations	
Text Books/ References / Readings:	1. Gerald Karp. Cell and Molecular Biology: Concepts and experiments. John Wiley and sons, Inc. 8th edition (2015). 2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. Molecular cell biology. W.H. Freeman and company, New York. 8th edition (2016). 3. DeRobertis and Saunders. Cell and Molecular Biology. 8th edition (2017). 4. Michael Pelczar, Jr, R.D. Reid, E.C.S. Chan. Microbiology. MacGraw-Hill. 5th edition (2001). 5. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 7th Edition (2016). 6. Roberta H. Smith. Plant tissue culture: technique and experiments. Academic Press. 3rd edition (2012).	

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Programme: M. Sc. (Biochemistry)
Course Code: **BCO 404** **Title of the Course:** Analytical Biochemistry-II
Number of Credits: 3
Effective from AY: 2021-22

Prerequisites for the course:	Students should have studied the theory/ instrumentation and application of some of the basic bio-analytical techniques. It is assumed that students have a basic knowledge of fundamentals in biochemistry and certain basic techniques in routine laboratory analysis.	
Course Objectives:	1. Introduction of various bioanalytical techniques for analysis. 2. Evaluate the utility of various analytical techniques as a qualitative and quantitative tool. 3. Develop concepts in techniques and instruments required for macromolecule structure determination and other techniques such as tracers for metabolic pathways.	
Course Outcomes:	1. Students should be able to differentiate between various analytical techniques based on their theory and sensitivity achieved. 2. Students should be in a position to explain the principles of various techniques and apply the knowledge of the techniques for designing various experiments in research and development. 3. Students should be able to choose between various techniques of structure elucidation based on the information desired and interpret the data obtained to a fair level.	

Content:	**1. Optical methods of analysis:** Theory and application of UV-visible spectrophotometry, fluorimetry, atomic absorption spectrophotometry (AAS).	**4 h**
	2. Microscopy: Basic aspects of compound microscope, theory and applications of Light, Dark, Phase-contrast, and Inverted.	**4 h**
	3. Bioimaging and image processing: Principle, application and profile analysis: fluorescence microscopy, epifluorescence, immuno-fluorescence microscopy, and confocal scanning microscopy. Theory, instrumentation and applications of atomic force microscopy (AFM), scanning electron microscopy (SEM), transmission electron microscopy (TEM). Optical tweezers, photography, digital imaging and image processing,	**7 h**
	4. Radioisotopes: Nature of radioactivity and its detection, measurement of radioactivity, Disintegration kinetics, Radio-activity counters – GM Counter, Scintillation Counter, Isotope dilution analysis, Autoradiography, radiorespirometry, Tracer techniques for metabolic pathways. Safety measures in handling radioisotopes.	**7 h**
	5. Spectroscopic techniques for macromolecule structure determination: Principles, application and profile analysis of FTIR, NMR, X-ray diffraction, optical rotatory dispersion, circular dichroism.	**8 h**
	6. Mass Spectrometry: Principle, components, working and applications of mass spectrometer, different types of ionization methods used in mass spectrometer (CI, EI, ESI, FAB), different types of mass analysers used in mass spectrometer (magnetic sector, quadrapole), MALDI-MS, MALDI-TOF-MS, ICP-MS, introduction to GCMS, LCMS.	**6 h**
Pedagogy:	Lectures (online or physical)/ tutorials/ laboratory work/ outreach activities/ project work/ vocational training/ seminars/ term papers/ assignments/ presentations/ self-study etc. or a combination of some of these. Sessions shall 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. Norris, J. R.; Ribbons, D.W.; Methods in Microbiology; Academic Press; 1971/1st Edition. 5. Parakhia, M. V.; Tomar, R. S.; Patel, S.; Golakiya, B. A.; Molecular	

	Biology and Biotechnology: Microbial Methods; New India, 2010. 6. Homes, D. J.; Peck, H.; Analytical Biochemistry; Pearson Education Limited; 1998, 3rd Edition. 7. de Hoffmann, E.; Stroobant, V.; Mass Spectrometry: Principles and Applications; John Wiley & Sons Ltd; 2007/ 3rd Edition.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 405

Title of the Course: Laboratory techniques and Applications of Biochemistry

Number of Credits: 4

Effective from AY: 2021-22

Prerequisites for the course:	Should have basic knowledge on Biochemistry.	
Course Objectives	1. This course develops basic understanding and skills of various techniques and instruments in biochemistry research, Immunology and Environmental science.	
Course Outcomes	1. The Cell biology part of the practical will give them understanding and hands-on training of basic Cell culture techniques needed to work in a Biological research laboratory. 1. Immunology and Immunotechniques unit of this practical will train the students with skillful handling of various techniques in Immunological research. 2. Analytical Biochemistry-II part of this practical will explain the principle and working of basic instruments in analytical laboratory that will train the students in handling various instruments in Analysis. 3. Biochemistry of environmental pollution part of this practical will train the students about analysis of environmentally significant water quality parameters and predicting the environmental quality based on observed data.	
Content		
	I. Cell Biology I. **Microbial culture techniques:** Isolation, identification and characterization and maintenance of bacterial and fungal cells; Cell counting and viability (fungal/bacterial cells). II. **Animal cell culture techniques:** Isolation, culturing and maintenance of cell lines, Microscopic examination, Cell counting, cytotoxicity and viability testing. III. **Plant tissue culture techniques:** Surface sterilization of plant material, excision, Aseptic tissue transfer, callus culture and micropropagation.	
	II. Immunology and Immunotechniques 1. Agglutination assays: A) Determination of ABO and Rh blood group, B) Latex bead agglutination C) Widal test 2. Immunodiffusion assays: A) Single Immunodiffusion 3. VDRL test 4. Rapid tests: A) Malarial antigens Pv/Pf B) Dengue IgM and IgG antibodies	**24 h**

	C) Hepatitis HBsAg 5. ELISA 6. Determination of Immunoglobulins. A) Precipitation of antibodies with (NH4)2 SO4 B) Determination of antibody concentration. C) Separation and visualization of immunoglobulins by SDS-PAGE.	
	III. Analytical Biochemistry – II 1. Visualization of cells by Light and Phase contrast microscopy 2. UV-Visible spectroscopic studies to demonstrate Beer-Lambert Law, 3. UV-Visible spectroscopic studies to determine extinction coefficient and quantitative analysis. 4. Measurement of fluorescence using Spectrofluorimeter. 5. Demonstration of: GC, IR, NMR, and Mass/MALDI-TOF 6. Elucidation of structure of cellular metabolites using IR, NMR and Mass profiles.	**24h**
	IV. Biochemistry of environmental pollution and remediation 1. Estimation of Dissolved oxygen (DO) using Winkler method. 2. Estimation of Biochemical Oxygen Demands (BOD) of given water sample using 5-day BOD test 3. Estimation of Chemical Oxygen Demands (COD) of water sample 4. Assessment of given water quality using observed BOD and COD values. 5. Detection of sewage pollution by screening for indicator organisms such as *E. coli*. 6. Biotransformation of xenobiotics.	**24 h**
Pedagogy:	Lectures/ tutorials/ laboratory work/ field work/ project work/ viva/ seminars/ assignments/ term papers.	
Text Books/ References / Readings:	1. Bhatia, S., Naved, T., Sardana, S. Animal tissue culture facilities. IOP publishing ltd., 2019. 2. Sharma G.K., Jagetiya, S., Dashora, R. General Techniques of Plant Tissue Culture. Lulu Press Inc., United States. 2015. 3. Prescott, H. Laboratory exercise in Microbiology. MacGraw-Hill Companies. 2002, 5th edition. 4. Vogel's Text book of Quantitative Inorganic Analysis, Pearson Education, Asia, 2000, 6th Ed. In addition to above, references given under respective theory courses (BCO 401, BCO 402, BCO 403, BCO 404) may be referred.	

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Annexure IB

M.Sc. Biochemistry Part-I revised syllabus

Core papers

Sl. No.	Subject code (OLD)	Subject code (NEW)	Paper title	Credits
1.	BCC 101	**BCC 401**	Fundamentals of Biomolecules [T]	3
2.	BCC 103	**BCC 402**	Analytical Biochemistry-I [T]	3
3.	BCC107	**BCC 403**	Molecular Biology [T]	3
4.	BCC106	**BCC 404**	Bioenergetics and metabolism [T]	3
5.	BCC108	**BCC 405**	Laboratory course in Biochemistry-I [P]	4
I.			Fundamentals of Biomolecules [P]	
II.			Analytical Biochemistry-I [P]	
III.			Molecular Biology [P]	
IV.			Field trip/study tour [P]	

Optional papers

1.	BCO110	BCO 401	Immunology and Immunotechniques [T]	3
2.	BCO111	BCO 402	Biochemistry of Environmental Pollution and Remediation [T]	3
3.	BCO124	BCO 403	Cell biology [T]	3
	BCO125	BCO 404	Analytical Biochemistry-II	3
5.	BCO126	BCO 405	Laboratory techniques and Applications of Biochemistry [P]	4
I			Immunology and Immunotechniques [P]	
II			Analytical Biochemistry-II [P]	
III			Biochemistry of Environmental Pollution and Remediation [P]	
IV			Cell biology [P]	

7/12/2021
Prof V.M.S. Varsenya
Dean, SCS

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The MSc Biochemistry programme syllabus has been revised from A.Y. 2021-2022. Old syllabus was framed by the Department of Microbiology which was followed from A.Y. 2014- 2020. During the syllabus revision significant minor and major changes were incorporated in the content/ title of the subject papers. Also, subject codes of few papers were retained or changed depending upon the percentage change in the subject content. After syllabus revision, during online examination form filling it was observed that GUMS system does not accept the subject codes for biochemistry discipline which is primarily due to retaining same subject code for the new course. Thus same course code exists for old and new course. 'y'

Looking at the current problem faced by students and to avoid any confusion it is mandatory for us to urgently change the codes for subjects. Later these changed codes will be sent for approval to school council/ BoS and academic council. In view of this approval is requested for change in subject code. 'x'

Submitted for the necessary action

Date 07-12-2021 Dr. P. Torney Dr. A. Kharangate Dr. K. Deshpande

Approval for 'x' above is requested.
7/12/2021

Dean, School of Chemical Sciences

VC Due to emergency 'x' above has been approved. This needs to be placed in Academic Council for its approval/reporting item.
07/12/2021

Deputy Sec 7/12/2021

Approval for change of codes of Biochemistry Part-I by VC may be seen above due to problems in GUMS as mentioned at 'y' above. It is requested to make necessary changes as per the attached list so that the Part-I students can fill their exam forms with new paper codes.
7/12/2021

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M.Sc. Biochemistry revised syllabus with effect from A.Y. 2022-2023

Annexure II

M.Sc. Biochemistry Part-II revised syllabus

Core Papers			
Sl. No.	**Subject code**	**Paper title**	**Credits**
1.	**BCC 501**	Medical Biochemistry	3
2.	**BCC 502**	Enzymology	3
3.	**BCC 503**	Industrial Biochemistry	3
4.	**BCC 504**	Biostatistics and technical writing	3
5.	**BCC 505**	Laboratory course in Biochemistry-II	4
Optional Papers			
1.	**BCO 501**	Hormones	2
2.	**BCO 502**	Neurochemistry	2
3.	**BCO 503**	Genetic engineering	3
4.	**BCO 504**	Microbes in health and disease	3
5.	**BCO 505**	Drug metabolism and Pharmaceutics	3
6.	**BCO 506**	Nutrition and food Biochemistry	3
7.	**BCO 507**	Bioprospecting	3
8.	**BCO 508**	Nanobiotechnology	3
9.	**BCO 509**	Internship	1
10.	**BCD 510**	Dissertation I	8
11.	**BCD 511**	Dissertation II *	5
12.	**BCO 512**	Laboratory techniques and trends in Research-I	4
13.	**BCO 513**	Laboratory techniques and trends in Research -II	4

*BCD 511 can be taken along with additional 3 credit theory optional course of part II level in lieu of BCD 510.

PART -II PAPERS CORE

Programme: M. Sc. (Biochemistry)

Course Code: BCC 501 **Title of the Course:** Medical Biochemistry

Number of Credits: 3

Effective from AY: 2022-23

Prerequisites for the course:	Students should have knowledge of the metabolic pathways in human body.	
Course Objectives:	1. To develop an understanding of the metabolic diseases/disorders. 2. To impart knowledge of clinical investigations and analyses of clinical samples.	
Course Outcomes:	1. Students will acquire insights into the metabolic disorders/diseases caused due to imbalance or errors in metabolic pathways of humans 2. Students will be able to gain the knowledge on significance and principles of assessment of various clinical samples.	
Content:	**1. Analysis of Clinical sample** **Blood**: Collection and safety measures involved. Composition and function: Composition of blood, RBCs, Erythropoiesis, Hemoglobin, Gas transport by hemoglobin, Blood buffer system: acid-base balance and imbalance. Analysis: Haemoglobin, Total cell and Differential cell (TC/DC) counts, Erythrocyte sedimentation Rate (ESR); Bleeding time and Clotting time, Glucose; Lipid profile; Urea; Gases: Oxygen and Carbon dioxide levels; Ph, Blood grouping system: ABO, MN, Rh **Serum:** Collection and safety measures involved, Analysis: Proteins, Albumin/Globulin Ratio; Bilirubin; Creatinine; Uric acid; Electrolytes; Enzymes of clinical and diagnostic importance: Enzymes as markers in the diagnosis of diseases; Clinical significance of cholinesterase, alkaline and acid phosphatase, Lactate dehydrogenase (LDH), Creatine phosphokinase (CPK), Aspartate amino transferase (AST/SGOT), Alanine aminotransferase (ALT/SGPT). **Liver function tests (LFTs)** Functions of the liver Bilirubin metabolism and clinical significance Classification of LFTs **Renal function test (RFTs)** **Urine:** Composition of urine, Collection and safety measures, Kidney functions: Urine formation, Glomerular and Tubular functions, Water electrolyte balance. Analysis of urine/RFTs: Physical, Chemical and Microscopic examination	**6 h** **5 h** **3 h** **4 h**

	2. Metabolic disorders: **Disorders in metabolism** Carbohydrates: Regulation of Blood glucose, insulin and Diabetes mellitus; Diabetic ketoacidosis Lipids: Hyperlipidaemias and cardiovascular disease: Clinical significance of cholesterol, Atherosclerosis and Coronary Artery disease. Proteins: Kwashiorkor, Marasmus Blood: Anaemia: Iron deficiency anemia, Megaloblastic anemia, Pernicious anemia, Sickle cell disease, hemolytic anemia Liver: Jaundice, cirrhosis Kidney: Diabetes insipidus, Renal calculi. **Inborn errors of metabolism:** Prenatal diagnosis, New-born screening, laboratory investigations to diagnose metabolic disorders. Carbohydrate: Lactose intolerance, Galactosemia, Glycogen storage disease. Lipids: Lysosomal storage disorders: Tay-Sach's disease; Gaucher's disease; Niemann Pick disease; Fabry's disease. Amino acids: Phenylketonuria, Albinism Purine/pyramidine – Lesch-Nyhan Syndrome, Gout. Blood – Thallasemia Thyroid hormone- Hyperthyroidism and hypothyroidism **3. Biochemistry of cancer** Properties of cancer cells Biochemistry of cancerous growth Etiology of cancer cells Mutagens and carcinogens Oncogenic viruses Tumor markers Anticancer drugs	**9 h** **5 h** **4 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning.	
Text Books/ References / Readings	1. Vasudevan, D. M.; Sreekumari, S., Vaidyanathan, K., Textbook of Biochemistry for Medical students, Jaypee brothers Medical publishers; 2011, 6th Edition. 2. Chattergee, M. N; Shinde, R.; Textbook of Medical Biochemistry, Jaypee brothers Medical publishers Ltd., 2012, 8th Edition. 3. Smith, C.; Mark, A. D; Lieberman, M.; Marks' Basic Medical Biochemistry: A Clinical Approach; Lippincott's William and Wilkins; 2004, 2nd Edition. 4. Gaw, A.; Cowan, R. A.; Murphy, M. J.; O'Relly, D. S. J.; Srivastava, R.; Cklinical Biochemistry, Elsevier; 2013, 5th Edition.	

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Programme: M.Sc. (Biochemistry)

Course Code: BCC 502 **Title of the Course:** Enzymology

Number of Credits: 3

Effective from AY: 2022-23

Prerequisites for the course:	It is assumed that students have a basic understanding of biomolecules, their structure and function and catalysis.	
Course Objectives:	1. To develop basic concepts in enzymology including enzyme activity, kinetics, mechanism of action 2. To develop understanding about techniques used for purification of enzymes.	
Course Outcomes:	1. A better understanding of enzymes, their mechanism of action, regulation and kinetics. 2. Apply biochemical techniques for purification of enzymes for their study and application.	
Content:		
	1. **Enzymes: Classification and kinetics** Nomenclature and classification of enzymes, Enzymes as catalysts: role of enzymes to increase reaction rates. Coenzymes and cofactors and their role in enzyme activity Enzyme structure; enzyme-substrate complex, binding sites, concept of active site, stereo-specificity. Enzyme activity Enzyme Assay, specific activity (Definition and units) Effect of pH, temperature, and inhibitors. Enzyme kinetics: Michaelis-Menten Equation: formula and derivation, Line-Weaver Burk plot for one substrate reactions; significance of Vmax and Km. 2. **Enzyme -substrate interactions** Enzyme turnover: Ks and Kd, and measurement of enzyme turnover, correlation between the rates of enzyme turnover and structure function of enzymes; mechanism of enzyme degradation, significance of enzyme turnover. Bi-substrate reactions. Enzyme Inhibition: Reversible and irreversible inhibition: (Competitive, uncompetitive, non-competitive). 3. **Enzyme Mechanism of Action, Regulation, Multienzyme systems.** Enzyme catalysis mechanism: Determination of active centre: Identification of functional groups, factors affecting catalytic efficiency - proximity and orientation effects, covalent and acid -base catalysis, strain in catalysis. Enzyme Regulation: control of activity, availability of substrate and, inhibitor or enhancer molecules, change in the covalent structure of enzyme	**12 h** **6 h** **12 h**

	Regulatory enzymes: Allosteric (aspartate transcarbamylase) and Covalently Modulated Enzymes (glycogen phosphorylase, glutamine synthetase); Mechanism of action – and their significance in metabolism. Zymogens and Isozymes. Multienzyme systems: disassociated system (catabolic enzymes), multienzyme complex (pyruvate dehydrogenase); membrane-bound system (electron carrying enzymes). 4. **Enzyme purification** Isolation and purification of enzymes: intracellular and extracellular enzymes, salt precipitation; dialysis; ultrafiltration; molecular exclusion chromatography; affinity chromatography; ion exchange chromatography. Enzyme activity, Specific activity and fold purification as criteria of purity. Zymograms. Molecular weight determination: Exclusion chromatography; PAGE, SDS-PAGE, staining techniques.	**6 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning.	
Text books/ References/ Readings	1. Harper H., Review of Physiological Chemistry, Lange medical, Publications, (1977) 16th edition. 2. Berg, J.M., Stryer, L., Tymoczko, J., Gatto, G., Biochemistry, WH Freeman (2019), 9th edition. 3. Nelson, D. L. and Cox, M. M. Lehninger Principles of Biochemistry, WH Freeman (2017), 7th edition. 4. Price, N. and Stevens, L., Fundamentals of Enzymology, Oxford University Press, (1999), 3rd edition. 5. Plummer, D.T., An introduction to practical biochemistry, TATA McGraw Hill, (2006), 3rd edition. 6. Sambrook, J., Fritsch, E.F., Maniatis, T. Molecular cloning: a laboratory manual, Cold Spring Harbor Laboratory Press, New York. 1989, 2nd edition. 7. Dixon, M. and Webb E.C., Enzymology, Academic Press, Elsevier (1964), 2nd edition.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCC 503 **Title of the Course:** Industrial Biochemistry

Number of Credits: 3

Effective from AY: 2022-23

Prerequisites for the course:	Students should have basic knowledge of microbiology, chemistry, and/or biochemistry for understanding basic concepts.	
Course Objectives:	1. To develop the concepts and principles for handling, processing and managing biomolecules at commercial scale.	
Course Outcomes:	1. Students will 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:	**1. Industrial bioreactor designs** Fermentation: Introduction, 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. Fermenters: Basic components of a fermenter, types of fermenters with their advantages and disadvantages, solid state fermentation, anaerobic fermentation. Fermentation process, maintenance of aseptic conditions, methods of sterilisation, aeration and agitation. Scale up and scale down of a fermentation process. Significance and control of various fermentation parameters, online and offline monitoring, rheological properties of fermenter, computerization of fermenter operation. Downstream processing: Steps of downstream processing: Details of removal of insoluble, disruption of cell, isolation/purification, recovery and final product isolation of fermentation products. **2. Food technology** Characteristics of industrial microorganisms; strain improvement; use of auxotrophic mutants; Cultivation of microorganisms. Processed foods: Introduction about different food industries, general properties and microorganisms involved in it Production of foods made from milk: Cheese, Probiotics – yoghurt/ curd Production of alcohol-based fermentation products: wine, beer, vinegar Oriental fermented foods: Soy sauce, tofu, tempeh Indian fermented foods: Idli, dosa, dokhla. Fermented Food from Wheat: Bread Meat industry	**12 h** **12 h**

	3. Industrial production of biochemically important products **Production of protein/ carbohydrate/ lipids** Proteins from milk / SCP; Industrially important enzymes Production of dextrins, glucose. Production of fatty acids, lecithins **Production of pharmaceuticals/neutraceuticals/ biochemicals** Production of Antibiotics: penicillins Production of Vitamins: B12. Production of Amino acids: lysine. Production of Alcohol: ethanol Production of Organic acid: citric acid.	**12 h**
Pedagogy:	Lectures (online or physical)/ tutorials/ seminars/ term papers/assignments/ presentations. Sessions shall be interactive in nature to enable peer group learning.	
Text Books/ References / Readings	1. Okafor N.; Modern Industrial Microbiology and Biotechnology., Science Publishers, 2007. 2. Frazier W C. and Westhoff D C.; Food Microbiology –Tata McGraw Hill Publishers, 1995, 4th Edition. 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.	

Programme: M. Sc. (Biochemistry)
Course Code: BCC 504 **Title of the Course:** Biostatistics & technical writing **Number of Credits:** 3

Effective from AY: 2022-23

Prerequisites for the course:	Basic ability for data handling and calculations.	
Course Objectives:	1. To develops concepts about types of data observed in biological experiments, its handling and processing. 2. To develop understanding of the stages of the writing process (prewriting/writing/rewriting) and apply them.	
Course Outcomes:	1. Students will be able to collect, handle, process and present the biological data and apply the principles of statistics on biological experiments. 2. Students will be able to develop the skills needed to successfully communicate in a modern world through written materials.	

Content:	**1. Characteristics of biological data** Variables and constants, discrete and continuous variables, relationship and prediction, variables in biology (measurement, ranked, attributes), derived variables (ratio, index, rates), types of measurements of biological data (interval scale, ratio scale, ordinal scale, nominal scale, discrete and continuous data). **Elementary theory of errors** Exact and approximate numbers, source and classification of errors, decimal notation and rounding off numbers, absolute and relative errors, valid significant digits, relationship between number of valid digit and error, the error of sum, difference, product, quotient, power and root, rules of calculating digits. **Data handling:** Population and samples, random samples, parameter and statistics, accuracy and precision, accuracy in observations, Tabulation and frequency distribution, relative frequency distribution, cumulative frequency distribution. Graphical representation: types of graphs, preparation and their applications. **2. Measures of central tendency:** characteristics of ideal measure, Arithmetic mean – simple, weighted, combined, and corrected mean, limitations of arithmetic mean; Median – calculation for raw data, for grouped data, for continuous series, limitations of median; Mode – computation of mode for individual series, by grouping method, in a continuous frequency distribution, limitations of modes; Relationship between mean, median and mode; mid-range. **Measure of dispersion:** variability, Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation Skewness – definition, positive, negative, purpose, measure, relative measure, Karl Pearson's Coefficient, Bowley's Coefficient, Kelly's Measure, Moments 3. **Correlation analysis** Correlation, covariance, correlation coefficient for ungrouped and grouped data, Pearson's Rank Correlation coefficient, scatter and dot diagram (graphical method). Regression analysis - Linear and exponential function - examples: DNSA conversion by reducing sugar, survival/growth of bacteria, regression coefficients, properties, standard error of estimates, prediction, regression analysis for linear equation. **Probability:** Probability, Combinatorial Techniques, Elementary Genetics, Binomial, Poisson, Normal Distributions. **Hypothesis Testing:** parameter and statistics, sampling theory, sampling and non-sampling error, estimation theory, confidence limits, testing of	**10 h** **10 h** **10 h** **6 h**

	hypothesis, test of significance; Students' T-test, t-distribution, computation, paired t-test. Introduction to Chi-square test, F-test and ANOVA. **4. Scientific writing:** Different forms of scientific writing Articles in journals. Research notes and reports. Review articles, Monographs, Dissertations, Bibliographies. How to formulate outlines: The reasons for preparing outlines, guide for plan of writing, skeleton for the manuscript, Drafting Titles, Subtitles, Tables, Illustrations. Parts of Dissertation/Research report/Article: Introduction, Review of Literature, Method, Results and Discussion. Ask questions related to content, continuity, clarity, validity internal consistency and objectivity during writing each of the above parts. Writing for Grants.	
Pedagogy:	Lectures/ tutorials/ seminars/ term papers/assignments/ presentations/ MOODLE/Videos or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Text Books/ References / Readings	1. Danial W.W.;Biostatistics: Basic Concepts and Methodology for the Health Sciences, Wiley publishers, 2014, 10th Edition 2. Antonisamy B.; Premkumar P.S.; Christopher S.; Principles and Practice of Biostatistics, Elsevier India, 2017, 1st Edition 3. Glasman-Deal H.; Science Research Writing, Imperial College Press, 2010. 4. Kothari, C. R.; Quantitative Techniques, Vikas Publishing House., 2013, 3 rd Edition 5. Arora, P. N. and Malhan, P. K.; Biostatistics, Himalaya Publishing House. 2006, 9th Edition 6. Surya, R. K.; Biostatistics for health and life sciences, Himalaya Publishing House., 2010, 1st Edition 7. Annadurai A.; A Textbook of Biostatistics, New Age Publication, 2017, 1st Edition.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCC 505 **Title of the Course:** Laboratory course in Biochemistry-II

Number of Credits: 4

Effective from AY: 2022-23

Prerequisites for the course:	Should have studied the theoretical concepts in respective Biochemistry courses.	
Course Objectives:	1. To develops basic understanding and skills of various instruments and techniques used in Medical biochemistry, Clinical pathology, Enzymology, Industrial biochemistry. 2. To develop understanding about practical applications of Biostatistics and technical writing.	

Course Outcomes:	1. Medical Biochemistry unit of the practical will train the students with skilful handling and analysing clinical samples. 2. Enzymology part of this practical will impart skills on isolation of enzymes from living cells, their purification and understanding their substrate interactions. 3. The Industrial Biochemistry part of this course will develop the skills required for various techniques related to understanding industrial microbiology and biochemistry basics. 4. Biostatistics and technical writing part of this practical improves understanding of various statistical operations needed to process the biological data and improve technical writing skill.	
Content		
	I. Medical Biochemistry 1. Analysis of blood sample: (Any Two) A) Haemoglobin (Hb), Erythrocyte sedimentation Rate (ESR) and Clotting time B) Total cell and Differential cell (TC/DC) counts C) Blood glucose D) Blood cholesterol E) ABO Blood grouping 2. Liver function tests: (Any TWO) A) Serum SGPT and SGOT B) Serum Bilirubin C) Serum acid phosphatase and alkaline phosphatase 3. Renal function tests: (Any TWO) A) Physical examination of urine B) Chemical examination of urine C) Microscopic examination of urine.	**24 h**
	II. Enzymology 1. Assay of enzyme activity, rate of reaction. 2. Optimization of parameters for enzyme activity. 3. Determination of specific activity. 4. Determination of Km, Vmax. 5. Purification of enzyme: salting out; dialysis; gel filtration; determination of fold purification, percentage recovery of protein. 6. Molecular weight determination by SDS-PAGE.	**24 h**
	III. Industrial biochemistry 1. Fermentation: Production of wine, monitoring of sugar reduction and alcohol production. 2. Fermentation: Production of vinegar and estimation of acetic acid. 3. Monitoring of fermentation process of milk to curd: 4. Isolation and screening of probiotics 5. Monitoring of fermentation process of milk to curd: Microscopic observation, Monitoring pH. 6. Fortification of foods (grains) by addition of mineral solutions: Production of fortified foods and estimation of mineral content. 7. Rheology of substrate solutions and/or fermentation broth.	**24 h**

	IV. Biostatistics and technical writing 1. Excel spreadsheet and data analysis. 2. Linear equation analysis (regression analysis). 3. Normal distribution. 4. Hypothesis testing. 5. Discussion in the class regarding abstract of different types of research and writing report. 6. Introduction to different kinds of Scientific Report writings and presentation.	**24 h**
Pedagogy:	Pre-lab/ tutorials/ laboratory work/ field work/ outreach activities/ viva/ assignments/ term papers.	
Text Books/ References / Readings:	1. Damodaran, G. Practical Biochemistry. Jaypee Brothers Medical Publishers (P) Ltd. 2011. 2. Mohanty, S. Practical clinical Biochemistry. Jaypee Brothers Medical Publishers (P) Ltd., 2013, 1st edition. 3. Glasman-Deal H.; Science Research Writing, Imperial College Press, 2010. 4. In addition to above, references given under respective theory courses (BCC 501, BCC 502, BCC 503, BCC 504) may be referred.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 501 **Title of the Course:** Hormones

Number of Credits: 2

Effective from AY: 2022-23

Prerequisites for the course:	Basic knowledge on cell signalling in animal systems.	
Course Objectives:	1. To develop a robust knowledge on human endocrine system including it's role in physiology, 2. To acquaint students on the mechanism of action of hormones, their regulation and clinical disorders associated with them.	
Course Outcomes:	1. At the end of the course the students will have a thorough knowledge and understanding of signaling mechanisms of different hormones in human system. 2. The students will also be able to understand the diseases associated with hormonal imbalance and the pathophysiology behind it.	
Content:	**1. Hormones: Definition, history, classification, and mechanism of action** Introduction to hormones, History of hormones, Classification of hormones. Understanding of endocrine system, Pathways of hormone release,	**8 h**

	Signal transduction pathways, second messengers, regulation of signaling Pathways. Hormones and their receptors: cell surface receptor, signaling through G protein coupled receptors, Steroid hormone receptors, Thyroid hormone receptors Mechanism of sensitization & desensitization of hormone receptors **2. Stimulus of hormones, regulation of biosynthesis, release and** Hypothalamic Hormones: CRH, TRH, GnRH, PRL/PRIH,	**8 h**
	GHRH/GHRIH Anterior Pituitary hormones: Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH Posterior Pituitary Hormones: Vasopressin, Oxytocin Adrenal Cortex Hormones: Aldosterone (renin angiotensin system) & cortisol Hormones of Adrenal Medulla: Epinephrine and norepinephrine Hormones regulating Ca2+ Homeostasis: PTH, Vit D, Calcitonin Pancreatic Hormones: Insulin, Glucagon. GI tract Hormones: Gastrin, Secretin, CCK, GIP, Ghrelin. **3. Reproductive hormones and hormones by organs with endocrine function:** Reproductive Hormones: Male and female Sex hormones, interplay of hormones during reproductive cycle, Pregnancy, Parturition and Lactation Role of Oral Contraceptives. Other organs with endocrine function: Heart (ANP), Kidney (erythropoietin), Liver (Angiotensinogen, IGF-1), Adipose tissue (Leptin, adiponectin); Growth factors: PDGF, EGF, IGF-I, II	**4 h**
	Pathophysiology and diseases associated with the hyper or hypo secretion: Hypothalamus and pituitary associated hormonal conditions: Goiter, Graves' disease, Cretinism, Myxedema, Hashimoto's disease, Gigantism, Acromegaly, dwarfism Adrenal cortex associated hormonal conditions: Addison's disease, Conn's syndrome, Cushing's syndrome, Calcium homeostasis related hormonal conditions: Rickets, Osteomalacia, Osteoporosis. Pancreatic hormone associated hormonal conditions: Diabetes insipidus.	**4 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning.	

Text Books/ References / Readings	1. Kline B and Rossmanith W.G, Hormones and the endocrine system, Springer, 2016 2. Ilie I.R. Introduction to endocrinology, Springer, 2020. 3. Berg, J.M., Stryer, L., Tymoczko, J., Gatto, G., Biochemistry, WH Freeman (2019), 9th edition. 4. Mathews, C.K., van Holde, K.E. & Ahern, K.G. Biochemistry, pearson Publishers, (1999), 3rd edition 5. Nelson, D. L. and Cox, M. M. Lehninger Principles of Biochemistry, WH Freeman (2017), 7th edition. 6. Norman A. W., Gerald Litwack. Hormones, Elsevier (1997), 2nd edition 7. David, G. & Dolores, S., Greenspan's Basic and Clinical Endocrinology, Mc Graw Hill Education, (2018), 10th edition 8. Belfiore A and Leroith D, Principles of Endocrinology and hormone action, Springer, (2018).	

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Programme: M. Sc. (Biochemistry)
Course Code: BCO 502 **Title of the Course:** Neurochemistry
Number of Credits: 2
Effective from AY: 2022-23

Prerequisites for the course:	Students should have basic knowledge of human nervous system.	
Course Objectives:	1. To develop insights into structure and organization of nervous system, sense organs and their functions. 2. To develop a basic understanding role of neurotransmitters and mental disorders.	
Course Outcomes:	1. Students will be able to gain the knowledge on importance of nervous system for normal functioning of human body.	
Content:	1. **Organization of Nervous system:** Central Nervous system, Peripheral nervous system, Blood Brain Barrier. Cerebrospinal fluid: composition, function and circulation Cellular components of nervous system: Nerve, neuron, neuroglial cells 2. **Cell Membrane Structures and Functions of nerve cells and membrane transport:** Phospholipid bilayer, membrane proteins, Biological membrane Membrane transport: Primary ion transporters, Ca2+ pumps, V-ATPase pump, secondary active transport, cation antiporters, facilitators. **Energy metabolism in brain** Substrates for cerebral energy metabolism, regulation of the	**2 h** **3 h** **3 h**

	cerebral metabolic rate, glycolysis, glycogen metabolism, Pentose, phosphate shunt, Malate–aspartate shuttle, lactate metabolism, TCA, Glutamate/glutamine metabolism. **3. Synaptic Transmission:** Synapse structure, Chemical and Electrical synapses, membrane potential in steady state, Action potential generation and propagation, pre and post synaptic events. **Neurotransmitters and neuromodulators: Structure, functions, metabolism, receptors** Acetylcholine, Excitatory Amino Acids (EAAs): Glutamic Acid, Inhibitory Amino Acids (IAAs): g-Aminobutyric Acid and Glycine, Serotonin (5-HT), Catecholamine, Purines (Cannabinoids), Neuropeptides and Nitric oxide. **Sensory transduction:** Vision, Olfaction and taste, Hearing and balance, touch. **Biochemistry of memory, Biochemistry of mental and neurodegenerative disease**: Mental illness: Depression, Schizophrenia Neurodegenerative diseases: Alzheimer's disease, Parkinson's disease , Huntington's disease **CNS active drugs and drugs of abuse: their classification and mode of action** Drugs of abuse: Opiates, Nicotine, alcohol.	**4 h** **7 h** **3 h** **2 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning	
Text Books/ References / Readings	1. Albers, R.W., Brady, S.T., Price, D. L., Basic neurochemistry: Molecular, cellular and medical aspects., Elsevier Academic Press publishers; 2006, 7th Edition. 2. Smith, C.U.M., Elements of Molecular Neurobiology., John Wiley & Sons Ltd., 2002, 3rd edition. 3. Kandel, E.R., Swartchz, J.H., Jesselle, T.M., Principles of Neural science, McGraw-Hill, New York publishers., 2000, 4th edition. 4. Mathew, B., Parambi, T., Principles of Neurochemistry: Fundamentals and Applications. Springer, Singapore., 2020.	

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Programme: M. Sc. (Biochemistry)
Course Code: BCO 503 **Title of the Course:** Genetic Engineering
Number of Credits: 3
Effective from AY: 2022-23

Prerequisites for the course:	Knowledge of bacterial and animal genetics, basic molecular and microbiology is a prerequisite.	
Course Objectives:	1. This course aims to introduce the fundamental tools and techniques required for molecular cloning, with emphasis on DNA editing to protein expression in wide variety of hosts. 2. Applications of genetic engineering in agriculture, therapeutics and industry will be covered.	
Course Outcomes:	1. Understanding of tools and techniques involved in molecular cloning. 2. Overall understanding about the importance of GMOs, GMPs and other engineered products in science and industry.	
Content:	**1. Introduction to genetic engineering and tools involved in genetic manipulation** Introduction to genetic engineering Tools and techniques involved in genetic manipulation **DNA modifying enzymes:** restriction endonucleases, exonucleases, DNA ligases (T4 DNA Ligase and *E.coli* DNA ligase), Terminal DNA transferase, DNA Polymerases (Taq, Amplitaq, vent, Exo-vent, Pfu, T4 etc), Reverse transcriptase, T4 polynucleotide kinases, Alkaline phosphatase, S-1 Nuclease, Mung bean nuclease, RNases. **Gene cloning systems/Hosts:** Gene cloning in *E. coli* and other organisms such as *Bacillus subtilis*, *Saccharomyces cerevisiae* and other microbial eukaryotes. **Cloning vectors:** plasmid (pUC19, pBR 322), λ phage based vectors, cosmid vectors, Phasmid vectors, shuttle vectors, High capacity Cloning vectors (BAC and YACs). **Sequencing Vectors:** pUC 19 and M-13 Phage vector. **Expression vectors:** Prokaryotic (pET, pGEX-2T and others). **Characteristics of expression vectors:** strong bacterial and viral promoters (lac, trp, tac, SV 40, T7, T3) for induction of gene expression. **Construction of rDNA molecule and it's transfer to appropriate host (bacteria/yeast/plant cell/animal cell) using a suitable technique:** transformation, electroporation, transfection, gene gun. **Other Recombinant DNA techniques:** Use of radioactive and non-radioactive nucleotides for DNA probe preparation and detection of hybrids, Gel retardation assay, Restriction mapping, RFLP, PCR, RT-PCR, Real time PCR, Microarray, DNA sequencing using Sanger's Dideoxy chain termination method and automated sequencer; chromosome walking, Hybrid release and hybrid arrest translation to screen clones, site directed mutagenesis, CRISPR/case system. **2. Application of Genetic Engineering in Biology, forensics**	**16 h**

	and medicine Screening of Genetic diseases using DNA probes (DNA diagnostics). Production of recombinant proteins and drugs (insulin, tissue plasminogen activator, erythropoietin, human growth hormones, Antibodies (including bispecific antibodies), vaccines, interferons, DNA vaccines: merits and demerits, Edible vaccines- merits and demerits. Application of recombinant DNA technology in solving parental dispute and criminal cases (DNA finger printing). Manipulation of gene expression in Prokaryotes; gene expression from strong and regulatable promoters, Developing fusion proteins and separation of cloned protein by protease induced cleavage. Genetic manipulation to increase recombinant protein stability and secretion using signal sequences. **3. Application of Genetic Engineering in Agriculture** Development of transgenic crops resistant to insect pests, bacterial, fungal and viral pathogens. Strategies to develop transgenic crops and horticulture plants using various tools of recombinant DNA technology: Development of Bt Brinjal, Golden Rice and flavr-savr tomato. Importance of *Agrobacterium tumefaciens* in genetic manipulation of plants (Role of Ti plasmids), Role of *Bacillus thuringiensis* (*Bt* genes) to develop insect pest resistant crops. **4. Applications of Genetically engineered microbes in industries and environment** Genetic manipulation of microbes to over-produce industrially valuable enzymes, biomolecules and fermentation products. Production of microbial SCPs. Microbial bioremediation and biomonitoring of xenobiotics by recombinant microbes. Bioremediation of toxic heavy metals and organometals by recombinant microbes. Biohydrometallurgy using recombinant microbes for recovery of precious metals.	**10 h** **5 h** **5 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning	
Text Books/ References / Readings	1. Old, R. W. and Primrose, S. B., Principles of Gene Manipulation: An introduction to Genetic Engineering, University of California Press (1981) 2nd edition. 2. Glick, B. R., Pasternak, J. J. and Patten, C. L., Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press (2010) 4th edition. 3. Williamson, R., Genetic Engineering, Volumes 4-7, Academic Press (1981) 1st edition. 4. Glover, D. M., Gene cloning: The Mechanics of DNA Manipulation,	

	Springer (1984) 5. Green, M. R. and Sambrook, J., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory, New York (2014), 4th edition. 6. Davis, L. G., Dibner, M. D. and Battey, J. F., Basic Methods in Molecular Biology, Elsevier, (1986), 1st edition. 7. Gerhardt, P., Methods for General and Molecular Bacteriology, Elsevier (1994). 8. Grinsted, J. and Bennett, P. M., Methods in Microbiology, Vol. 21, Plasmid Technology, Academic Press (1988).	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 504 **Title of the Course:** Microbes in health and disease

Number of Credits: 3

Effective from AY: 2022-23

Prerequisites for the course:	Students should have basic knowledge of microorganisms and infectious diseases and also should have basic understanding of Immune system.	
Course Objectives:	1. To develop an understanding of the diseases caused by microorganisms. 2. To impart knowledge on significance of commensal or normal microflora for human health.	
Course Outcomes:	1. Students will be able to gain the knowledge on significance of microflora in human health. 2. Students will acquire insights into the diseases caused by pathogenic microorganisms.	
Content:	1. **Normal microbiota of human body** Introduction: Distribution of the normal microbiota; Commensals; Relationship between normal microbiota and host 2. **Human microbiota in health:** Skin microbiota: Functions; Skin microbiota- host interaction. Gut microbiota: Functions of gut microbiota, mechanism of action; health beneficial effects. Normal microbiota of oral cavity: Functions of oral microbiota; health benefits. Normal microbiota of genitourinary tract: Function; distribution in male and female genitourinary tract. 3. **Human microbiota in disease** **Human microbiota and infectious disease:** Opportunistic infections; Nosocomial infections; Infections: Gastroentric (*Clostridium difficile*; *Helicobacter pylori*; *E. coli*); Skin (Staphylococcal); Respiratory (Streptococcal,); Urogenital tract (UTIs, Bacterial vaginosis); Oral cavity (Dental caries, Periodontitis).	**3 h** **12 h** **12 h**

	Human microbiota and metabolic disorders: Irritable bowel disease; Obesity; Type 2 diabetes mellitus; Allergic diseases; Liver diseases. **Secondary infections:** Infections associated with HIV; Influenza. **Fungal mycoses** 4. **Applications of human microbiota** Probiotics; Prebiotics; Fecal microbiome transplantation 5. **Antimicrobial agents and drug resistance** Classification, mechanism of action of Antibacterial agents; antifungal agents; antiviral agents and their resistance.	**3 h** **6 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning	
Text Books/ References / Readings	1. Tortora, G. J., Funke, B. R., Case, C. L., Microbiology: An Introduction., Pearson Benjamin Cummings publishers; 2010, 10th Edition. 2. Willey, J., Sandman, K., Wood, D.; Prescott's Microbiology., Mc Graw Hill., 2020, 11th Edition. 3. Harvey, R. A., Cornelissen, C. N., Fisher, B. D., Lippincott's Illustrated review: Microbiology., Lippincott's William and Wilkins; 2007, 3rd Edition. 4. 4Chauhan, N. S. Introductory Chapter: Human and Microbes in Health and Diseases. In *Role of Microbes in Human Health and Diseases*. IntechOpen., 2019 5. Feng, Q., Chen, W. D., & Wang, Y. D. (2018). Gut microbiota: an integral moderator in health and disease. *Frontiers in microbiology*, *9*, 151. 6. Haller, D., *The gut microbiome in health and disease*. Springer International publishing., 2018.	

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Programme: M.Sc. (Biochemistry)

Course Code: BCO 505 **Title of the Course:** Drug Metabolism and Pharmaceutics

Number of Credits: 3

Effective from Academic Year: 2022-23

Prerequisites for the course:	The candidates choosing this course are expected to have knowledge of basic chemistry, clinical biochemistry and analytical techniques.	
Course Objectives:	1. To introduce the students to pharmacopoeia, drug synthesis, drug formulations and GMP and quality control practices in a pharmaceutical set-up. 2. To introduce concepts of drug administration, metabolism and monitoring.	
Course Outcomes:	1. Students will understand the basic pathways of drug distribution, metabolism and excretion in the body. 2. Students will be aware of all the types of drug formulations and their	

	contents and also the quality testing for these formulations which will help them when working in a pharmaceutical industry.	
Content:	**1. Drugs – Absorption and distribution in human body** Drugs: Definition and types (therapeutic, drugs of abuse, poisons). Routes of drug administration, introduction to absorption , distribution, metabolism, and excretion (ADME) of drug. Absorption and distribution of drug through organ /tissue. Factors affecting drug distribution: Physicochemical properties of drugs, organ/tissue size, blood flow to the organ, physiological barriers to the distribution of drugs, drug binding blood/ tissue/ macromolecules. Protein/tissue binding of drugs – factors affecting protein binding of drugs, significance and kinetics, tissue binding of drugs **2.. Drug Metabolism:** Biotransformation of drugs and factors affecting biotransformation. Organs of drug metabolism: hepatic and extrahepatic metabolism. Mechanisms of drug metabolism – inactivation, bioactivation, reactive intermediates. Phase 1 reactions - CYP-Catalyzed: Hydroxylation (Primarily at C, N, some at S), Dealkylation (N- and O-dealkylation), Deamination, Epoxidation, Reduction. Non-CYP-Catalyzed: Oxidation (Alcohol and Aldehyde Dehydrogenase, Flavin-Containing Monooxygenase, Monoamine Oxidase), Reductase (Quinone Reductase), Hydrolysis (Esterases, Amidases, Epoxide Hydrolase). Phase 2 reactions -Glucuronidation, Sulfation, Acetylation, Glycine conjugation (minor), Glutathione conjugation (toxic substances). Significance of drug metabolism. 3. **Excretion of drugs:** Renal excretion, factors affecting renal excretion. Nonrenal routes of excretion, factors affecting excretion and enterohepatic circulation. 4. **Posology:** Determination of doses; dose response relationship, dosage form design, biopharmaceutical consideration, drug antagonism, drug – drug interaction. 5. **Drug Extraction:** Solvents used in extraction of drugs, processes used for extraction (infusion, decoction, maceration, percolation, hot extraction). Water as universal pharmaceutical vehicle. 6. **Types of formulations:** Tablets: advantages of tablets; types of tablets: effervescent, lozenges, chewable, buccal and sublingual, dispersible, orodispersible, soluble; excipients in tableting, coating in tablets. Sustained release (SR): Delayed absorption and/or a mixture of slow- and fast-release particles to produce rapid and sustained absorption in the same dose. Granulation: methods and equipment, direct compression.	**3 h** **5 h** **2 h** **2 h** **4 h** **12 h**

	Capsules: hard gelatin and soft gelatin capsules- differences and composition, advantages and limitations, excipients. Liquids and Gels: Types of liquid formulations, excipients including solubilizers, stabilizers, buffers, tonicity modifiers, bulking agents, viscosity enhancers/reducers, surfactants, chelating agents and adjuvants, hydrophilic-lipophilic balance (HLB) values. Parenterals: Intravenous, subcutaneous, intramuscular or intra-articular administration, stored in liquid form, or in lyophilized form if unstable. Topical: Cream, ointment, gel, paste, powder. 7. **Quality assurance/ Quality control:** Introduction to GLP, GMP and SOPs Raw material analysis (RMA), Quality control of pharmaceutical excipients. Packaging material testing (PMT): Permeability of plastic; testing of foil, bottles, carrions. Limit tests – chloride, sulphate, arsenic, lead, iron, nitrate, alkali and alkaline earth metals Limits of insoluble matter, soluble matter, nonvolatile matter, volatile matter, residue on ignition and ash value. Product labeling: Drug indication; composition; dosage; storage; instructions; cautions; contraindications; batch number; manufacture date, expiry date. 8. **Research and Development:** Drug design: Drug discovery and development; Clinical trials	**6 h** **2 h**
Pedagogy:	Lectures (online or physical)/ tutorials/ seminars/ term papers/assignments/ presentations. Sessions shall be interactive in nature to enable peer group learning.	
Text Books/ References / Readings	1. Brunton, L. L., Hilal-Dandan, R., Knollmann, B. C.; Goodman & Gilman's: The Pharmacological Basis of Therapeutics, McGraw-Hill Education, 2018, 13th Edition. 2. Mahato R. I., Narang A. S., Pharmaceutical Dosage Forms and Drug Delivery: Revised and Expanded, CRC Press, 2017, 3rd Edition. 3. Aulton, M. E., Pharmaceutics: The Science of Dosage Form Design, Churchill Livingstone; 1988, 7th edition. 4. Aulton, M. E., Taylor, K.; Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Elsevier, 2017, 5th Edition. 5. Allen, L., Popovich, N. G., Ansel, H.; Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Willimas & Wilkins, 2018, 11th Edition.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 506 **Title of the Course:** Nutrition and Food biochemistry

Number of Credits: 3

Effective from AY: 2022-23

Prerequisites for the course:	Basic knowledge in Biochemistry and Microbiology.	
Course Objectives:	1. To learn about the basic nutrients in foods and deficiency diseases associated with these nutrients. 2. To understand food spoilage, food preservation and how they play and important role in food processing industry.	
Course Outcomes:	1. The students will develop a strong knowledge and understanding on the basic nutrients of food and nutrient associated diseases. 2. They will also gain knowledge on food spoilage, food preservation mechanisms and standards used in industry to maintain food hygiene.	
Content:	**1. Vitamins, Minerals, Water, Fibre** Fat soluble vitamins: physiological role, deficiency disorders, toxicity. Water soluble vitamins: physiological role, deficiency disorders, toxicity. Mineral metabolism, physiologic role and deficiency disorders: macronutrients: calcium, magnesium, sodium, potassium, phosphorus, sulphur and chlorine Trace elements: essential and non-essential elements Concept of Dehydration and its pathophysiology Fibre and its significance in diet. **2. Diet, Nutritional and related Disorders/Diseases** Protein malnutrition disorders: Marasmus, Kwashiorkar. Carbohydrate excess and imbalanced diet based clinical disorders (Diabetes, Hypertension, Renal disease) Concept of Starvation and its pathophysiology Eating disorders: Anorexia nervosa, Bulimia **3. Food Spoilage and Food Preservation** Forms of food spoilage – physical, chemical, microbiological parameters. Factors affecting the growth and survival of microorganisms in foods: Intrinsic and extrinsic factors Predictive food spoilage microbiology of milk, meat, poultry, vegetables and fruits, grains and legumes. Food preservation technologies: Traditional and natural food preservatives, Heat processing, low temperature storage, control of water activity, irradiation, high pressure processing, modified atmospheres, preservatives (chemicals, natural organic molecules	**12 h** **8 h** **12 h**

	(nisin) and enzymes). **4. Quality control and Validation** Microbiological examination of foods Plant sanitation Hazard Analysis and Critical Control Point (HACCP) concept, Good Manufacturing Practice (GMP) and Quality Systems.	**4 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning.	
Text Books/ References / Readings	1. Frazier, W. C & Westhoff, C.W. Food Microbiology. Graw-Hill Companies, Inc., New York (2017), 5th edition. 2. Hayes, P. R. Food Microbiology and Hygiene. Springer (1995), 2nd edition. 3. Kniel, K. E., Montville, T. J., Matthews, K. R, Food Microbiology., ASM Press, NW Washington, USA. (2017) 4th edition 4. Ray B., & Bhunia A., Fundamental Food Microbiology. CRC Press, Taylor Francis Group New York (2014) 5th edition. 5. Jay, J.M., Loessner, M.J., Golden, D.A., Modern Food Microbiology. Springer Science, New York, (2005), 7th edition 6. Adams, M. R. & Moss, M. O. Food Microbiology. Royal Society of Chemistry, (2015), 4th edition 7. Mudambi, R. Sumathi & Rajagpal M.V, Fundamentals of Food, Nutrition and diet therapy, New age International Publishers (1983), 6th edition.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 507 **Title of the Course:** Bioprospecting

Number of Credits: 3

Effective from AY: 2022-23

Prerequisites for the course:	It assumed that students have basic knowledge about bioactive molecules like enzyme, antibiotics.	
Course Objectives:	1. This course develops concept of Bioprospecting. Different sources and types for bioactive compounds and their application. 2. Characterization using separation and analytical techniques for identification of the novel metabolites from biological sources.	
Course Outcomes:	1. A better understanding of various techniques of biotechnology (plant and animal tissue culture, metagenomics, proteomics, transgenics) for application in agriculture, medicine, aquaculture, food and space.	
Content:	**1. Sources and Sampling of potential microbes and plants** Sources - microbes and plants Marine ecosystem: Water and sediment; sponges; corals- microbes, thraustochytrids, others. Coastal: mangroves; sand dunes; salterns.	**12 h**

	Terrestrial: Forest/Ghats; industrial waste. Extreme environments: thermophilic; psychrophilic; halophilic; alkaliphilic; others. Sampling Microorganisms Samplers – Niskin water sampler and Van Veen Grab sediment sampler; aseptic collection of samples Sampling of plants: Selection criteria viz. Type, physical condition, stage of growth, plant part. Sample treatment – surface sterilization; excision of desired plant component; extraction. **2. Strain improvement** Microorganisms: UV radiation mutation, chemical mutation, genetic engineering. Plants: Hybrid technology, tissue culture **3. Industrially and medically important biomolecules from plants and microorganisms: Screening, detection and characterization** Enzymes – extremozymes; food additives/ quality enncers; medicine. Antioxidants and antitumor agents Pigments – food colorants; fabric dyes Biocontrol agents – herbicides; pesticides Nanoparticles – medicine, drug carriers. Biofuels – microbially produced; plant based Optical and electronic devices: archaeal metabolites (bacteriorhodopsin and cell wall S-layer as membrane for ultrafiltration) Biopolymers – biodegradable plastics: PHAs, blended plastic polymers; EPS; biosurfactants and bioemulsifiers Plant growth promoters- gibberellins, autoxins, cytokinins **4. Intellectual property and Intellectual rights** Patent laws – International, Indian. Biopiracy.	**6 h** **14h** **4 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning	
Text Books/ References / Readings	1. Jogdand, S.N., Gene Biotechnology. Himalaya publishing house, 2016, 4th edition. 2. Jogdand, S.N., Advances in Biotechnology. Himalaya publishing house. 2007, 2nd edition. 3. Ravi, I., Baunthiyal, M. & Saxena, J. Advances in Biotechnology. Springer, 2014, 1st edition. 4. Satyanarayana, U. and Chakrapani U. Biotechnology, Books & Allied (P) Ltd, 2020.	

	5. Altman, A. & Hasegawa, P., Plant Biotechnology and Agriculture, Elsevier 2011, 1st edition 6. Clark, D. & Pazdernik, N. Biotechnology, Academic Press cell, 2015, 2nd edition. 7. Bielecki, S., Tramper, J., & Polak, J. Food Biotechnology. Elsevier, 2000. 8. Pongracz, J. & Keen, M., Medical Biotechnology. Churchill Livingstone, 2009 9. Fletcher, G. L. & Rise, M. L. Aquaculture Biotechnology. Wiley, 2011 10. Verma, A. & Singh, A. Animal Biotechnology Models in Discovery and Translation. Academic press, 2020, 2nd edition.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 508 **Title of the Course:** Nanobiotechnology

Number of Credits: 3

Effective from AY: 2022-23

Prerequisites for the course:	Students should have basic knowledge of biology, chemistry, physics for understanding basic concepts.	
Course Objectives:	1. To develop the understanding of nanoparticles and nanomaterials, their biosynthesis, characterization 2. To develop understanding about the industrial and medical applications of nanomaterials.	
Course Outcomes:	1. Students will acquire insights about characterization, biosynthesis, detection and application of nanoparticles 2. Students will understand the relevant application of nanobiotechnology in medicine and industry.	
Content:	**1. Introduction** Definition; historical background; concepts. **2. Biological cellular nanostructures** Protein and Peptide based: Proteins; bilayers and membrane arrays; ATPase; archaeal S-layers, bacteriorhodopsins; eubacterial magnetosomes – greigite, magnetite. DNA based: DNA molecule; self-assembled DNA nanotubes Virus particles; diatoms. **3. Nanomaterials** Shapes, size and properties: spherical, triangular, prisms, rods, cubes. Nanoparticles, nanocrystals, quantum dots, nanotubes and nanowires. Miniaturized devices in nanobiotechnology - types and applications, lab-on-a-chip (LOC). **4. Biosynthesis** Concept of top-down versus bottom-up approach. Uniformity and	**1 h** **6 h** **4 h** **7 h**

	heterogeneity. Agglomeration of nanoparticles: monitoring and control of agglomerates, collision efficiencies, agglomeration. Green technologies: nanoparticle biosynthesis using microbes, plant extracts, reductases. **5. Detection and characterization of nanoparticles** Optical: Visual colour change; UV-Vis spectrum; Fluorescence. Size imaging: Electron microscopy (SEM, TEM), light scattering, Zetapotential Surface and composition: FT-IR, Raman spectroscopy, EDAX, AFM, XRD. Magnetic resonance methods: NMR, 13C-NMR. **6. Medical Applications** Drug development – Drug discovery; toxicity evaluation: cyto-toxicity, geno-toxicity. Diagnostics – LOC technology; Imaging agents: MRI; Nanosensors for early-stage cancer detection; Nano-optics and fluorescence-based assays; Drug delivery systems –Lipid and inorganic nanoparticles. Antimicrobials – Metal/metal oxide nanoparticles against bacteria, fungi, viruses. Therapeutics – Cardiovascular diseases; neurological disorders (Alzheimer's, Parkinson's). Cancer therapy – Quantum dots for targeted drug delivery. **7. Industrial Applications** Electronic – Photodiodes; semiconductor Quantum dots, Water purification – Nanoadsorbents and magnetic nanoparticles Oil industry – enhanced oil recovery Food industry – Magnetosomes for detection of pathogens Environment – nanobiosensors for pollution detection. Bioremediation – Quantum dots for degradation of biological pollutants: oil	**7 h** **7 h** **4 h**
Pedagogy:	Lectures/ tutorials/ assignments/ seminars/ interactive learning.	
Text Books/ References / Readings	1. Nicolini, C.; Nanobiotechnology & Nanobiosciences, Jenny Stanford Publishing., 2008,1st Edition. 2. Niemeyer C.M., and Mirkin, C.A.; Nanobiotechnology, Concepts, Applications and perspectives, Wiley- Verlag GmbH & Co., 2004. 3. DeVilliers, M.M., Aramwit, P., and Kwon, G.S.; Nanotechnology in Drug Delivery; Springer-American Association of Pharmaceutical Scientists Press., 2009 4. Yao, N. and Wang, Z.L.; Handbook of Microscopy for Nanotechnology. Kluwer Academic Publishers., 2005 5. Pradeep T.; Nano: The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited., 2007, 1st Edition. 6. Mirkin, C.A. and Niemeyer, C.M. Nanobiotechnology- II, More Concepts and Applications, Wiley, Verlag GmbH &Co., 2007 7. Bulte, J.W.M. and Modo, M.M.J.; Design and Applications of Nanoparticles in Biomedical Imaging, Springer International Publishing, 2016 8. Shoseyov, O. and Levy, I.; Nanobiotechnology-Bio Inspired Devices and Materials of the Future, Humana Press Inc., 2008.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 509 **Title of the Course:** Internship

Number of Credits: 1

Effective from AY: 2022-23

Prerequisites for the course:	Students should have knowledge about the basic techniques in biochemistry.	
Course Objectives:	1. To provide hands-on experience in the application of biochemical techniques in research institutes/industries/universities. 2. To experience the workings of commercial industries.	
Course Outcomes:	1. Students will be able to apply the techniques of biochemistry to a range of practical situations. 2. Students will gain first-hand experience in the real working world. (Skill development programme)	
Content:	1. The student shall be required to: Undertake training for a minimum period of 2 weeks / 15 days or its equivalent in research institutes/industries/universities. Submit to School of Chemical sciences, Goa University, a Certificate of attendance signed by the Training Coordinator of the respective Institute / Industry / University. Submit to the Department a Report of the work undertaken. Make a Presentation of the work carried out, to the Department Council for evaluation.	**24 h**
Pedagogy:	Short-term internship (minimum 15 days) at an institute/industry/university.	
Text Books/ References / Readings	As suggested by the demonstrator to the participating students.	

Programme: M. Sc. (Biochemistry)

Course Code: BCD 510 **Title of the Course:** Dissertation I

Number of Credits: 8

Effective from AY: 2021-22

Prerequisites for the course:	Students should have knowledge about the basic techniques in biochemistry.	
Course Objective:	1. To develop the skills of preparing and conducting independent research in students.	
Course Outcomes:	1. Students will be able to apply the tools and techniques of biochemistry in conducting independent research.	

	2. Students will gain practical experience of the laboratory oriented research work (Skill development programme).	
Content:	1. Research to be carried out under the guidance of an assigned guide. 2. Periodic reports (as determined at the initiation of the research work). 3. Dissertation to be carried out in subjects related to Life sciences. 4.Viva- Voce.	**192h**
Pedagogy:	Project carried out individually by each student throughout the academic year.	
Text Books/ References / Readings	As required for the development of review and methodology.	

Programme: M. Sc. (Biochemistry)

Course Code: BCD 511 **Title of the Course:** Dissertation II

Number of Credits: 5

Effective from AY: 2021-22

Prerequisites for the course:	Students should have knowledge about the basic techniques in biochemistry.	
Course Objective:	1. To develop the skills of preparing and conducting independent research in students.	
Course Outcome:	1. Students will be able to apply the tools and techniques of biochemistry in conducting independent research.	
Content:	1.Research to be carried out under the guidance of an assigned guide. 2.Periodic reports (as determined at the initiation of the research work). 3.Dissertation to be carried out in subjects related to Life sciences. 4.Viva- Voce.	**120 h**
Pedagogy:	Project carried out individually by each student throughout the academic year.	
Text Books/ References / Readings	As required for the development of review and methodology.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 512 **Title of the Course:** Laboratory techniques and trends in Research-I

Number of Credits: 4

Effective from AY: 2022-23

Prerequisites for the course:	Should have studied the theoretical concepts in respective Biochemistry courses.	
Course Objective:	1. To develop hands-on experience of skills of various instruments and techniques in Animal cell and tissue culture and microbial cells, Genomics and proteomics, Bioprospecting microbes for industrial purpose and Advanced analytical techniques in Industries and research.	
Course Outcomes:	1. Animal and plant tissue culture techniques and Microbial techniques unit of the practical will provide hands-on experience for the students with skilful handling and examining microorganisms, Animal and plant cells and laboratory culture techniques. 2. Genomics and proteomics part of this practical will provide hands-on experience in Isolating and evaluating DNA, RNA and proteins from various sources. This course will also provide them the insights of Bioinformatics. 3. Bioprospecting of microorganisms in industries unit of this course will provide hands-on experience on some of the techniques involved in Industrial sectors. 4. Advanced Analytical techniques in industry and research will provide the students will hands-on experience with the important techniques involving QC in industries. 5. Students will be able to apply the tools and techniques of biochemistry in conducting independent research.	
Content	**I. Animal and plant tissue culture techniques and Microbial techniques** **1. Animal tissue culture techniques: (Any Two)** i) Laboratory safety protocols and Preparation of media and sterilization techniques. ii) Primary cell culture and established cell lines. iii) Cell counting and viability techniques. iv) Preservation of cell lines. **2. Plant tissue culture techniques: (Any Two)** i) Laboratory safety protocols and Preparation of media and sterilization techniques. ii) Germination of seeds *in vitro.* iii) Establishment of primary culture and Micropropagation.	**24h**

	iv) Low cost strategies in plant tissue culture. **3. Microbial culture techniques: (Any Two)** i) Laboratory safety protocols and Preparation of media and sterilization techniques. ii) Isolation and enumeration of bacterial and fungal cultures from various environmental samples. iii) Identification of microbial isolates: Morphological and biochemical identification techniques.	
	II. Genomics and proteomics (Any six) 1. Sample Preparation for isolating DNA, RNA and proteins from animal, plant and bacterial/fungal samples. 2. Isolation of Plasmid DNA, RNA and proteins. 3. Qualitative and quantitative estimations. 4. Electrophoretic techniques and various gel staining techniques. 5. DNA:- PCR amplification, electrophoresis and purification. 6. Molecular identification technique for microbial isolates: understanding of 16s and 18s rRNA sequencing, BLAST analysis and construction of phylogenetic trees. 7. Protein identification techniques: understanding of protein sequencing, Protein BLAST, Protein Data bank (PDB) studies.	**24h**
	III. Bioprospecting of microorganisms in industries 1. Bioassay: Antibiotic assays 2. Strain improvement: Using UV radiations Using a Chemical mutagen 3. Production of protoplast: Using lytic enzymes Using antibiotics. 4. Immobilization of enzymes and determination of its activity.	**24h**
	IV. Advanced Analytical techniques in industry and research (Any six) 1. Extraction, purification and quantification of bioactive components from different source 2. Gas chromatographic analysis of volatile organic impurities in different samples 3. Purification of various analytes using advance chromatographic techniques such as size exclusion and ion exchange chromatography 4. Fluorometric analysis of the vitamins and drug molecules 5. Removal of impurity from commercial food products using adsorption on column and analysis by potentiometry. 6. Determination of potassium in plants by Flame Emission Spectroscopy 7. Determination of Aspirin and Caffeine in tablets by UV- visible spectroscopy 8. Separation of pigments using TLC and paper chromatography 9. Qualitative and quantitative analysis of given sample using HPLC 10. Structural elucidation of biomolecule using various spectroscopic	**24h**

	techniques.	
Pedagogy:	Pre-lab/ tutorials/ laboratory work/ field work/ outreach activities/ viva/ assignments/ term papers.	
Text Books/ References / Readings:	1. Harley, J. P., Prescott, L. M., Laboratory exercises in Microbiology. Mc Graw Hill companies. 2002, 5th edition. 2. .R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell. 2016, 7th Edition. 3. Aneja, K.R. Experiments in Microbiology, Plant pathology, tissue culture and Microbial Biotechnology. New Age International publishers. 2005, 5th edition. 4. Christian G. D., Dasgupta P. K , Schug K. A; Analytical Chemistry; John Wiley & Sons; 2013/ 7th Edition. 5. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis; Cengage Learning 2016/ 7th Edition.	

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Programme: M. Sc. (Biochemistry)

Course Code: BCO 513**Title of the Course:** Laboratory techniques and trends in Research-II

Number of Credits: 4

Effective from AY: 2022-23

Prerequisites for the course:	Should have studied the theoretical concepts in respective Biochemistry courses.	
Course Objective	1. To develop basic understanding and skills of various instruments and techniques in Medical Microbiology, Nutrition and food biochemistry, Drug metabolism and Pharmaceutics and Nanobiotechnology.	
Course Outcomes	1. Microbes in health and disease unit of the practical will train the students with skillful handling and examining microorganisms including pathogenic ones. 2. .Nutrition and food Biochemistry practicals will help students identify food spoilage microorganisms and evaluate foods based on their nutrient content. 3. Pharmaceutics and Drug metabolism will train the students to perform basic analysis and characterisation of drug formulations and API. 4. Nanobiotechnology unit of the course develops the understanding of techniques for synthesis and applications of nanoparticles. 5. Students will be able to apply the tools and techniques of biochemistry in conducting independent research.	
Content		
	I. Microbes in health and disease Antimicrobial susceptibility testing A) Disc diffusion method	**24 h**

	B) Agar well diffusion method 1. Isolation and identification of normal microflora from human body: (Any Two) A) Oral cavity B) Skin C) Respiratory tract 2. Isolation and identification of pathogenic microorganisms from clinical samples: (Any TWO) A) Pus and Wounds B) Blood C) Feces and Urine	
	II. Nutrition and Food Biochemistry 1. .Estimation of vitamin C 2. Estimation of minerals such as magnesium and ions such chloride 3. Examination of foods and determination of food spoilage microorganisms 4. Biochemical reactions: (Any two) 5. Enzymatic browning of fruits 6. Autooxidation 7. Rancidity of fats.	**24 h**
	III. Drug metabolism and Pharmaceutics (Any six) 1. To estimate quantitatively the amount of paracetamol in a given tablet. 2. TLC analysis of commercially available analgesics and identification of the active ingredient. 3. Separation of paracetamol from commercial tablet by column chromatography 4. Determination of moisture content of tablets using Karl Fischer titration. 5. Determination and interpretation of IR/FTIR spectra of some pharmaceutical drugs. (any two drugs). 6. To quantify paracetamol drug in the given formulation by UV-Visible spectroscopy 7. HPLC analysis of analgesics in a commercial sample/tablet. 8. To analyze the dispersibility of paracetamol tablet. 9. Analysis of antacids.	**24 h**
	IV. Nanobiotechnology 1. Biosynthesis of metal nanoparticles using plant extract. 2. Characterization of synthesized nanoparticles using UV-Vis spectroscopy. 3. To study different instrumental techniques for nanoparticle characterization (SEM/XRD/FT-IR). 4. Antimicrobial activity of synthesized nanoparticles. 5. Removal of pollutants from water using nanoadsorbents. 6. Application of nanoparticles in research and industries: discussion	**24 h**

	of two research publications/lab work/presentation/assignments.	
Pedagogy:	Pre-lab/ tutorials/ laboratory work/ field work/ outreach activities/ viva/ assignments/ term papers.	
Text Books/ References / Readings:	1. Harley, J. P., Prescott, L. M., Laboratory exercises in Microbiology. Mc Graw Hill companies. 2002, 5th edition. 2. Pradeep T.; Nano: The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited., 2007, 1st Edition 3. In addition to above, references given under respective theory courses (BCO 504, BCO 505, BCO 506, BCO508) may be referred.	

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Annexure III

M.Sc Biochemistry syllabus

	Part-I		Part-II		Total Credits		
	Papers	Credits	Papers	Credits	Part-I	Part-II	P-I + P-II
Core Theory	4	3	4	3	12	12	24
Opt. Theory	4	3	2 1	3 2	12	8	20
Core Pract.	1	4	1	4	4	4	8
Opt. Pract.	1	4	4	2	4	8	12
Dissertation			1	8			
Dissertation[a]			1	5			
				Total credits	32	32	64

Core: optional ratio is 1:1 as required and Theory: Practical ratio is 2:1

a ; Additional 3 credit theory course of Part II level from courses listed in syllabus should be added to make it total 8 credit Addition two, 4 credit practical papers can be floated, in place of dissertation if required.

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M.Sc. Biochemistry Part-II papers

Core papers					
Sl. No.	**Existing Paper code and title**	**Modified code and Paper title**	**Approx. % of modification**	**Credit s**	**Justification for modification**
1.	BCC 201 Clinical Biochemistry	BCC 501 Medical Biochemistry	20%	3	The content of the course BCC 201 Medical biochemistry has rearranged with re-allotment of lectures. 10% syllabus is added. The course title is changed to Medical Biochemistry from Clinical Biochemistry as the term Medical biochemistry includes clinical Biochemistry as well as metabolic diseases and disorders which are included in this syllabus.
2.	BCC 103 Enzymology [T]	BCC 502 Enzymology	20%	3	The content of the course has been rearranged for better understanding. Content written in elaborated form. Three new topics have been added considering research applications.
3.	BCO 113 Industrial Biochemistry [T]	BCC 503 Industrial Biochemistry	10 %	3	The content of the course has been rearranged for better understanding. Content written in elaborated form.
4.	BCC 104 Biostatistics [T]	BCC 504 Biostatistics and technical writing	20 %	3	20 % material is added. This new content is added for orienting the students for research field. The course title is modified to Biostatistics and technical writing.
5.	BCC 206 Practical- II	BCC 505 Laboratory course in Biochemistry-II	50 %	4	The course title is modified to Laboratory course in Biochemistry-I and the courses have been edited as per the theory course sequence as below:

					Modification in the course content is done as per the rearrangement in theory course content.
	BCC 206, Practical- II, section I-Clinical Biochemistry	Medical Biochemistry	20%	1	The experiments of the BCC 206, Practical-II, section I-Clinical Biochemistry has been rearranged and 20% experiments are added considering the current need for job and research.
	BCC 105, Practical- I, section-II Enzymology	Enzymology	0%	1	Experiments in these sections are unchanged.
	BCO 113 Industrial Biochemistry [T]	Industrial Biochemistry	80%	1	80% new experiments are added considering the current industrial need.
	BCC 105 Practical- I, section-IV	Biostatistics and technical writing	30%	1	30 % material is added. This content is added to match the revised theory course content. The new course title is modified to Biostatistics and technical writing
Optional papers					
Sl. No.	**Existing Paper code and title**	**Modified code and Paper title**	**Approx. % of modification**	**Credit s**	**Justification for modification**
1.	BCO 101 Hormones [T]	BCO 501 Hormones	**5 %**	**2**	The content of the course 101 Hormones is restructured and 5% syllabus is added.

					In the previous syllabus the syllabus was divided into two sections that overlapped in several areas. current syllabus divides the syllabus into four specific sections. Syllabus is restructured to give students better clarity on the topics covered in each section. The additional topics have been modified based on CSIR NET and SET syllabus.
2.	BCO 102 Neurochemistry	BCO 502 Neurochemistry	20%	2	The content of the course BCO 102 Neurochemistry has rearranged with re-allotment of lectures. 15% syllabus is added for better understanding of the concepts.
3.	BCO 103 Genetic engineering [T]	BCO 503 Genetic engineering	5%	3	The content of the course BCO 103 Genetic engineering is restructured for better understanding and 5% syllabus is added.
4.	BCO 107 Microbes in health and disease [T]	BCO 504 Microbes in health and disease	50%	3	Almost 50% syllabus is added and around 50% deleted from the existing one. The added syllabus is pertaining to the title of the course and thus topics on microflora has been added.
5.	BCO 109 Drug metabolism [T] BCO 120 Pharmaceutics [T]	BCO 505 Drug metabolism and Pharmaceutics	50%	3	The optional papers BCO Drug metabolism (1 credit) and BCO Pharmaceutics (3 credits) have been combined as a single paper considering the scope and future prospects of students in pharmaceutical industry. Some of the content has been deleted and re- alloted to get 3 credit paper.

6.	BCO 105 Nutrition and food Biochemistry [T]	BCO 506 Nutrition and food Biochemistry	20%	3	The syllabus is modified by 20%. Spoilage of microorganisms with respect to poultry, food grains, fruits and vegetables has been introduced. Traditional and natural preservative techniques for food preservation have been added. The syllabus has been restructured to give better clarity on the topics covered in each section.
7.	BCO 117 Bioprospecting [T]	BCO 507 Bioprospecting	10%	3	The paper has been modified to a 3 credit paper.10% of the syllabus is modified by addition of more growth promoting substances and understanding blended and natural plastics. These topics have been added more in line with the CSIR NET and Set exam perspective. The analytical techniques involved in analyzing the biomolecules have been deleted. These techniques were a repetition of the syllabus as they are being covered in the revised course of Analytical Biochemistry- I and Analytical Biochemistry- II
8.	BCO 118 Nanobiotechnolog [T]	BCO 508 Nanobiotechnology	0%	3	This section is unchanged
9.	BCO 202 Training in an Institute /	BCO 509 Internship	0%	1	This section is unchanged only the title has been changed to Internship

	Industry / University				
10.	BCD Dissertation	BCO 510 Dissertation	0%	8	
11.		BCD- 511 Dissertation	100%	5	This course is a newly added one. Considering the current unavailability of lab for biochemistry dissertation and time required for setting biochemistry Post graduate labs the course is developed.
12.		BCO 512 Concepts and trends in Research-I	100 %	4	This course is a newly added one. The importance of this paper is that it's practical hands-on training.
13.		BCO 513 Concepts and trends in Research-II	100%	4	This course is a newly added one. The main objective here is to impart knowledge about practical hands-on training
I.	BCO 108 Microbes in health and disease [P]	Microbes in health and disease	50%	1	The experiments of BCO 108 Microbes in health and disease [P] have been rearranged and 50% experiments are added and some deleted. The practical componnent has been shifted from 1 credit BCO 108 Microbes in health and disease [P] to Concepts and trends in Research-II section. The experiments are deleted and added to better suit the title of the course. Some of the experiments will be covered under the added experimental parts.
II.	BCO 106 Nutrition and Food Biochemistry [P]	Nutrition and Food Biochemistry	0%	1	This section is unchanged only shifted from 1 credit BCO 106 Nutrition and food [P] to Concepts and trends in Research-II section.

III.	BCO 128 Pharmaceutics	Drug metabolism and Pharmaceutics	50%	1	Two courses- drug metabolism and pharmaceutics are combined considering the scope and future prospects of students in the pharmaceutical industry.
IV.	BCO 119 Nanobiotechnology	Nanobiotechnology	0%	1	This section is unchanged only shifted from 1 credit BCO 119 Nanotechnology [P] to Concepts andtrends in Research-II section. This change has been done to keep uninformatively in the course structure in terms of course credits.
		Total credits		32	

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