**GOA UNIVERSITY**
**Taleigao Plateau, Goa 403 206**

# REVISED MINUTES

**of the 5th Meeting of the Standing Committee of**

**X ACADEMIC COUNCIL**

**Day & Date**

**Tuesday, 14th February, 2023 & Thursday, 23rd February, 2023**

**Time**

**10.00 a.m.**

**Venue**
**Council Hall,**
**Administrative Block**
**Goa University**

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| **D 3.12** | **Minutes of the Board of Studies in Portuguese meeting held on 18.10.2022.**<br>The Standing Committee of the Academic Council approved the minutes of the Board of Studies in Portuguese meeting held on 18.10.2022 with the suggestion to thoroughly verify the translation of titles/font in languages before uploading the Syllabus on the website.<br><br>**(Action: Assistant Registrar Academic-PG)** |
| **D 3.13** | **Minutes of the Board of Studies in Biochemistry meeting held on 22.10.2022.**<br>The Standing Committee of the Academic Council approved the minutes of the Board of Studies in Biochemistry meeting held on 22.10.2022 with the suggestion to replace terminology 'Text Books/References/Readings' with 'References/Readings.'<br><br>**(Action: Assistant Registrar Academic-PG)** |
| **D 3.14** | **Minutes of the Board of Studies in Philosophy meeting (by circulation)**<br>The Standing Committee of the Academic Council approved the minutes of the Board of Studies in Philosophy meeting held by circulation with the following suggestions:<br><br>1. Prerequisites for the Course PYTC 601 – Research Methodology to be added.<br>2. Pedagogy for the Course to be included.<br><br>**(Action: Assistant Registrar Academic-PG)** |
| **D 3.15** | **Minutes of the Board of Studies in Biotechnology meeting held on 13.10.2022.**<br>The Standing Committee of the Academic Council approved the minutes of the Board of Studies in Biotechnology meeting held on 13.10.2022 with the following suggestions:<br><br>1. Heading 'Elective Generic Course' mentioned under Course Structure to be replaced with 'Generic Elective Course'.<br>2. Course level listed below the Course structure to be deleted.<br>3. The syllabus to be submitted as per prescribed syllabus template.<br>4. Number of hours of the Course Code GBTR-502, Bioprocess Technology to be corrected.<br>5. Course Code of the Course Scuba Diving to be verified.<br><br>**(Action: Assistant Registrar Academic-PG)** |
| **D 3.16** | **Minutes of the Board of Studies in Marathi meeting held on 19 and 20.10.2022.**<br>The Standing Committee of the Academic Council approved the minutes of the Board of Studies in Marathi meeting held on 19.10.2022 and 20.10.2022 with the following suggestions:<br><br>1. Title of the Courses to be indicated in both Marathi and English languages.<br>2. Translation of titles/font in languages to be thoroughly verified before uploading on the website.<br><br>Hon'ble Vice-Chancellor (Chairperson) thanked Prof. K. S. Bhat on behalf of the Academic Council for his cooperation and contribution to the academic progress of |

Std. Com. X AC-5
14.02.2023

**GOA UNIVERSITY**
**Taleigao Plateau, Goa 403 206**

# F I N A L  A G E N D A

**For the 5th Meeting of the Standing Committee of**

**X ACADEMIC COUNCIL**

**Day & Date**

**Tuesday, 14th February, 2023**

**Time**

**10.00 a.m.**

**Venue**
**Conference Hall**
**Administrative Block**
**Goa University**

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|---|---|
| | **Important points for consideration/ approval of Academic Council:** NIL<br>The meeting ended with closing remarks by Prof. K. Shripad Bhat, Dean, Shenoi Goembab School of Languages & Literature and Chairman, BoS Department of Portuguese and Lusophone Studies.<br><br>Date: 18.10.2022. Sd/-<br>Signature of the Chairman<br>**Part G:**<br>Remarks of the Dean, Faculty of Languages and Literature:<br>i) The minutes are in order.<br>ii) The minutes may be placed before the Academic Council.<br>iii) May be recommended for approval by the Academic Council.<br><br>Date: 18.10.2022. Sd/-<br>Dean, Shenoi Goembab School of Languages and Literature<br>**(Back to Index)** |
| **D 3.13** | **Minutes of the Board of Studies in Biochemistry meeting held on 22.10.2022.**<br>**Part A**<br>i. Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level: NIL<br>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).<br>**To discuss the revision of semester III & IV syllabus of M.Sc. Biochemistry program**<br>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 program is attached as **[Annexure I Refer page No. 496]**<br><br>**Approval** of **syllabus for the Ph.D. Coursework paper in Research Methodology, (Paper-I; 4 Credits) for Research Scholars**<br>After due deliberations and incorporating the suggestions made by the members, the BOS unanimously resolved to approve the draft syllabus of 4 credit Paper-I titled "Research methodology" for the Ph.D. Coursework for research scholars. The BOS approved syllabus of Ph.D. coursework in Research Methodology is attached as **[Annexure II Refer page No. 530]**<br><br>**Approval** of **around 16 PG level Swayam courses in Biochemistry and allied subjects that M.Sc. students can offer.**<br>After going through the syllabus of total 22 different courses from SWAYAM portal, 16 were selected which Biochemistry PG students can offer. The list is attached as **[Annexure III Refer page No. 533]**<br><br>**Part B**<br>i. Scheme of Examinations at undergraduate level: NIL<br>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: 22nd October 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 Nos. PART-A (ii)**
iii. May be recommended for approval of Academic Council.
iv. Special remarks if any.

Sd/-
Date: 22.10.2022 Prof. V. M. S. Verenkar
Place: Taleigao Plateau Dean, School of Chemical Sciences

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**D 3.13 Minutes of the Board of Studies in Biochemistry meeting held on 22.10.2022.**

**Annexure I**

**M.Sc. Biochemistry Part-II revised syllabus (SEM III and SEM IV) for AY 2023-24 based on NEP-2020**

| Sl. No. | Subject code | Paper title | Credits |
|---|---|---|---|
| | | **Research Specific** | |
| 1. | **CHBR-511** | Practical Course in Biochemistry-III | 4 |
| 2. | **CHBR-512** | Practical Course in Biochemistry-IV | 4 |
| 3. | **CHBR-513** | Medical Biochemistry | 4 |
| 4. | **CHBR-514** | Nanobiotechnology | 4 |
| 5. | **CHBR-515** | Concepts in Genetic Engineering | 4 |
| 6. | **CHBR-516** | Research methodology, Biostatistics and Bioethics | 4 |
| | | **Generic Elective** | |
| 1. | **CHBG-511** | Hormones and Neurochemistry | 4 |
| 2. | **CHBG-512** | Clinical Microbiology and Food Biochemistry | 4 |
| 3. | **CHBG-513** | Drug metabolism and Pharmaceutics | 4 |
| 4. | **CHBG-514** | Bioprospecting and Bioremediation | 4 |
| 5. | **CHIG-515** | Bioinorganic Chemistry | 4 |
| 6. | **CHAG-511** | Fundamentals of Crystallography | 4 |
| | | **Dissertation** | |
| 1. | **CHBD-511** | Discipline Specific Dissertation | 16 |

**M.Sc. Biochemistry Part-II revised syllabus (SEM III and SEM IV)**

| **SEM-III** | | | |
|---|---|---|---|
| **Sr. No.** | **Subject code** | **Paper title** | **Credits** |
| | | **Research Specific** | |
| 1. | **CHBR-511** | Practical Course in Biochemistry-III | 4 |
| 2. | **CHBR-512** | Practical Course in Biochemistry-IV | 4 |
| 3. | **CHBR-515** | Concepts in Genetic Engineering | 4 |
| 4. | **CHBR-516** | Research methodology, Biostatistics and Bioethics | 4 |
| | | **Generic Elective** | |

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|---|---|---|---|
| 5. | **CHBG-511** | Hormones and Neurochemistry | 4 |
| 6. | **CHBG-512** | Clinical Microbiology and Food Biochemistry | 4 |
| 7. | **CHBG-513** | Drug metabolism and Pharmaceutics | 4 |
| 8. | **CHBG-514** | Bioprospecting and Bioremediation | 4 |
| 5. | **CHIG-511** | Bioinorganic Chemistry | 4 |
| 6. | **CHAG-511** | Fundamentals of Crystallography | 4 |
| **SEM-IV** | | | |
| **Research Specific** | | | |
| 1. | **CHBR-513** | Medical Biochemistry | 4 |
| 2. | **CHBR-514** | Nanobiotechnology | 4 |
| 3. | **CHBD-511** | Discipline Specific Dissertation | 16 |

Programme: **M.Sc. Part-II (Biochemistry)**

Course Code: **CHBR-511**

Title of the course: **Practical course in Biochemistry-III**

Number of Credits: **04** Total Hours: **120** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied biochemistry courses at MSc. part I level. |
| *Course Objective:* | 1. To acquaint the students with various methods of analyses of clinical samples for metabolic diseases/ disorders essential in pathological laboratories.<br>2. To develop skills in the analysis of water samples according to critical parameters.<br>3. To impart an understanding of various statistical operations needed to process biological data and improve technical writing skills.<br>4. To develop techniques for handling, identification, and culturing of microorganisms. |
| *Course Outcome:* | 1. Students will be able to analyse clinical samples for metabolic diseases/ disorders essential in pathological laboratories and further will be able to design various techniques in clinical biochemistry research.<br>2. Students will be able to evaluate water samples and assess its suitability<br>3. Students will be able to apply various statistical operations needed to process any biological data and have good technical writing skills.<br>4. Students will be in a position to handle, culture, and identify microorganisms |

| *Content* | *Hrs* |
|---|---|
| **A. Medical Biochemistry**<br>Introduction to use of autoanalyzer and Rapid test for various clinical samples<br>**1. Analysis of blood sample: (ANY THREE)**<br>a. Examination of Haemoglobin (Hb) content of blood by copper sulphate method or Sahli's method; determination of erythrocyte sedimentation rate (ESR) of blood by Westergren method and ABO Blood grouping for determination of blood group.<br>b. Examination of clotting time of blood by capillary tube method and examination of total cell and differential cell (TC/DC) counts of blood sample.<br>c. Examination of blood glucose by glucose oxidase method or Folin-Wu method or HbA1c rapid test<br>d. Examination of blood cholesterol level by Zak's method.<br>e. Rapid test for drug abuse<br>f. Rapid test for pregnancy<br>**2. Liver function tests: (ANY ONE)**<br>a. Estimation of serum alanine transaminase (SGPT) and aspartate transaminase (SGOT) by Reitman and Frankel method.<br>b. Estimation of serum bilirubin level by Malloy and Evelyn method<br>**3. Renal function tests:**<br>a. Physical examination of urine: assessment of volume, appearance, odour, color, pH and specific gravity and microscopic examination of urine: assessment of crystals, casts, cells in urine sample.<br>**b.** Chemical examination of urine: **(ANY ONE)**<br>i. Estimation of glucose in urine sample by Benedict's method and estimation of albumin content in urine sample by Sulfosalicylic acid method.<br>ii. Estimation of blood urea by Diacetyl-monoxime method. | **30** |
| **B. Bioprospecting and Bioremediation (ANY FIVE)**<br>**1.** Estimation of Dissolved oxygen (DO) and Biochemical Oxygen Demands (BOD) of given water sample using Winkler method.<br>2. Estimation of Chemical Oxygen Demands (COD) of water sample and assessment of water quality using observed BOD and COD values.<br>3. Detection of sewage pollution by screening for indicator organisms such as *E. coli*.<br>4. Biotransformation of xenobiotics.<br>5. Bioassay: Antibiotic assays<br>6. Techniques of strain improvement:<br>a. Using UV radiations<br>b. Using a Chemical mutagen<br>7. Production of protoplast:<br>a. Using lytic enzymes<br>b. Using antibiotics.<br>8. Immobilization of enzymes and determination of its activity. | **25** |

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| 9. Separation and purification of secondary metabolites from microbial extracts using preparative HPLC. | |
| **C. Biostatistics and technical writing (ANY FIVE)**<br>1. Use of graphical modes to represent biological data<br>2. Developing understanding for linear equation analysis (regression analysis).<br>3. To study normal distribution curve<br>4. To carry out Hypothesis testing using Z-test and t-test<br>5. To develop scientific abstract writing skills.<br>6. To develop scientific reports writing skill<br>7. Formation of frequency distribution and calculation of descriptive measures-mean, median, mode, variance, standard deviation and standard error<br>8. Study application of biostatistics in pharmacology and medical research<br>9. To study one way and two-way classification of biological data using ANOVA.<br>10. To estimate genetic components and heritability using ANOVA data.<br>11. To analyse Paired t-test with an example. | **25** |
| **D. Clinical Microbiology and food biochemistry (ANY FIVE)**<br>1. Study of the bacterial growth curve.<br>2. Microscopic examination of blood films for identification of malarial parasites/ Rapid test for malaria.<br>3. Study and identification of bacterial pathogens.<br>4. Antibiotic susceptibility testing for bacterial pathogens.<br>5. Study and identification of fungi.<br>6. Examination of foods and determination of food spoilage microorganisms<br>7. Study of Enzymatic browning of fruits<br>8. Study of Auto Oxidation and Rancidity of fats. | **25** |
| **E. QA and QC in pharmaceuticals (ANY THREE)**<br>1. Qualitative and Quantitative tests of Paracetamol/Aspirin as per IP Monograph<br>2. To study the dissolution rate of sustained release Diclofenac/Theophylline tablets IP.<br>3. To develop and validate the analytical method of any one drug using high performance liquid chromatography.<br>4. To identify the given drug amongst paracetamol, aspirin, and caffeine citrate with the help of thin layer chromatography and calculate its Rf value.<br>5. Titrimetric Assay of the following bulk drugs: Chloramphenicol capsules IP /Furosemide injection IP/Ketoprofen/ Phenytoin (Any 1)<br>6. UV Spectrophotometric Assay of the following drugs (in different dosage forms): Mefenamic acid/ Furosemide/ Chloramphenicol (Any 1) | **15** |
| *Pedagogy* | Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning. |

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| *Text Books/ References / Readings* | 1. Damodaran, G.; Practical Biochemistry; Jaypee Brothers Medical Publishers (P) Ltd., 2011.<br>2. Mohanty, S.; Practical clinical Biochemistry; Jaypee Brothers Medical Publishers (P) Ltd., 2013, 1st Edition.<br>3. Glasman-Deal H.; Science Research Writing, Imperial College Press, 2010.<br>4. Vogel's Text book of Quantitative Inorganic Analysis, Pearson Education, Asia, 2000, 6th Edition.<br>5. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; 2010; 7th Edition.<br>6. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; 2005.<br>7. Poornima B., Food Science & Quality Control, Centrum Press First, 2014, 1st Edition.<br>8. Sathe, A.Y., A first course in Food Analysis, New Age International Pvt. Ltd., 1999, 1st Edition.<br>9. Prescott, H. Laboratory exercise in Microbiology. MacGraw-Hill Companies. 2002, 5th edition.<br>10. K. A. Connors, Text book of Pharmaceutical analysis, 3rd Edition, Wiley Interscience Publication, 1990.<br>11. J. Moini, Pharmaceutical Laboratory Procedures, 1st Edition, Cengage Learning India Pvt. Ltd., New Delhi, 2010. |

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Programme: **M.Sc. Part-II (Biochemistry)**

Course Code: **CHBR- 512**
Title of the course: **Practical course in Biochemistry-IV**
Number of Credits: **04** Total Hours: **120** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied biochemistry courses at MSc. part I level. |
| *Course Objective:* | 1. To develop hands-on experience of skills in various instruments and techniques in animal cell and tissue culture and microbial cells.<br>2. To develop skills in genomics and proteomics<br>3. To gain experience in bioprospecting of microbes for industrial purpose<br>4. To study advanced analytical techniques in the separation and characterization of biomolecules. |
| *Course Outcome:* | 1. Students will be able to use various instruments and techniques in tissue culture and microbial culture.<br>2. Students will be able to have skills in genomics and proteomics.<br>3. Students will be able to apply the techniques in bioprospecting of microbes for industrial purposes<br>4. Students will be able to use advanced analytical techniques in the separation and characterization of biomolecules. |
| **A. Animal and plant tissue culture techniques and Microbial techniques (any nine)** | **45** |

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| 1. Animal tissue culture techniques:<br>a. Laboratory safety protocols, Preparation of media and sterilization techniques.<br>b. Primary cell culture<br>c. Establishing cell lines<br>d. Cell counting and viability techniques.<br>e. Preservation of cell lines.<br>2. Plant tissue culture techniques:<br>a. Laboratory safety protocols and Preparation of media and sterilization techniques.<br>b. Germination of seeds in vitro.<br>c. Establishment of primary culture and Micropropagation.<br>d. Low cost strategies in plant tissue culture.<br>3. Microbial culture techniques:<br>a. Laboratory safety protocols and Preparation of media and sterilization techniques.<br>b. Isolation and enumeration of bacterial and fungal cultures from various environmental samples.<br>c. Identification of microbial isolates: Morphological and biochemical identification techniques. | |
| **B. Genomics and proteomics (any six)**<br>1. Isolation of genomic DNA from Prokaryotic cells.<br>2. Isolation of genomic DNA from Eukaryotic cells.<br>3. Isolation of RNA from prokaryotic cells<br>4. Isolation of plasmid DNA using Rapid boiling and Alkaline lysis method.<br>5. Isolation of protease degraders from soil and estimation of protease activity.<br>6. Quantitative Estimation of DNA and RNA<br>7. Electrophoretic techniques and various gel staining techniques.<br>8. DNA: PCR amplification, electrophoresis and purification.<br>9. Molecular identification techniques for microbial isolates: understanding of 16s and 18s rRNA sequencing, BLAST analysis and construction of phylogenetic trees.<br>10. Protein identification techniques: understanding of protein sequencing, Protein BLAST, Protein Data bank (PDB) studies. | **30** |
| **C. Advanced Analytical techniques in industry and research (any nine)**<br>1. Extraction, purification and quantification of bioactive components from different source<br>2. Gas chromatographic analysis of volatile organic impurities in different samples<br>3. Purification of various analytes using advance chromatographic techniques such as size exclusion and ion exchange chromatography<br>4. Fluorometric analysis of the vitamins and drug molecules<br>5. Removal of impurity from commercial food products using adsorption on column and analysis by potentiometry.<br>6. Determination of sodium in plants by Flame Emission Spectroscopy | **45** |

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| 7. Determination of potassium in plants by Flame Emission Spectroscopy<br>8. Determination of Caffeine in tablets by UV- visible spectroscopy<br>9.Determination of Aspirin in tablets by UV- visible spectroscopy<br>10. Extraction and Separation of microbial pigments using TLC and paper chromatography<br>11. Qualitative and quantitative analysis of given sample using HPLC<br>12. Structural elucidation of amino acids (proline/tryptophan/cysteine) using various spectroscopic techniques.<br>13.Decolorization and crystallization of brown sugar (sucrose) with animal charcoal<br>using gravity filtration.<br>14. Estimation of lead/cadmium in water sample by AES/AAS/ICP.<br>15. Estimation of iron/ manganese in water sample by AES/AAS/ICP.<br>16. Structural elucidation of carbohydrates (glucose) using various spectroscopic techniques. | |
| *Pedagogy* | Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Freshney, R. I., Masters, J. R. W.; Animal Cell Culture: A Practical Approach: No. 232; Oxford University Press; 2002, 3rd Edition.<br>2. Freshney, R. I., Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell; 2016, 7th Edition.<br>3. Smith, R. H.; Plant Tissue Culture: Techniques and Experiments, Academic Press; 2012, 3rd Edition.<br>4. Vogel's Text book of Quantitative Inorganic Analysis, Pearson Education, Asia, 2000, 6th Edition.<br>5. Wilson K, Walker J; Principles and Techniques of Practical Biochemistry; Cambridge University Press; 2010; 7th Edition.<br>6. Sawhney, S. K., Singh, R.; Introductory Practical Biochemistry; Narosa Publishing House; 2005<br>7. Poornima B., Food Science & Quality Control, Centrum Press First ,2014, 1st Edition.<br>8. Sathe, A.Y., A first course in Food Analysis, New Age International Pvt. Ltd., 1999, 1st Edition. |

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Programme: **M.Sc. Part-II (Biochemistry)**

Course Code: **CHBR-513**

Title of the course: **Medical Biochemistry**

Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied biochemistry courses at MSc. part I level. |
| *Course Objective:* | 1. To understand the biochemistry of metabolic diseases/disorders of the human body. |

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| | 2. To introduce knowledge on clinical investigations and analyses of clinical samples.<br>3. To provide insights on biochemistry of cancer and ageing. |
| *Course Outcome:* | 1. Students will be able to explain the biochemistry of metabolic disorders/diseases caused due to imbalances and metabolic errors.<br>2. Students will be able to illustrate the mechanisms of cancer and aging in the human body.<br>3. Students will be able to employ technical knowledge for assessment of various clinical samples.<br>4. The students will be able to devise strategies in designing experiments based on their understanding about physiological processes. |

| *Content* | *Hrs* |
|---|---|
| **1. Analysis of Clinical sample**<br>**a. Blood sample**<br>i. Collection and safety measures involved.<br>ii. Composition and function: Composition of blood, RBCs, Erythropoiesis, Hemoglobin, gas transport by hemoglobin, Blood buffer system: acid-base balance and imbalance.<br>iii. 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.<br>iv. Immunohaematology: Blood group systems – MN, Rh, ABO; hemolytic disease of newborn. | **8** |
| **b. Serum sample**<br>i. Collection and safety measures involved.<br>ii. Analysis: Proteins, albumin/globulin ratio; bilirubin; creatinine; uric acid; electrolytes; Thyroid function tests (serum free and total T3 & T4 and serum TSH)<br>iii. 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 aminotransferase (AST/SGOT), alanine aminotransferase (ALT/SGPT). | **7** |
| **c. Liver function tests (LFTs)**<br>i. Functions of the liver and liver profile in health and disease<br>ii. Bilirubin metabolism and clinical significance<br>iii. Classification of LFTs and their clinical significance in the diagnosis of liver diseases. | **5** |

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| **d. Renal function test (RFTs)**<br>i. Urine: Composition of urine, collection and safety measures,<br>ii. Kidney functions: Urine formation, glomerular and tubular functions, water electrolyte balance.<br>iii. Analysis of urine/RFTs: Physical, chemical and microscopic examination. | **4** |
| **e. Gastric and Pancreatic Function tests**<br>Gastric function tests (gastric analysis), hypo (achlorhydria) and hyper acidity, tests to confirm pancreatic involvement in disease. | **2** |
| **2. Metabolic disorders**<br>**a. Disorders in metabolism**<br>i. Carbohydrates: Regulation of blood glucose, insulin and diabetes mellitus (classification, stages and diagnosis); Hypoglycaemia; Diabetic ketoacidosis.<br>ii. Lipids: Hyperlipidaemias, clinical significance of cholesterol, hypercholesteremia,<br>iii. Heart: Cardiovascular disease (Atherosclerosis and Coronary artery disease), hypertension<br>iv. Proteins: Kwashiorkor, Marasmus<br>Protein misfolding, Creutzfeldt-Jakob disease, mad cow disease, *encephalopathy*<br>v. Blood Anaemia: Iron deficiency anemia, Megaloblastic anemia, Pernicious anemia, Sickle cell disease, hemolytic anemia<br>vi. Liver: Jaundice, cirrhosis<br>vii. Kidney: Diabetes insipidus, Renal calculi. | **15** |
| **b. Inborn errors of metabolism**<br>i. Prenatal diagnosis, newborn screening, laboratory investigations to diagnose metabolic disorders.<br>ii. Carbohydrate: Lactose intolerance, galactosemia, Glycogen storage disease.<br>iii. Lipids: Lysosomal storage disorders: Tay-Sach'sdisease; Gaucher's disease; Niemann Pick disease; Fabry's disease.<br>iv. Amino acids: Phenylketonuria, Albinism<br>v. Purine/pyrimidine: Lesch-Nyhan Syndrome, Gout.<br>vi. Blood: Thalassemia<br>vii. Thyroid hormone: hyperthyroidism and hypothyroidism<br>viii. Skin: Xeroderma Pigmentosum | **7** |
| **3. Biochemistry of cancer**<br>a. Properties of cancer cells<br>b. Biochemistry of cancerous growth<br>c. Etiology of cancer cells<br>d. Apoptosis in carcinogenesis<br>e. Metastasis<br>f. Mutagens and carcinogens | **8** |

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|---|---|
| g. Oncogenic viruses: DNA viruses (Hepatitis B virus and Epstein-Barr virus)<br>h. RNA viruses (Rous sarcoma virus and Human T-cell lymphotropic virus-1)<br>i. Tumor markers<br>j. Anticancer drugs | |
| **4. Biochemistry of ageing**<br>a. Definition and symptoms<br>b. Ageing theories: Programmed theories and Error theories | **4** |

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| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Vasudevan, D. M.; Sreekumari, S., Vaidyanathan, K., Textbook of Biochemistry for Medical students, Jaypee brothers Medical publishers; 2011, 6th Edition.<br>2. Chattergee, M. N; Shinde, R.; Textbook of Medical Biochemistry, Jaypee brothers Medical publishers Ltd., 2012, 8th Edition.<br>3. Smith, C.; Mark, A. D; Lieberman, M.; Marks' Basic Medical Biochemistry: A Clinical Approach; Lippincott's William and Wilkins; 2004, 2nd Edition.<br>4. Gaw, A.; Cowan, R. A.; Murphy, M. J.; O'Relly, D. S. J.; Srivastava, R.; Clinical Biochemistry, Elsevier; 2013, 5th Edition. |

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Programme: **M.Sc. Part-II (Biochemistry)**

Course Code: **CHBR-514**
Title of the course: **Nanobiotechnology**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied biochemistry courses at MSc. part I level. |
| *Course Objective:* | 1. To introduce the concept of nanoparticles and nanomaterials.<br>2. To understand methods to develop nanoparticles from plants and microbes.<br>3. To familiarize students with different characterization tools, to identify bio-nanoparticle<br>4. To develop an understanding of applications of Bio-nanomaterials in Health, Food, and the Environment. |
| *Course Outcome:* | 1. Students will be able to biosynthesize, and characterize nanoparticles<br>2. Students will be able to apply concepts of Nano-biotechnology in Healthcare, Environment and Food Industry. |

| *Content* | *Hrs* |
|---|---|
| **1. Introduction to biological cellular nanostructure and nanomaterials** | **20** |

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| a. Introduction to nanobiotechnology: definition; historical background; concepts.<br>b. Basics of biology for nanobiotechnology: cell, organelles and nucleic acids as genetic material.<br>c. Biological cellular nanostructures**:**<br>i. Protein and Peptide based: Proteins, Bilayers and membrane arrays: ATPase Archaeal S-layers, bacteriorhodopsin<br>ii. Eubacterial magnetosomes – greigite, magnetite.<br>iii. DNA based: DNA molecule; self-assembled DNA nanotubes<br>iv. Virus particles<br>v. Diatoms<br>d. Application of nanobiotechnology to biomineralization<br>**2. Nanomaterials**<br>a. Shapes, size and properties: spherical, triangular, prisms, rods, cubes. Nanoparticles, nanocrystals, quantum dots, nanotubes and nanowires.<br>b. Miniaturized devices in nanobiotechnology - types and applications<br>c. Introduction to lab-on-a-chip (LOC). | |
| **3. Biosynthesis of nanomaterials and characterization**<br>**a. Biosynthesis**<br>i. Concept of top-down versus bottom-up approach.<br>ii. Uniformity and heterogeneity.<br>iii. Agglomeration of nanoparticles monitoring and control of agglomerates and collision efficiencies.<br>**b. Green technologies:** nanoparticle biosynthesis using microbes, plant extracts, reductases.<br>**c. Detection and characterization of nanoparticles: Optical:**<br>i. Visual colour change; UV-Vis spectrum; Fluorescence, single molecule spectroscopy<br>ii. Size imaging: Electron microscopy (SEM, TEM), light scattering, FRET microscopy.<br>iii. Zeta Potential surface and composition: FT-IR, Raman spectroscopy, EDAX, AFM, XRD, $^{1}$H NMR, $^{13}$C-NMR. | **15** |
| **4. Nanobiotechnological applications in health and disease - infectious and chronic.**<br>**A. Introduction to Biosensors:**<br>i. Different classes -molecular recognition elements and transducing elements.<br>ii. Applications of molecular recognition elements in nanosensing of different analytes<br>iii. Various transducing elements as part of nanobiosensors.<br>iv. Miniaturized devices in nanobiotechnology - types and applications,<br>v. Lab on a chip concept (discussion with example)<br>**B. Medical Applications**<br>i. Drug development – Drug discovery; toxicity evaluation: cyto-toxicity, geno-toxicity. | **15** |

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| ii. Diagnostics – LOC technology; Imaging agents: MRI; nanosensors for early-stage cancer detection<br>iii. Nano-optics and fluorescence-based assays<br>iv. Drug delivery systems –Lipid and inorganic nanoparticles<br>v. Antimicrobials – Metal/metal oxide nanoparticles against bacteria, fungi, viruses.<br>vi. Therapeutics – Cardiovascular diseases; neurological disorders (Alzheimer's, and Parkinson's disease). Cancer therapy – quantum dots for targeted drug delivery. | |
| **5. Nanobiotechnological applications in Environment and food - detection and mitigation**<br>**a. Environment analysis and remediation**<br>i. Nanobiosensors for pollution detection<br>ii. Water purification – Nanoadsorbents and magnetic nanoparticles<br>iii. Bioremediation –nanoparticles for degradation of biological pollutants<br>**b. Food industry**<br>i. Magnetosomes for detection of pathogens<br>ii. Nanobiosensors for food quality monitoring.<br>iii. Nanobiosensors as emerging safety tools for the food industry. | **10** |
| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Nicolini, C.; Nanobiotechnology &Nanobiosciences, Jenny Stanford Publishing., 2008,1st Edition.<br>2. Niemeyer C.M., and Mirkin, C.A.; Nanobiotechnology, Concepts, Applications and perspectives, Wiley- Verlag GmbH & Co., 2004.<br>3. DeVilliers, M.M., Aramwit, P., and Kwon, G.S.; Nanotechnology in Drug Delivery; Springer-American Association of Pharmaceutical Scientists Press., 2009<br>4. Yao, N. and Wang, Z.L.; Handbook of Microscopy for Nanotechnology. Kluwer Academic Publishers., 2005<br>5. Pradeep T.; Nano: The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited., 2007, 1st Edition.<br>6. Mirkin, C.A. and Niemeyer, C.M. Nanobiotechnology- II, More Concepts and Applications, Wiley, Verlag GmbH &Co., 2007<br>7. Bulte, J.W.M. and Modo, M.M.J.; Design and Applications of Nanoparticles in Biomedical Imaging, Springer International Publishing, 2016<br>8. Shoseyov, O. and Levy, I.; Nanobiotechnology-Bio Inspired Devices and Materials of the Future, Humana Press Inc., 2008. |

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Course Code: **CHBR-515**
Title of the course: **Concepts in Genetic Engineering**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied biochemistry courses at MSc. part I level. |
| *Course Objective:* | 1. To introduce fundamental tools and techniques in Genetic engineering.<br>2. To understand the mechanisms of recombinant DNA technology<br>3. To familiarize the students with the applications of genetic engineering in agriculture, therapeutics, environment and industry. |
| *Course Outcome:* | 1. The students will be able to explain the tools and techniques involved in Genetic Engineering.<br>2. The students will be able to apply the techniques learnt in recombinant DNA technology.<br>3. They will be able to explain the significance of transgenic organisms in various sectors of human development.<br>4. Students will be able to understand the risks and benefits of genetically modified organisms. |

| *Content* | *Hrs* |
|---|---|
| **1. Introduction**<br>a. Concept of genetic engineering<br>b. History and milestones<br>c. Introduction to gene manipulation tools (enzymes, hosts, vectors and transformation techniques). | **5** |
| **2. Tools in Recombinant DNA technology**<br>a. DNA modifying enzymes: restriction endonucleases, exonucleases, DNA ligases, terminal DNA transferase, DNA polymerases, reverse transcriptase, T4 polynucleotide kinases, alkaline phosphatase, S-1 Nuclease, mung bean nuclease, RNases.<br>b. Gene cloning systems/Hosts: Gene cloning in *E. coli*, *Saccharomyces cerevisiae*.<br>c. Vectors: Plasmid (pUC19, pBR 322), λ phage-based vectors, cosmid vectors, phasmid vectors, shuttle vectors, high capacity cloning vectors.<br>d. Gene transfer techniques: Transformation, electroporation, transfection, gene gun. | **16** |
| **3. Recombinant DNA techniques:**<br>a. Preparation of probes<br>b. Principles & applications of nucleic acid hybridization,<br>c. Restriction mapping, RFLP,<br>d. Polymerase chain reaction: PCR, RT- PCR, real time PCR,<br>e. DNA Microarray<br>f. DNA sequencing using Sanger's dideoxy chain termination method and automated sequencer<br>g. Gene editing: Introduction to CRISPR/cas9 gene editing system. | **10** |

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| **4. Genetic Engineering in Biology, forensics and medicine**<br>a. Screening of genetic diseases using DNA probes (DNA diagnostics).<br>b. Production of recombinant proteins and drugs (insulin, Antibodies),<br>c. DNA vaccines: merits and demerits<br>d. Edible vaccines- merits and demerits<br>e. Application of recombinant DNA technology in paternity disputes and solving criminal cases (DNA fingerprinting). | **10** |
| **5. Genetic Engineering in Agriculture**<br>a. Importance of *Agrobacterium tumefaciens*<br>b. Transgenic plants<br>c. Significance of *Bacillus thuringiensis* (Bt genes)<br>d. Biofortification of foods using genetic engineering. | **8** |
| **6. Genetic Engineering in Animal Husbandry and Aquaculture**<br>a. Development of transgenic animals<br>b. Development of transgenic fish<br>c. Animal cloning | **6** |
| **7. Genetically engineered microbes in industries and the environment.**<br>a. Application of genetic engineering for enzyme production.<br>b. Bioremediation using genetically modified microbes.<br>c. Safety and bioethics of genetically modified organisms. | **5** |
| *Pedagogy* | Mainly lectures and tutorials. Seminars /term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Old, R. W. and Primrose, S. B., Principles of Gene Manipulation: An introduction to Genetic Engineering, University of California Press 1981, 2nd edition.<br>2. Glick, B. R., Pasternak, J. J. and Patten, C. L., Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press, 2010, 4th edition.<br>3. Williamson, R., Genetic Engineering, Volumes 4-7, Academic Press 1981, 1stedition.<br>4. Glover, D. M., Gene cloning: The Mechanics of DNA Manipulation, Springer, 1984.<br>5. Green, M. R. and Sambrook, J., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory, New York (2014), 4th edition.<br>6. Davis, L. G., Dibner, M. D. and Battey, J. F., Basic Methods in Molecular Biology, Elsevier, 1986, 1st edition.<br>7. Gerhardt, P., Methods for General and Molecular Bacteriology, Elsevier 1994.<br>8. Brown, T.A., Gene Cloning and DNA analysis: An introduction, John Wiley and Sons, UK, 2021, 8th edition. |

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Course Code: **CHBR-516**
Title of the course: **Research methodology, Biostatistics and Bioethics**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied Biochemistry courses at MSc. part I level. |
| *Course Objective:* | 1. To develop a basic understanding of various types of biological data, its handling and processing.<br>2. To introduce various technical writing skills.<br>3. To understand various ethical considerations while studying biological data. |
| *Course Outcome:* | 1. Students will be able to collect, handle, process and present the biological data.<br>2. Students will be able to apply statistics to biological data.<br>3. Students will be able to develop the skills needed to successfully communicate through technical writing skills. |

| *Content* | *Hrs* |
|---|---|
| **1. Introduction to Research, Research Design & literature review**<br>**a. Basics of research**<br>i. Definition and meaning of research, the significance of research, research & scientific method.<br>ii. Types of research, criteria for good research, problems encountered by researchers in India, selecting & defining a research problem.<br>iii. Research approaches: research methods vs methodology.<br>iv. Basic principles of experimental designs, sampling, sample size determination, plan for data collection, methods of data collection, plan for data processing and analysis.<br>**b. Literature Review**<br>i. Primary and secondary Sources<br>ii. Web sources –critical literature review<br>iii. Hypothesis – Different types, significance, development of working hypothesis, null hypothesis<br>iv. Research Methods: Scientific method vs arbitrary method, logical scientific methods: deductive, inductive, deductive-inductive, pattern of deductive – inductive logical process, different types of inductive logical methods. | |
| 2. **Technical writing**<br>a. Different forms of technical writing: articles, research notes and reports in journals, review articles, monographs, dissertations, bibliographies.<br>b. How to formulate outlines: The reasons for preparing outlines, guide for plan of writing, skeleton for the manuscript, drafting titles, subtitles, tables, illustrations.<br>c. Parts of dissertation/research report/article: introduction, review of literature, method, results and discussion. | **5** |

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| d. Significant subtopics related to scientific writing such as content, its continuity, clarity, validity, internal consistency and objectivity<br>e. Basic attributes for writing for grants. | |
| **3. Introduction to Biological data**<br>**a. Basic characteristics of biological data**<br>i. Variables and constants, discrete and continuous variables, relationship and prediction, variables in biology (measurement, ranked, attributes), derived variables (ratio, index, rates).<br>**b. Types of measurements in biological data**<br>i. Interval scale, ratio scale, ordinal scale, nominal scale, discrete and continuous data, exact and approximate numbers.<br>ii. 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 and rules of calculating digits. | **10** |
| **4. Data handling**<br>**a. Population and Sampling**<br>i. Random samples, parameter and statistics, accuracy and precision, accuracy in observations<br>ii. Tabulation and types of frequency distribution: relative & cumulative.<br>iii. Graphical representation: types of graphs, preparation and their applications.<br>**b. Measures of central tendency:**<br>i. Characteristics of ideal measure, arithmetic mean – simple, weighted, combined, and corrected mean, limitations of arithmetic mean;<br>ii. Median – calculation for raw data, for grouped data, for continuous series, limitations of median;<br>iii. Mode – computation of mode for individual series, by grouping method, in a continuous frequency distribution, limitations of modes<br>iv. Relationship between mean, median and mode<br>**c. Measures of dispersion:**<br>i. Variability, Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series)<br>ii. Variance, coefficient of variance, limitation.<br>iii. Skewness – definition, positive, negative, purpose, measure, relative measure, iv. Karl Pearson's coefficient, Bowley's coefficient, Kelly's measure, moments. | **15** |
| **5. Correlation analysis, Population Biostatistics and Hypothesis testing**<br>**a. Covariance, correlation coefficient for ungrouped and grouped data, scatter and dot diagram (graphical method).**<br>i. Regression analysis - linear and exponential function<br>ii. Examples: DNSA conversion by reducing sugar, survival/growth of bacteria, regression coefficients, regression analysis for linear equations.<br>**b. Population Biostatistics** | **15** |

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| i. Concept of probability, theories of probability- additive and multiplicative theory<br>ii. Probability distributions: binomial, poisson and normal<br>**c Hypothesis testing**.<br>i. Hypothesis and its types: Null and Alternative<br>ii. Level of significance, one tailed and two tailed test, test for single mean and single proportion, critical region, level of confidence, level of significance,<br>iii. Parametric and Non- Parametric test<br>t-test, Z- test. F-test and ANOVA<br>Introduction to Chi-square test | |
| **6. Bioethics**<br>a. Bioethics: Definition, ethics in biology, role and importance of ethics in biology, basic approaches to ethics.<br>b. Legal and regulatory values related to bioethics.<br>c. Bioethics in Healthcare, agriculture, biotechnology, animal welfare and rights/PETA in research, wildlife conservation and management, commercialization in scientific research.<br>d. Bioethics related to genetically modified organisms (GMOs): concerns about GMOs, benefit and risk of GMOs, reasoning behind acceptance and rejection of GMOs.<br>e. Past and present bioethical conflicts in life sciences.<br>f. Biopiracy, ethical committees, copyright, royalty, IPR and patent law, plagiarism, citation and acknowledgement.<br>g. Bio-waste disposal: Types of biowaste, ways to dispose of biowaste. | **5** |

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| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning |
| *Text Books/ References / Readings* | 1. Daniel W.W.; Biostatistics: Basic Concepts and Methodology for the Health Sciences, Wiley publishers, 2014, 10th Edition<br>2. Antonisamy B.; Premkumar P.S.; Christopher S.; Principles and Practice of Biostatistics, Elsevier India, 2017, 1st Edition<br>3. Glasman-Deal H.; Science Research Writing, Imperial College Press, 2010.<br>4. Kothari, C. R.; Quantitative Techniques, Vikas Publishing House., 2013, 3 rd Edition<br>5. Arora, P. N. and Malhan, P. K.; Biostatistics, Himalaya Publishing House. 2006, 9th Edition<br>6. Surya, R. K.; Biostatistics for health and life sciences, Himalaya Publishing House., 2010, 1st Edition<br>7. Annadurai A.; A Textbook of Biostatistics, New Age Publication, 2017, 1st Edition. |

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Programme: **M.Sc. Part-II (Biochemistry)**

Course Code: **CHBG-511**

Title of the course: **Hormones and Neurochemistry**

Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied life sciences at M.Sc. Part I Level |
| *Course Objective:* | 1. To develop knowledge on the human endocrine system and its role in human physiology.<br>2. To acquaint students with the mechanism of hormone action, their regulation and clinical disorders associated with them.<br>3. To develop insights into the structure and organization of a nervous system, sensory organs and their functions.<br>4. To develop a basic understanding of the significance of neurotransmitters.<br>5. To introduce the biochemistryof mental disorders. |
| *Course Outcome:* | 1. Students will be able to apply the knowledge of the signalling mechanisms of different hormones in the human system.<br>2. The students will also be able to correlate the diseases associated with hormonal imbalance and the biochemistry behind them.<br>3. Students will be able to explain the significance of the nervous system for the normal functioning of the human body.<br>4. Students will be able to illustrate the role of neurotransmitters in signal generation and the biochemistryof mental disorders in the human body. |

| ***Content*** | *Hrs* |
|---|---|
| **Hormones** | |
| **1. Introduction to hormones**<br>a. Definition, history, classification, and mechanism of action, History of hormones, Classification of hormones.<br>b. Understanding of endocrine system, Pathways of hormone release,<br>c. Signal transduction pathways, second messengers, regulation of signaling Pathways.<br>d. Hormones and their receptors: cell surface receptor, signaling through G-protein coupled receptors, Steroid hormone receptors, Thyroid hormone receptors<br>**e.** Mechanism of sensitization & desensitization of hormone receptors | **6** |
| **2. Stimulus, regulation of biosynthesis and release of hormones**<br>a. Hypothalamic Hormones: CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH<br>b. Anterior Pituitary hormones: Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH<br>c. Posterior Pituitary Hormones: Vasopressin, Oxytocin<br>d. Adrenal Cortex Hormones: Aldosterone (renin angiotensin system) & cortisol | **9** |

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| e. Hormones of Adrenal Medulla: Epinephrine and norepinephrine Hormones regulating Ca2+ Homeostasis: PTH, Vitamin D, Calcitonin<br>f. Pancreatic Hormones: Insulin, Glucagon.<br>**g.** GI tract Hormones: Gastrin, Secretin, CCK, GIP, Ghrelin. | |
| **3. Reproductive hormones and hormones by organs with endocrine function:**<br>a. Reproductive Hormones: Male and female Sex hormones, interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Introduction to rapid test for pregnancy.<br>b. Role of oral contraceptives.<br>**c.** Other organs with endocrine function: Heart (ANP), Kidney (erythropoietin), Liver (angiotensinogen, IGF-1), adipose tissue (leptin, adiponectin); growth factors: PDGF, EGF, IGF-I, II | **6** |
| **4.** Biochemistry **and diseases associated with hyper or hypo secretion:**<br>a. Hypothalamus and pituitary associated hormonal conditions: Goiter, Graves' disease, Cretinism, Myxedema, Hashimoto's disease, Gigantism, Acromegaly, dwarfism.<br>b. Adrenal cortex-associated hormonal conditions: Addison's disease, Conn's syndrome, Cushing's syndrome,<br>c. Calcium homeostasis-related hormonal conditions: Rickets, Osteomalacia, Osteoporosis.<br>**d.** Pancreatic hormone-associated hormonal conditions: Diabetes insipidus. | **9** |
| **Neurochemistry** | |
| 1. **Organization of Nervous system: Definition, parts and anatomy**<br>a. Central Nervous system and Peripheral nervous system; Blood Brain Barrier.<br>b. Cerebrospinal fluid: composition, function and circulation.<br>c. Cellular components of nervous system: Nerve, neuron, neuroglial cells. | **4** |
| **2. Nerve cell Membranes:**<br>**a. Structures and Functions of nerve cells and membrane transport:**<br>i. Phospholipid bilayer, membrane proteins, Biological membrane<br>ii. Membrane transport: Primary ion transporters, Ca2+ pumps, V-ATPase pump, secondary active transport, cation antiporters, facilitators. | **3** |
| **b. Energy metabolism in brain:**<br>Substrates for cerebral energy metabolism, regulation of the cerebral metabolic rate, glycolysis, glycogen metabolism, Pentose, phosphate shunt, Malate–aspartate shuttle, lactate metabolism, TCA, Glutamate/glutamine metabolism. | **3** |

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| **3. Synaptic Transmission:**<br>a. Synapse structure, Chemical and Electrical synapses, membrane potential in steady state, Action potential generation and propagation, pre and post synaptic events. | **4** |
| **b. Neurotransmitters and neuromodulators: Structure, functions, metabolism, receptors:**<br>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. | **4** |
| **c. Sensory transduction:** Vision, Olfaction and taste, Hearing and balance, touch. | **3** |
| d. **Biochemistry of memory; mental and neurodegenerative disease**:<br>i. Biochemistry of memory: Learning and memory; Divisions of memory (Qualitative and Quantitative categories); Synaptic signalling in learning and memory<br>ii. Mental illness: Depression, Schizophrenia<br>iii. Neurodegenerative diseases: Alzheimer's disease, Parkinson's disease, Huntington's disease, Dementia | **6** |
| e. **CNS active drugs and drugs of abuse: classification and mode of action**<br>Drugs of abuse: Opiates, Nicotine, alcohol: Molecular mechanisms, receptors and signalling | **3** |

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| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Kline B and Rossmanith W.G, Hormones and the endocrine system, Springer, 2016<br>2. Ilie I.R. Introduction to endocrinology, Springer, 2020.<br>3. Berg, J.M., Stryer, L., Tymoczko, J., Gatto, G., Biochemistry, WH Freeman, 2019, 9th edition.<br>4. Mathews, C.K., van Holde, K.E. & Ahern, K.G. Biochemistry, pearson Publishers, 1999, 3rd edition<br>5. Nelson, D. L. and Cox, M. M. Lehninger Principles of Biochemistry, WH Freeman, 2017, 7th edition.<br>6. Norman A. W., Gerald Litwack. Hormones, Elsevier, 1997, 2nd edition<br>7. David, G. & Dolores, S., Greenspan's Basic and Clinical Endocrinology, Mc Graw Hill Education, (2018), 10th edition<br>8. Belfiore A and Leroith D, Principles of Endocrinology and hormone action, Springer, 2018.<br>9. Albers, R.W., Brady, S.T., Price, D. L., Basic neurochemistry: Molecular, cellular and medical aspects., Elsevier Academic Press publishers; 2006, 7th Edition. |

10. Smith, C.U.M., Elements of Molecular Neurobiology., John Wiley & Sons Ltd., 2002, 3rd edition.
11. Kandel, E.R., Swartchz, J.H., Jesselle, T.M., Principles of Neural science, McGraw-Hill, New York publishers., 2000, 4th edition.
12. Mathew, B., Parambi, T., Principles of Neurochemistry: Fundamentals and Applications. Springer, Singapore., 2020.

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Programme: **M.Sc. Part-II (Biochemistry)**

**Course Code: CHBG-512**

Title of the course: **Clinical Microbiology and Food Biochemistry**

Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the Course:* | Students should have studied life sciences at M.Sc Part I Level |
| *Course Objective:* | 1. To develop an understanding of the diseases caused by microorganisms and their biochemistry.<br>2. To develop a basic understanding on significance of commensal and normal microflora for human health.<br>3. Introduction of the fundamental concepts of food spoilage and food preservation.<br>4. To provide insights on quality control and good practices in the food industry. |
| *Course Outcome:* | 1. Students will be able to explain the significance of normal microbiota and the biochemistry of infectious diseases in the human body.<br>2. Students will be able to explain the importance of antimicrobial agents in antibiotic therapy.<br>3. They will be able to apply the concepts of food spoilage and food preservation in maintaining food safety.<br>4. The student will be able to implement the Good Laboratory Practices and Good Manufacturing Practices used in industries to maintain food hygiene. |

| *Content* | *Hrs* |
|---|---|
| 1. **Introduction to Microbiology**<br>a. Introduction to bacteriology, mycology, virology and parasitology.<br>b. Sterilization and Disinfection: Introduction and its types, principle, procedure and its application, biosafety in microbiology lab, biowaste management. | **3** |

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| **2. Normal microbial flora and pathogenic microorganisms**<br>a. **Introduction**: Distribution of the normal microbiota; Commensals; relationship between normal microbiota and host; collection and transport of specimens, processing of clinical specimens for microbiological examination.<br>b. **Human microbiota in health: functions, microbe-host interaction, health benefits:** Skin microbiota, Gut microbiota, Normal microbiota of oral cavity, Normal microbiota of genitourinary tract<br>c. **Human microbiota in disease**<br>i. **Human microbiota and infectious disease:** Opportunistic infections; Nosocomial infections; bacterial Infections: Gastroenteric (*Clostridium difficile*; *Helicobacter pylori*; *E. coli*); Skin *(Staphylococcal)*; Respiratory (*Streptococcal*, *Pneumococcal, tuberculosis*); Urogenital tract (UTIs, Bacterial vaginosis); Oral cavity (Dental caries, Periodontitis).<br>ii. **Human microbiota and metabolic disorders:** Irritable bowel disease; Obesity; Type 2 diabetes mellitus; Allergic diseases; Liver diseases.<br>iii. **Secondary infections:** Infections associated with HIV; Influenza | **12** |
| **3. Fungal and parasitic infections**<br>**a. Fungal infections/mycoses:** Cutaneous, Sub-cutaneous, systemic and opportunistic mycoses<br>**b. Parasitic infectious:**<br>i. Protozoan infections: Malaria, Amoebiasis<br>ii. Helminthic infections: Ascariasis | **5** |
| 4. **Viral infections:**<br>HIV, Influenza, Poliomyelitis, Dengue fever, Chikungunya, Hepatitis, Rabies. ***Coronavirus*** disease (***COVID***-19) | **4** |
| 5. **Antimicrobial agents and drug resistance:**<br>a. Classification, mechanism of action of antibacterial agents; antifungal agents; antiviral agents and their resistance<br>b. Antibiotic sensitivity tests and its medical importance | **6** |
| **4. Food Spoilage and Food Preservation**<br>a. Forms of food spoilage: physical, chemical, microbiological parameters.<br>b. Factors affecting the growth and survival of microorganisms in foods: Intrinsic and extrinsic factors<br>c. Predictive food spoilage microbiology of milk, meat, poultry, vegetables and fruits, grains and legumes.<br>d. Food preservation technologies: Traditional methods of food preservation, Heat processing, low temperature storage, control of water activity, irradiation, high pressure processing, modified atmospheres, preservatives (chemicals, natural organic molecules (nisin) and enzymes). | **12** |
| **5**. **Vitamins and minerals in health**<br>a. Fat soluble vitamins: physiological role, deficiency disorders, toxicity.<br>b. Water soluble vitamins: physiological role, deficiency disorders, toxicity.<br>c. Mineral metabolism, physiologic role and deficiency disorders: calcium, iron, | **10** |

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| magnesium, sodium, zinc, manganese, potassium, phosphorus, sulphur and chlorine. | |
| **6. Quality control and Quality Assurance in Food industries**<br>a. Microbiological examination of food, air and water in industries.<br>b. Plant sanitation<br>c. Hazard analysis and critical control point concept<br>d. Good lab practices (GLP) Good Manufacturing Practice (GMP) and Quality Systems in the food industry. | **8** |

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| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Tortora, G. J., Funke, B. R., Case, C. L., Microbiology: An Introduction., Pearson Benjamin Cummings publishers; 2010, 10th Edition.<br>2. Willey, J., Sandman, K., Wood, D.; Prescott's Microbiology., Mc Graw Hill., 2020, 11th Edition.<br>3. Harvey, R. A., Cornelissen, C. N., Fisher, B. D., Lippincott's Illustrated review: Microbiology., Lippincott's William and Wilkins; 2007, 3rd Edition.<br>4. Chauhan, N. S. Introductory Chapter: Human and Microbes in Health and Diseases. In *Role of Microbes in Human Health and Diseases*. IntechOpen., 2019.<br>5. Feng, Q., Chen, W. D., & Wang, Y. D. (2018). Gut microbiota: an integral moderator in health and disease. *Frontiers in microbiology*, *9*, 151.<br>6. Frazier, W. C &Westhoff, C.W. Food Microbiology. Graw-Hill Companies, Inc., New York (2017), 5th edition.<br>7. Hayes, P. R. Food Microbiology and Hygiene. Springer, 1995, 2nd edition.<br>8. Kniel, K. E., Montville, T. J., Matthews, K. R, Food Microbiology., ASM Press, NW Washington, USA., 2017, 4th edition<br>9. Jay, J. M., Loessner, M.J., Golden, D.A., Modern Food Microbiology. Springer Science, New York, 2005, 7th edition<br>10. Adams, M. R. & Moss, M. O. Food Microbiology. Royal Society of Chemistry, 2015, 4th edition<br>11. 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. Part-II (Biochemistry)**

Course Code: **CHBG-513**

Title of the course: **Drug metabolism and Pharmaceutics (GE)**

Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied natural and life sciences at M.Sc Part I Level |
| *Course Objective:* | 1. To introduce concepts of drug administration, distribution, metabolism and excretion.<br>2. To introduce the students to pharmacopoeia, and types of drug formulations.<br>3. To acquaint the students with GMP and quality control practices in a pharmaceutical set-up. |
| *Course Outcome:* | 1. Students will be able to explain the basic pathways of drug distribution, metabolism and excretion in the body.<br>2. Students will be able to categorize different types of drug formulations and their contents.<br>3. They will be able to implement quality assurance and quality control procedures for drug formulations. |

| *Content* | *Hrs* |
|---|---|
| **1. Drugs Absorption and distribution in human body:**<br>a. Definition and types of drugs (therapeutic, drugs of abuse, poisons).<br>b. Introduction to pharmacokinetics and pharmacodynamics.<br>c. Routes of drug administration, introduction to absorption, distribution, metabolism, and excretion (ADME) of drug.<br>d. Absorption and distribution of drug through organ /tissue.<br>e. 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.<br>f. Protein/tissue binding of drugs – factors affecting protein binding of drugs, significance and kinetics, tissue binding of drugs. | **6** |
| **2. Drug Metabolism**<br>a. Biotransformation of drugs and factors affecting biotransformation. Organs of drug metabolism: hepatic and extrahepatic metabolism.<br>b. Mechanisms of drug metabolism – inactivation, bioactivation, reactive intermediates.<br>c. 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).<br>d. Phase 2 reactions -Glucuronidation, Sulfation, Acetylation, Glycine conjugation (minor), Glutathione conjugation (toxic substances).<br>e. Significance of drug metabolism (paracetamol/aspirin/ ibuprofen/ antibiotics). | **7** |
| **3. Excretion of drugs**<br>a. Renal excretion, factors affecting renal excretion.<br>b. Non renal routes of excretion, factors affecting excretion and enterohepatic circulation. | **2** |

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| **4. Posology**<br>a. Determination of doses; dose response relationship, dosage form design, biopharmaceutical consideration.<br>b. Drug antagonism and drug–drug interaction. | **2** |
| **5. Drug Extraction**<br>a. Solvents used in extraction of drugs, processes used for extraction (infusion, decoction, maceration, percolation, hot extraction).<br>b. Water as a universal pharmaceutical vehicle. | **5** |
| **6. Types of formulations:**<br>a. Tablets: advantages of tablets; types of tablets: effervescent, lozenges, chewable, buccal and sublingual, dispersible, orodispersible, soluble; excipients in tableting, coating in tablets.<br>b. Granulation: methods and equipment, direct compression.<br>c. Sustained release: Delayed absorption and/or a mixture of slow- and fast-release particles to produce rapid and sustained absorption in the same dose.<br>d. Capsules: hard gelatin and soft gelatin capsules- differences and composition, advantages and limitations, Excipients in capsule.<br>e. 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.<br>f. Parenterals: Intravenous, subcutaneous, intramuscular or intra articular administration, stored in liquid form, or in lyophilized form if unstable.<br>g. Topical: Cream, ointment, gel, paste, powder. | **15** |
| **7. Quality assurance/ Quality control**<br>a. Introduction to GLP, GMP and SOPs Raw material analysis (RMA), Quality control of pharmaceutical excipients.<br>b. 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.<br>c. Sources of contamination in pharmaceutical compounds (as per Pharmacopoeia).<br>d. Physico-chemical and microbiological analyses of formulations.<br>e. Types of errors, selection of sample, precision and accuracy. | **15** |
| **8. Drug Stability**<br>a. Solid state, solution phase physical stability testing, Stability testing general protocol, climatic zones, reference to regulatory requirements (ICH guidelines).<br>b. Kinetic principles applied for stability evaluation and their applications in predicting shelf life, accelerated stability study and shelf life assignment.<br>c. Forced degradation studies. | **5** |
| **9. Research and Development**<br>a. Introduction to drug design | **3** |

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| b. Drug discovery and development<br>c. Clinical trials. | |
| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Brunton, L. L., Hilal-Dandan, R., Knollmann, B. C.; Goodman & Gilman's: The Pharmacological Basis of Therapeutics, McGrawHill Education, 2018, 13th Edition.<br>2. Mahato R. I., Narang A. S., Pharmaceutical Dosage Forms and Drug Delivery: Revised and Expanded, CRC Press, 2017, 3rd Edition.<br>3. Aulton, M. E., Pharmaceutics: The Science of Dosage Form Design, Churchill Livingstone; 1988, 7th edition.<br>4. Aulton, M. E., Taylor, K.; Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Elsevier, 2017, 5th Edition.<br>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. Part-II (Biochemistry)**
Course Code: **CHBG-514**
Title of the course: **Bioprospecting and Bioremediation**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied natural and life sciences at M.Sc. Part I Level |
| *Course Objective:* | 1. To introduce the concept of bioprospecting of bioactive compounds from plant and microbial sources.<br>2. To impart knowledge on purification and characterization of novel metabolites from biological sources using analytical techniques.<br>3. To develop concepts in environmental pollution and role of microorganisms in biogeochemical cycles and bioremediation of pollutants |
| *Course Outcome:* | 1. Students will be able to screen, isolate and identify novel biomolecules from plant and microbial sources.<br>2. The students will be able to correlate the role of microorganisms in biogeochemical cycles and design strategies for bioremediation of pollutants. |

| *Content* | *Hrs* |
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| **1. Sources and Sampling of potential microbes and plants sources**<br>**a. Sources: microbes and plants**<br>i. Marine and other coastal ecosystems: Water and sediment samples, microorganisms from mangroves, sand dunes and salterns.<br>ii. Terrestrial: Forest/Ghats<br>iii. Microbes in Extreme environments: thermophilic, psychrophilic, halophilic, alkaliphilic, barophilic<br>**b. Sampling microorganisms**<br>i. Niskin water sampler<br>ii. Van Veen Grab sediment sampler<br>**c. Aseptic collection of samples**<br>i. Sampling of plants: Selection criteria: Type, physical condition, stage of growth, plant part.<br>ii. Sample treatment: surface sterilization, excision of desired plant component, extraction. | **6** |
| **2. Industrially and medically important biomolecules from plants and microorganisms:** Screening, detection, purification and characterization using analytical tools<br>a. Enzymes: extremozymes; food additives/ quality enhancers, medicine, antioxidants and antitumor agents<br>b. Pigments: food colorants, fabric dyes<br>c. Biocontrol agents:herbicides, pesticides<br>d. Nanoparticles : medicine, drug carriers.<br>e. Biofuels: microbially produced; plant based<br>f. Optical and electronic devices: archaeal metabolites (bacteriorhodopsin and cell wall S-layer as membrane for ultrafiltration)<br>g. Biopolymers – biodegradable plastics: PHAs, blended plastic polymers, EPS, biosurfactants and bioemulsifiers<br>h. Plant growth promoters- gibberellins, auxins, cytokinins<br>i. Pharmaceuticals: Antimicrobials, Antitumour agents, drug carriers.<br>j. Nutraceuticals: PUFAs, β-carotenes, antioxidants<br>k. Cosmeceuticals: humectants (polyols).<br>l. Drugs from Sea | **24** |
| **3. Pollutants in the environment and their impact:**<br>**a. Environment and pollutants**<br>i. Classification of pollutants<br>ii. Toxicity, synergistic or antagonistic action.<br>iii. Eco-toxicology: concept of permissible limits, ED50 & LD50<br>iv. Acute and chronic exposures; biochemical effects and genotoxicity.<br>**b. Significant environmental pollutants: source, effect and impact**<br>i. Soil Xenobiotics<br>ii. Agricultural chemicals<br>iii. Pesticides<br>iv. lead and other heavy metals<br>v. Marine pollutants<br>**c. Monitoring of pollution** | **10** |

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| i. Using indicator microorganisms<br>ii. Biosensors: genetically modified organisms and enzymes<br>**d. Significant environmental monitoring parameters**<br>i. Dissolved oxygen<br>ii. Biochemical Oxygen Demand<br>iii. Chemical Oxygen demand .<br>iv. Environment protection regulations, impact assessment and standards.<br>v. Environmental pollutants , improper waste disposal | |
| **4. Remediation of waste**<br>a. Treatment of waste : Concepts of Reuse, Recycle, Recovery.<br>b. Introduction to waste treatment<br>i. Wastewater/sewage treatment<br>ii. Solid waste management<br>iii. Hospital waste management.<br>c. Biological systems for remediation: plants, bacteria and fungi<br>d. Microbial consortia and related microbial processes<br>i. Enzymatic transformations<br>ii. Co-metabolism<br>iii. Microbial adhesion<br>iv. Biofilms<br>v. Production of extracellular polymers and emulsifiers.<br>e. Other pollutant removal techniques<br>i. Sedimentation<br>ii. Sorption<br>iii. Precipitation<br>iv. Speciation conversion<br>f. Emerging eco-friendly alternatives for chemical industry –Green chemistry and Green Technology | **10** |
| **5. Biotechnological methods to control pollution**<br>a. Bioremediation<br>i. In situ and Ex-situ bioremediation<br>ii. Factors affecting process of bioremediation<br>iii. Methods in determining Biodegradability<br>iv. Use of microbes (bacteria and fungi) bioremediation<br>v. Bioremediation of common environmental pollutant<br>vi. Evaluating Bioremediation<br>b. Biofilters<br>c. Biotransformation<br>d. Phytoremediation<br>e. Biodegradation | **10** |
| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |

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| *Text Books/ References / Readings* | 1. Manahan S. E; Environmental Chemistry; Lewis Publishers, 2000/7 th edition.<br>2. Salker A. V; Environmental Chemistry; NarosaNublishing; 2017, 1st edition<br>3. De A. k; Environmental Chemistry; New Age International Publishers; 2005, 3 rd Ed<br>4. Dara, S.S., Mishra D. D; A text book of Environmental Chemistry and Pollution Control; S. Chand Publishers; 2004.<br>5. Enger E. D., Smith B. E.; Environmental Science: A study of Interrelationships; WCB Publication, McGraw-Hill Higher Education.; 2019, 15 th edition.<br>6. Khopkar S. M., Environmental Pollution Analysis. New Age International Pvt. Ltd.; 2005, 1 st edition.<br>7. Mitchell R., Cu J. D.; Environmental Microbiology; Wiley-Blackwell Publication; 2009.<br>8. Moore J. W., Moore, E. A.; Environmental Chemistry; Academic Press; 1976, 1 st edition<br>9.Maier R., Pepper I., Gerba, C., Gentry T.; Environmental Microbiology; Academic Press; 2008, 2 nd edition<br>10. Jogdand, S.N., Gene Biotechnology. Himalaya publishing house, 2016, 4th edition.<br>11. Jogdand, S.N., Advances in Biotechnology. Himalaya publishing house. 2007, 2nd edition.<br>12. Ravi, I., Baunthiyal, M. & Saxena, J. Advances in Biotechnology. Springer, 2014, 1st edition.<br>14. Satyanarayana, U. and Chakrapani U. Biotechnology, Books & Allied (P) Ltd, 2020.<br>15. Altman, A. & Hasegawa, P., Plant Biotechnology and Agriculture, Elsevier 2011, 1st edition<br>16. Clark, D. & Pazdernik, N. Biotechnology, Academic Press cell, 2015, 2nd edition.<br>17. Bielecki, S., Tramper, J., &Polak, J. Food Biotechnology. Elsevier, 2000.<br>18. Pongracz, J. & Keen, M., Medical Biotechnology. Churchill Livingstone, 2009<br>19. Fletcher, G. L. & Rise, M. L. Aquaculture Biotechnology. Wiley, 2011.<br>20. Verma, A. & Singh, A. Animal Biotechnology Models in Discovery and Translation. Academic press, 2020, 2nd edition. |

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Programme: **M.Sc. Part-II (Biochemistry)**
Course Code: **CHBD-511**
Title of the course: **Discipline Specific Dissertation**
Number of Credits: **16**Total Hours: **480** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied Biochemistry courses at MSc-I level. |
| *Course Objective:* | To develop the skills of preparing and conducting independent research. |
| *Course Outcome:* | Students will be able to understand and apply the tools and techniques of Biochemistry in conducting independent research. |

| *Content* | *Hours* |
|---|---|
| As per OA-35 | 480 |

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| *Pedagogy* | Dissertation carried out individually by each student throughout the academic year. |
| *Textbooks/ References / Readings* | As required for the development of review and methodology |

Programme: **M.Sc. Part-II (Chemistry/Biochemistry)**
Course Code: **CHIG-511**
Title of the course: **Bioinorganic Chemistry**
Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students have studied chemistry/biochemistry courses at M.Sc. Part-I. |
| *Course Objective:* | 1. To understand the role of inorganic elements especially metal ions in biology.<br>2. To introduce metallobiolecules, metalloproteins & metalloenymes.<br>3. To understand the role of small molecule model compounds.<br>4. To introduce the concept of Biomimetic chemistry. |
| *Course Outcome:* | 1. Students will be in a position to clarify the significance of essential elements in biology.<br>2. Students will be able to explain the role played by metal ions in vital processes like i) oxygen storage and transport and ii) electron transfer.<br>3. Students will be able to explain basic concepts in Biomimetic chemistry.<br>4. The students will be able use different techniques in Bioinorganic Chemistry. |

| *Content* | *Hours* |
|---|---|
| **1. Essential elements in biology**<br>Periodicity of elements, distribution of elements in biosphere, bio-availability, bio-stability, building blocks of the biosphere; carbohydrates, nucleic acids and proteins, biological importance of water, and brief review of the chemistry of biopolymers. Metallobiomolecules: classification, metalloproteins (enzymes), metal activated proteins (enzymes), metal functions in metalloproteins, Principles of coordination chemistry related to bioinorganic research, physical methods in bioinorganic chemistry. | 12 |
| **2. Alkali and alkaline earth metals in biology**<br>Introduction, biological importance of the alkali and the alkaline earth cations, | 12 |

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| Cation transport through membranes (ion pumps). Photosynthesis, Hill reaction, Chlorin macrocycle and chlorophyll, Absorption of light by chlorophyll, role of metals in photosynthesis, in vitro photosynthesis. | |
| **3. Non-redox metalloenzymes**<br>Zinc metalloenzymes like carboxypeptidase, carbonic anhydrase and alcohol dehydrogenase, Bio-functions of zinc enzymes, active site structure and model complexes. | 12 |
| **4. Biochemistry of a few transition metals**<br>Role of Fe, Mo, Cu and Ni. Oxygen carriers and oxygen transport proteins, iron porphyrins (Haemoglobin and myoglobin). Haemocyanins and Haemerythrins, Synthetic models for oxygen binding haemproteins. Cytochrome C, catalase, peroxidase, and superoxide dismutase, blue copper proteins, vitamin $B_{12}$ coenzymes, nitrogen fixation and iron-sulfur proteins, biological nitrogen fixation, nitrogenase and dinitrogen complexes, iron-sulfur proteins, synthetic analogues for Fe-S proteins, core extrusion reactions. Metal transport and storage: A brief review of iron transport. transferrin, ferritin, hemosiderin, siderophores, iron biomineralization | 12 |
| **5. Biomimetic Inorganic Chemistry**<br>Fundamentals of biomimetic chemistry, metal – oxygen intermediates, techniques used to probe the active sites of oxygen carriers, redox chemistry of free molecular dioxygen, spectroscopy of Fe-O-Fe moiety, geometry and electronic structure of coordinated dioxygen, other ligands for biological oxygen carriers, reactions of metal-oxygen compounds, oxygenases, Cytochrome P-450, synthetic procedures of simple ligands, isolation of S-containing amino acidor extraction of chlorophyll from green leaves, recrystallization of carboxylic acids. Non-Heme and heme ligands. | 12 |

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| *Pedagogy* | Mainly lectures / tutorials / assignments /group discussion / self-study /presentations or a combination of some of these could also be used to some extent. |
| *Textbooks / Reference / Readings* | 1. S. J. Lippard & J. M. Berg, *Principles of Bioinorganic chemistry*, Panima Publishing Corporation<br>2. I. Britini, H. B. Gray, S. J. Lippard & J. S. Valentine, *Bioiorganic chemistry*, University Science books, Mill Valey, CA, 1994.<br>3. E. Fenton, *Biocoordination Chemistry*, Oxford Chemistry Printers,25 Oxford University Press, 1995<br>4. E. Conn, P.K. Stumpf, G. Bruening & R. H. Doi, *Outlines of Bioinorganic Chemistry*, 5th Ed.; Wiley Eastern, 1983.<br>5. F.A. Cotton, G. Wilkinson, P.L. Gaus, *Basic Inorganic Chemistry*, 3rd Ed. (Chapter 31); WileyIndia, 2007.<br>6. M. Weller, T. Overton, J. Rourke & F. Armstrong *Inorganic Chemistry*, Int. Ed. (Chapter 25); Oxford University Press, 2018.<br>7. P Atkins, T Overton, J Rourke, M Weller & F Armstrong, *Shriver & Atkins' Inorganic Chemistry,* 5th Ed. (Chapter 27); Oxford University Press, 2010.<br>8. J. E. Huheey, E. A. Keiter, R. L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity,* 5th Ed. (Chapter 19); Addison Wesley Publishing.<br>9. R. W. Hay, *Bioinorganic chemistry*, Ellis Horwood Chichester, 1984.<br>10. M.N. Hughes, *The Inorganic Chemistry of Biological processes*, 2nd Ed.; Wiley (Interscience), 1984. |

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| | 11. R. R. Crichton, *Biological Inorganic Chemistry*, Elsevier, 2012.<br>12. R. Breslow, *Biomimetic Chemistry: Biology as an Inspiration*, The Journal of Biological Chemistry, vol. 284, no. 3, pp. 1337–1342, 2009.<br>13. C. Housecroft, A. G. Sharpe, *Inorganic Chemistry*, 4th Ed; Pearson Publishing, 2012. |

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Programme: **M.Sc. Part-II (Analytical Chemistry)**

Course Code: **CHAG- 511**

Title of the course: **Fundamentals of Crystallography**

Number of Credits: **04** Total Hours: **60** Effective from AY: **2023-24**

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| *Prerequisites for the course:* | Students should have studied M.Sc. Part-I. |
| *Course Objective:* | 1. To introduce basic concepts of crystallography.<br>2. To impart knowledge of single crystal and powder X-ray diffraction methods.<br>3. To analyse Materials and understand Structure. |
| *Course Outcome:* | 1. Student will acquire fundamental concepts of crystallography.<br>2. Students will gain insights into single crystal and powder X-ray diffraction methods.<br>3. Students will be able to use X-ray diffraction methods for materials characterization. |

| *Content* | *Hours* |
|---|---|
| **1. Basics of Crystallography**<br>a. The Crystalline state, symmetry elements.<br>b. Lattices, unit cell, crystallographic directions, planes, point groups and symmetry classes.<br>c. The Laue classes, the seven crystal systems, Bravais lattices, space groups and International Tables.<br>d. Description of crystal structures, unit cell projections and atomic coordinates, unit cell content.<br>e. Ionic crystals, molecules and molecular crystals, protein crystals, physical properties of crystals. | 10 |
| **2. Diffraction of X-rays by Crystals:**<br>a. Interaction of X-rays with matter.<br>b. Scattering of X-rays by an electron, atom, atomic scattering factor, temperature factor, scattering by molecule or unit cell.<br>c. Diffraction by crystals, structure factor, Bragg's law, the reflection and the limiting spheres, symmetry in reciprocal space, systematic absences, diffraction intensities.<br>d. Experimental methods in X-ray crystallography: X-ray sources, monochromatization, collimation, and focusing of X-rays. | 10 |
| **3. Single Crystal X-ray Diffraction:**<br>a. Crystals and their properties: crystallization, growing and choosing crystals, microscopic observation<br>b. Data collection techniques for single crystals, diffractometer geometry, measurement of the integrated intensities, data collection with area | 10 |

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| detectors,<br>c. Data reduction: Lorentz correction, polarization correction, absorption corrections, radiation damage corrections, relative scaling.<br>d. Solution and refinement of crystal structures: Wilson plot, the heavy atom method, Direct methods, phase determination procedures, figures of merit,<br>e. Completing and refining the structure: difference Fourier method, least-squares method, absolute configuration.<br>f. Introduction to crystallographic software's (e.g. APEX 4, Olex2 etc) and IUCr validation of the data (CIF) | |
| **4. Powder X-ray Diffraction:**<br>a. Origin of powder diffraction pattern, position, shape, and intensity of powder diffraction peaks.<br>b. Powder diffractometry: beam conditioning, goniometer design, nonambient powder diffractometry.<br>c. Collecting quality powder diffraction data: sample preparation, data acquisition, quality of data, data processing.<br>d. Determination of unit cell: indexing methods.<br>e. Introduction to the Rietveld method.<br>d. Introduction to powder diffraction software's for indexing, unit cell refinement (e.g. Winplotr, UnitCell). | 10 |
| **5. Applications of Crystallography:**<br>a. Chemistry and Materials science: understanding crystal structures of compounds, alloys, metals, polymers, phase transitions etc.<br>b. Geology, mineralogy, gemology.<br>c. Pharmaceuticals: polymorphs, excipient analysis, active pharmaceutical ingredients.<br>d. Forensics and environmental analysis.<br>e. Nano materials characterization.<br>f. Biomolecules: determination of structures of proteins, nucleic acids and other biological macromolecules.<br>g. Other diffraction techniques: neutron diffraction, thin film, microstructure properties, pair distribution function analysis, etc. | 10 |
| **6. Analysis of Materials and Structural Understanding:**<br>a. Characterisation of Solids using diffraction techniques.<br>b. Introduction to databases: powder diffraction files, inorganic and organic crystal structure database, protein data bank etc.<br>c. Inspection of crystals/powders with light microscope.<br>d. Visualization of crystal structures using softwares (e.g. Diamond, VESTA).<br>e. Beyond ideal crystals: crystal twins, modulated structures, quasicrystals | 10 |
| *Pedagogy* | Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. |
| *Textbooks/ References / Readings* | 1. M. Milanesio, G. Zanotti, G. Gilli, M. Catti, H. Monaco, G. Ferraris, G. Artioli, P. Gilli, D. Viterbo, C. Giacovazzo - *Fundamentals of Crystallography*, 3rd Ed., Oxford University Press, 2015. |

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| | 2. C. Hammond - *The Basics of Crystallography and Diffraction (International Union of Crystallography Texts on Crystallography)* 4th Ed., Oxford University Press, 2015.<br>3. R. West, *Solid State Chemistry and Its Applications*, 2nd Ed.; Wiley, 2022.<br>4. F. Hoffmann, *Introduction to Crystallography*, 1st Ed. Springer, 2020.<br>5. D. Sherwood, *Crystals, X-rays and Proteins: Comprehensive Protein Crystallography*, 1st Ed. Oxford University Press, 2015.<br>6. A. Hofmann, S. Clokie, *Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology*, 8th Ed.; Cambridge University Press, 2018.<br>7. V. Pecharsky and P. Zavalij, *Fundamentals of Powder Diffraction and Structural Characterization of Materials*, 2nd Ed.; Springer, 2009.<br>8. R. Young, *The Rietveld Method*, 1st Ed., Oxford University Press, 1995<br>9. W. David, K. Shankland, L. McCusker, C. Bärlocher, *Structure Determination from Powder Diffraction Data*, 1st Ed., Oxford University Press, 2006.<br>10. B. He, *Two-dimensional X-ray Diffraction*, 1st Ed., Wiley, 2009.<br>11. W. Massa, *Crystal Structure Determination*, 2nd Ed., Springer, 2010.<br>12. R. Dinnebier, S. Billinge, *Powder Diffraction: Theory and Practice*, 1st Ed., Royal Society of Chemistry, 2008. |

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**Annexure II**

Programme: Ph.D. Biochemistry
Paper-I Syllabus
Title of the course: Research Methodology
Number of Credits: 04 Total Hours: 60 Effective from AY: 2022-23

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| *Prerequisites for the course:* | Provisional registration for PhD in Biochemistry |
| *Course Objective:* | 1. To introduce research students to various aspects of research methodology<br>2. To provide an understanding of various databases used in biochemistry<br>3. To introduce the fundamental roles of computers in biochemical research.<br>4. To provide understanding and importance of lab safety to make students aware of the statistical methods used in biochemical research<br>5. To understand the usefulness of various techniques in the characterization and purification of biochemical compounds |
| *Course Outcome:* | 1. Students will be familiar with research methodology concepts.<br>2. Students will be able to use computers to solve their research problems in biochemistry.<br>3. Students will know in advance the safety precautions to be taken in the biochemistry lab.<br>4. Students will apply statistical methods of data handling in their research. Students will gain fundamental knowledge of characterization and purification techniques. |

| *Content* | *Hours* |
|---|---|
| **1. Introduction to Research Methodology**<br>a) Research- meaning, objectives, motivation, types and methodology.<br>b) Process- formulating the research problem; literature survey; developing the hypothesis and the research design; sample design and collection of the data; execution of the project; analysis of data; testing of hypothesis; generalizations and interpretation, and preparation of the report or presentation of the results & conclusions.<br>c) Nature of scientific information- types of books, types of presentations published in journals, standard format for reporting original research, introduction to various scientific (chemistry) databases & sources from the internet. | 10 |
| **2. Role of Computers in Research and Biochemistry**<br>a) Role of Computers in Research and chemistry<br>b) Applications of computers in research.<br>c) Applications of computer in Chemistry - Need of computers in chemistry-introduction & history; Introduction to programming & programming languages; Solving a problem with computers-algorithm, flowchart and program; Use of software for data handling, plotting graphs and drawing molecular structures, visualisation of 3-D data; Software for literature survey, software for reference citing | 10 |

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| **d)** Optimisation techniques and applications in molecular geometry optimisation | |
| **3. Safety in biochemistry**<br>a) Introduction to lab safety.<br>b) Handling of various chemicals, solvents and glassware<br>c) Fires and fighting with fires<br>d) Hazardous substances and their classification and handling<br>e) Biosafety procedures for handling of biological samples<br>f) Preventing laboratory acquired infections | 8 |
| **4. Introduction to Statistical Methods**<br>a) Errors & their types, precision & accuracy in chemical analysis.<br>b) Application of statistical methods to data treatment & evaluation.<br>c) Confidence limits; hypothesis testing.<br>d) F-tests, Chi square test, correlation and linear regression.<br>e) Use of software for statistical analysis. | 10 |
| **5. A. Introduction to Basic concepts**<br>a) Sterilization and disinfection<br>b) Sample collection<br>c) Biological sample maintenance<br>**B. Purification and characterization techniques in biochemistry research**<br>a) Purification techniques: agarose and polyacrylamide gel electrophoresis, gel filtration, ion exchange; affinity chromatography techniques, HPLC, GC<br>b) Methods of DNA analysis: Extraction and purification of nucleic acids, PCR, DNA sequencing and cloning techniques<br>c) Spectroscopic techniques: Ultraviolet-Visible (UV-Vis), basics of Infrared (IR), Nuclear magnetic resonance NMR and Mass spectroscopy (MS).<br>d) Introduction to Hyphenated techniques: GC-MS, LC-MS, ICP-MS<br>e) Microscopic techniques: Optical Microscopy (light, dark, phase contrast, Fluorescence), AFM, SEM, TEM | 22 |

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| *Pedagogy* | Lectures, Discussions, seminars, internal exams, assignments/self-study or a combination of some of these can be used. ICT mode should be preferred sessions should be interactive in nature to enable peer group learning. |
| *Text Books/ References / Readings* | 1. Research Methodology: Methods and Techniques by C.R. Kothari. New Age International Pvt. Ltd., 2004.<br>2. The ACS Style Guide: Effective Communication of Scientific Information, Edited by Anne M. Coghill and Lorrin R. Garson, American Chemical Society Washington, DC and Oxford University press New York Oxford, 2006.<br>3. Fundamentals of Research Methodology and Statistics by Y K Singh, New Age International Pvt. Ltd., 2006.<br>4. Prudent practices in the laboratory: handling and management of chemical hazards, The National Academies Press, USA, 2011.<br>5. Spectrometric Identification of Organic Compounds (5th Ed) by R M Silverstein, G C Bassler and TC Morrill. John Wiley, Singapore. |

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|---|---|
| | 6. Principles of Biochemistry (7th Ed). D L Nelson, M M Cox, Lehninger. WH Freeman, 2017.<br>7. An introduction to practical biochemistry (3rd Ed). D T Plummer. Tata McGraw Hill, 2006<br>8. Principles and Techniques of Practical Biochemistry (7 th Ed) Wilson K, Walker J. Cambridge University Press, 2010<br>9. Analytical Chemistry (7th Ed) Christian G D, Dasgupta P K, Schug K A. John Wiley & Sons, 2013<br>10. Analytical Biochemistry, Homes D J, Peck H. Pearson education Limited, 1998.<br>11. Principles of Instrumental Analysis, (7th Ed) Skoog D A, Holler F J, Crouch S R, Cengage Learning. 2016.<br>12. Molecular cloning: a laboratory manual (2nd edition) J Sambrook, E F Fritsch, T Maniatis, Cold Spring Harbor Laboratory Press, New York, 1989.<br>13. Modern Quantum Chemistry Introduction to Advanced Electronic Structure Theory, Attila Szabo, Neil S. Ostlund, Dover Publications, Inc. Mineola, New York 1989<br>14. Introduction to Organic Spectroscopy Fifth Edition, D. Pavia, G. Lampman, G. Kriz and J. Vyvyan, Cengage Learning, 2015.<br>15. Computer Programming in Fortran 90 And 95, V. Rajaraman, PHI Learning Pvt. Ltd., 2013 |

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**Annexure III**

## SWAYAM COURSES FOR BIOCHEMISTRY STUDENTS

**Courses of UG/PG level which could be opted over and above existing PG courses from the curriculum:**

| Sr. No. | Name of the course | Credits | Level as per SWAYAM | Intended audience | Whether included in NET syllabus |
|---|---|---|---|---|---|
| 1. | Animal Physiology | 3 | Undergraduate /Postgraduate | UG and PG students pursuing biology, biotechnology, zoology and bio-engineering | Yes |
| 2. | Biomedical Nanotechnology | 1 | Undergraduate /Postgraduate | UG/PG students of Biotechnology/ Nanotechnology | No |
| 3. | Environmental Biotechnology | 3 | Undergraduate /Postgraduate | B Sc. (Biosciences, Microbiology, Biotechnology, Botany, Any other branches of Life Sciences); M Sc. (Biotechnology / Life Sciences/ Environmental Sciences); B Tech (Biotechnology/Bioengineering ) | Yes (partly) |
| 4. | Fundamentals of Protein Chemistry | 3 | Undergraduate /Postgraduate | Undergraduate and Graduate students | Yes |
| 5. | Genetic Engineering | 3 | Undergraduate /Postgraduate | - | Yes (partly) |
| 6. | Genome Editing and Engineering | 3 | Undergraduate /Postgraduate | UG/PG/PhD/Scientist in industry | No |
| 7. | Introduction to Proteogenomics | 2 | Undergraduate /Postgraduate | Biotechnology or Engineering background students having interest in latest technologies, (BE/B.Tech) Biotechnology. Students with science or engineering background but course is open to all. | Yes |
| 8. | Introduction to Proteomics | 2 | Undergraduate /Postgraduate | It would be applied to B.Sc., M.Sc. and MS. | Yes |
| 9. | Human Molecular Genetics | 1 | Undergraduate /Postgraduate | Students interested in pursuing research in human molecular genetics. Medical students and practicing clinicians interested in understanding the principles | Yes (partly) |

| | | | | | |
|---|---|---|---|---|---|
| | | | | and complexities of human genetics.<br>Students interested in careers in genetic counselling and DNA diagnostics.<br>Scientists working in public health service, counselling centres, and diagnostic laboratories. | |
| 10 | Cell Culture Technologies | 2 | Postgraduate | UG and PG students pursuing biology, biotechnology, zoology and bio-engineering. | No |
| 11 | Tissue Engineering | 2 | Postgraduate | Masters/Doctoral students and faculty interested in teaching Tissue Engineering | No |
| 12 | Bioreactors | 1 | Undergraduate | - | Yes (partly) |
| 13 | Functional Genomics | 1 | Undergraduate | •Students interested in pursuing research in genomics and biotechnology field.<br>•Medical students and practicing clinicians interested in genomics and molecular medicine.<br>•Students interested in careers in biotechnology and biopharma fields.<br>•Technical staff /scientists working in biotechnology, biopharma and molecular diagnostic laboratories/industry | No |
| 14 | Advanced Microbiology | 4 | Undergraduate | - | No |

**Courses of PG level which could be opted in lieu of existing PG optional courses of Biochemistry Part-II from the curriculum:**

| **Sr. No.** | **Name of the course** | **Credits** | **Level as per SWAYAM** | **Intended audience** | **Whether included in NET syllabus** |
|---|---|---|---|---|---|
| 1. | Cell Culture Technologies | 2 | Postgraduate | UG and PG students pursuing biology, biotechnology, zoology and bio-engineering. | No |
| 2. | Tissue Engineering | 2 | Postgraduate | Masters/Doctoral students and faculty interested in teaching Tissue Engineering | No |

***Syllabus for online courses related to Biochemistry field at UG/PG level***

***1-Animal Physiology***
***Credit=3***

**Level : Undergraduate/Postgraduate**
**INTENDED AUDIENCE** : UG and PG students pursuing biology, biotechnology,zoology and bio-engineering
**PREREQUISITES** : Biology at standard 10th (Secondary school examination)

***Course layout***
Week 1: Introduction
Week 2: Skeletal system
Week 3: Muscles
Week 4: Neural system
Week 5: Neural system
Week 6: Neural system
Week 7: Neural system
Week 8: Neural system and Special senses
Week 9: Neural system and Special senses
Week 10: Cardiovascular system
Week 11: Respiratory and Blood
Week 12: Endocrine, Digestive, Blood, Kidney, and Reproductive system
***Books and references***
1-Guyton and Hall Textbook of Medical Physiology
2-Ganong'S Rev of Med Physiology
3-Fundamentals of anatomy and physiology by Martini

***2-Biomedical Nanotechnology***
***Credit=1***

**Level : Undergraduate/Postgraduate**
INTENDED AUDIENCE : UG/PG students of Biotechnology/ Nanotechnology.

***Course layout***
Week 1: Introduction to nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterisation of nanomaterials.

Week 2: DNA nanotechnology, Protein & glyco nanotechnology, Lipid nanotechnology, Bio-nanomachines, Carbon nanotube and its bio-applications.

Week 3: Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing.

Week 4: Nanotechnology in point-of-care diagnostics, Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology.

***Books and references***

1-Malsch NH; Biomedical Nanotechnology; CRC Press; 2005; 1st edition.
2-Mirkin CA, Niemeyer CM; Nanobiotechnology II: More Concepts and Applications; Wiley-VCH; 2007; 1st edition.
3-Kumar CSSR, Hormes J, Leuschner C; Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact; Wiley-VCH Verlag GmbH & Co; 2005; 1st edition.
4-Lamprecht A; Nanotherapeutics: Drug delivery concepts in nanoscience; Pan Stanford; 2009; 1st edition.
5-Jain KK; The Handbook of Nanomedicine; Humana press; 2008; 1st edition.

***3-Environmental Biotechnology***
***Credit=3***

**Level : Undergraduate/Postgraduate**
**INTENDED AUDIENCE :** B Sc. (Biosciences, Microbiology, Biotechnology, Botany, Any other branches of Life Sciences); M Sc. (Biotechnology / Life Sciences/ Environmental Sciences); B Tech (Biotechnology/Bioengineering)

Week 1: Environmental Biotechnology and Sustainability. Scope and applications of the subject. Basics of ecosystem structure and function

Week 2: Microbial Ecology and Environmental Biotechnology: Concepts and importance of microbial ecology in Environmental Biotechnology

Week 3: Microbiology of Environmental Engineering System: Microbial diversity, growth and decay. Stoichiometry of microbial energetics and kinetics.

Week 4: Resource Exploitation by Microorganisms: Functions of various microbial groups relevant to environmental systems, including waste treatment and resource recovery, implications in biogeochemistry.

Week 5: Methods in Microbial Ecology with relevant to Environmental Biotechnology: Culture dependent and - independent analyses of microbial communities; PCR based methods, Microarray, Environmental genomics

Week 6: Microbial Principles of Biodegradation, Biodetoxification and other processes relevant for Environmental Applications: Microbial engines, (metabolism), Requirements for biodegradation, acclimation, Common biotransformation mechanisms; Effect of organic contaminant structure on biodegradability; Cooperation between different microbial species for enhanced biodegradation; Applying biodegradation kinetics to fate and transport modelling

Week 7: Bioremediation Technologies: Concepts, methods and applications of natural attenuation and engineered bioremediation (e.g bioaugmentation and biostimulation)

Week 8: Microbial Interactions with Heavy Metals and Metalloids: Bioremediation, Biohydrometallurgy and other aspects of Environmental Biotechnology

Week 9: Aerobic and Anaerobic Degradation of Aliphatic and Aromatic Compounds. Microbial interaction with plastics, antibiotics and others emerging pollutants.

Week 10: Microbially Enhanced Phosphorus and Nitrogen Removal

Week 11: Microbially Enhanced Oil Recovery; Microbial role in Carbon Storage and Capture (sequestration, conversion to useful biopolymers, etc.).

Week 12: Case studies : Bioremediation, Carbon Storage and Capture, Bioenergy.

***Books and references***

1. Rittman B. E, McCarty P. L ; Environmental Biotechnology Principles and Applications; McGraw-Hill Higher education.
2. Jördening H J , Wint J; Environmental Biotechnology; WILEY-VCH Verlag Gmbh & Co.
3. Alvarage P J J, Illman W A ; Bioremediation and Natural Attenuation; Wiley Interscience.
4. L K Wang et al; Environmental Biotechnology; Handbook of Environmental Engineering; Humana Press; Vol 10 .

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***4-Fundamentals of Protein Chemistry***
***Credit=3***

**Level : Undergraduate/Postgraduate**
I**NTENDED AUDIENCE :** Undergraduate and Graduate students

***Course layout***

Week 1: Amino acids and the Peptide Bond
Week 2: Protein Architecture
Week 3: Protein Folding and Denaturation
Week 4: Protein isolation and characterization
Week 5: Protein-ligand interactions
Week 6: Membrane Proteins and Transport
Week 7: Enzymes and Enzyme mechanisms
Week 8: Enzyme kinetics and Enzyme inhibition
Week 9: Metalloproteins and Motor Proteins
Week 10: Protein-Protein interactions
Week 11: Protein Structure analysis
Week 12: Special Topics in Protein Chemistry

***Books and references***

1- Branden C,Tooze J; Introduction to Protein Structure;2nd Edition.
2-Creighton T E; Proteins: Structures and Molecular Properties.
3- Holde K.E.van , Johnson C , Ho S P; Physical Biochemistry.
4- Kyte J; Structure in Protein Chemistry.

5- Lehninger L Albert, Nelson L D , Cox M M; Principles of Biochemistry; 6th Edition
6- Kessel A, Tal Ben N; Introduction to Proteins: Structure, Function, and Motion; 2018;2nd Edition .
7- Stryer L, Berg J ,Tymoczko J , Gatto G; Biochemistry; 2019;9th Edition.

***5- Genetic Engineering***
***Credit=3***

**Level: Undergraduate/Postgraduate**

***Course layout***
Week 1: Introduction and Basics of Biological System.
Week 2: Basics of Biological System
Week 3: Basics of Cloning (Part I)
Week 4: Basics of Cloning (Part II)
Week 5: Recombinant DNA Technology (Part I)
Week 6: Recombinant DNA Technology (Part II)
Week 7: Product Recovery and Purification (Part I)
Week 8: Product Recovery and Purification (Part II)
Week 9: Characterization of Isolated Products (Part I)
Week 10: Characterization of Isolated Products (Part II)
Week 11: Biotechnology in Social Welfare
Week 12: Summary & Conclusions

***Books and references***
1. Berg M J, Tymoczko L J,Stryer L; Biochemistry; W. H. Freeman and Company(New York);2006.
2. Nelson L D, Cox M. M; Lehninger Principles of Biochemistry; Macmillan Worth; 2007;5th Edition.
3. Alberts B, Johnson A, Lewis J, Raff M, Roberts K , Walters P; Molecular Biology of Cell; Garland Publishing; 2007;5th Edition.
4. Prescott M L, Harley P J, Klein A D; Microbiology; McGraw Hill; 2005; 6th Edition.
5. Primrose SB, Twyman RM; Principles of Gene Manipulation; Blackwell Science; 2006.
6. Lewin B; Genes IX; International Edition; Pearson education; 2008.

***6- Genome Editing and Engineering***
***Credit=3***

**Level : Undergraduate/Postgraduate**

**INTENDED AUDIENCE:** UG/PG/PhD/Scientist in industry

***Course layout***
Week 1: Introduction to genetics and genetic engineering
Week 2: Breakage and Repair Of Genomic DNA
Week 3: Recombination
Week 4: Targeted genetic modification
Week 5: Zinc Finger Nuclease (ZFN) Technology
Week 6: Transcription activator-like effector nuclease (TALEN) Technology

Week 7: Clustered regularly interspaced short palindromic repeats (CRISPR)/Cas9 technology
Week 8: Applications of genome editing in treating human diseases
Week 9: Genome engineered Disease modeling
Week 10: Engineered immune cells for cancer therapy
Week 11: Personalized therapy; Challenges: safety and specificity
Week 12: Ethical concerns: Germ line gene editing

***Books and references***

1-Harber , J. E., Genome Stability: DNA Repair and Recombination , Garland Science, 2013.
2-Yamamoto, T. , Targeted Genome Editing Using Site-Specific Nucleases, Springer, 2015.
3-Zlatanova, J. and Holde, K. van, Molecular Biology: Structure and Dynamics of Genomes and Proteomes. Garland Science, 2015.
4-Yamamoto, T.(Ed.), Targeted Genome Editing Using Site-Specific Nucleases: ZFNs, TALENs, and the CRISPR/Cas9 System , Springer 2015.
5-Barrangou , R. and Oost, J. van der, CRISPR-Cas Systems: RNA-mediated Adaptive Immunity in Bacteria and Archaea , Springer, 2013.
6-Addgene, CRISPR 101:A Desktop Resource , January 2016
7-Alberts , B. , Johnson , A., Lewis , J., Morgan, D., Raff, M., Roberts, K.and Walter, P., Molecular Biology of the Cell, 6th Edn., Garland Science, 2014.

***7-Introduction to Proteogenomics***
***Credit=2***

**Level : Undergraduate/Postgraduate**
INTENDED AUDIENCE : Biotechnology or Engineering background students having interest in latest technologies,(BE/B.Tech) Biotechnology. Students with science or engineering background but course is open to all.

***Course layout***
Week 1: Proteogenomics overview- Part I, Proteogenomics overview- Part II, Introduction to Genomics- Part I : Gene sequencing and mutations Introduction to Genomics-Part II : Sequence alignment, Introduction to Genomics-Part III :Transcriptome, SL1: Advancement in Cancer Genomics, SL2: Advancement in Cancer Genomics

Week 2: Introduction to Genomics IV : Epigenome, Introduction to Genomics : cBioPortal, Genotype, Gene expression & Phenotype - Part I, Genotype, Gene expression & Phenotype- Part II, An overview of NGS technology, SH1: NGS-Sequencing by synthesis, SH2: NGS- Sequencing by synthesis

Week 3: Introduction to Proteomics, Proteomics: Sample Prep & Protein Quantification, Proteomics: Sample Prep & Protein Quantification (Hands-on), Introduction to MS-based Proteomics- Part I, Introduction to MS-based Proteomics- Part II, SL 3: Applications of NGS – Ion Torrent, SL4: Applications of NGS – Ion Torrent

Week 4: Introduction to MS-based Proteomics- Part I (Hands-on), Introduction to MS-based Proteomics- Part II (Hands-on), Data analysis: Normalization, Data analysis: Batch Correction and Missing values, Data analysis: Statistical Tests, SH3: NGS- Ion Torrent, SH4: NGS- Ion Torrent

Week 5: Machine learning and Clustering, Hypothesis testing, ProTIGY- Part I, ProTIGY- Part II, Proteogenomics approach to unravel proteoforms, SL5: Genomic Analysis using Droplet PCR, SL6: Genomic Analysis using Droplet PCR

Week 6: Workflow to Automated Data Processing, Introduction to Fire Cloud, Fire Cloud and Data Model, Bioinformatics solutions for 'Big Data' Analysis- Part I, Bioinformatics solutions for 'Big Data' Analysis-Part II, SH5: Genomic Analysis using Droplet PCR, SH6: Genomic Analysis using Droplet PCR

Week 7: Data Science infrastructure management- Part I, Data Science infrastructure management- Part II, Data Science infrastructure management- Part III, DIA-SWATH Atlas-Part I, DIA-SWATH Atlas-Part II, SL7: Introduction to Targeted Proteomics, SH7: Data Analysis using Skyline

Week 8: Human Protein Atlas-Part I Clinical, Human Protein Atlas-Part II, Affinity based proteomics & HPA, Clinical Considerations for OMICS-Part I, Considerations for OMICS- Part II, SL8: Proteomics: PTMs, SL9: Clinical Proteomics

Week 9: ntroduction to Proteogenomics-Part I, Introduction to Proteogenomics-Part II, Sequence centric proteogenomics, Gene Variant Analysis, Proteomics in Clinical studies,SH8: ProTIGY

Week 10: Supervised Machine learning- Predictive Analysis Part I, Supervised Machine learning- Predictive Analysis Part II, Supervised Machine learning- Marker Selection, Gene Set Analysis using WebGestalt- Part I, Gene Set Analysis using WebGestalt- Part II, SH9: Supervised Machine Learning

Week 11: Biological Network Analysis- Part I, Biological Network Analysis- Part II, Mutation and Signaling - Part I, Mutation and Signaling- Part II, Pathway Enrichment,SH10: Pathway Enrichment and Network Analysis

Week 12: Gene Set Enrichment Analysis (GSEA), Pathway enrichment: GSEA, Linked Omics, Linked Omics (Hands-on), Proteogenomics Conclusions, SL10: Topics in Proteogenomics- Malaria and Cancer case study

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***Books and references***

Link A J, LaBaer J: Proteomics: A Cold Spring Harbor Laboratory Course Manual; Cold Spring Harbor Laboratory Press; 2009.

***8-Introduction to Proteomics***
***Credit=2***

**Level : Undergraduate/Postgraduate**
**INTENDED AUDIENCE** : It would be applied to B.Sc., M.Sc. and MS.

***Course layout***

Week 1 : Basics of Proteins and Proteomics

Lecture 1 : Introduction to amino acids
Lecture 2 : Introduction to Proteins
Lecture 3 : Protein folding & misfolding
Lecture 4 : Introduction to Proteomics
Lecture 5 : Lab session – Protein-protein interaction using label-free biosensors

Week 2 : Gel-based proteomics
Lecture 6: Sample preparation and pre-analytical factors
Lecture 7 : Sample preparation: Pre-analytical factors (contd.)
Lecture 8 : Sample preparation: Protein extraction and quantification
Lecture 9 : One-dimensional electrophoresis
Lecture 10 : Introduction to 2-DE

Week 3 : Two-dimensional gel electrophoresis (2-DE)
Lecture 11 : 2-DE: Second dimension, staining & destaining
Lecture 12 : 2-DE: Gel analysis
Lecture 13 : 2-DE Applications
Lecture 14 : 2-DE Applications (contd.) & Challenges
Lecture 15: Lab session - Protein/peptide pre-fractionation using OFFGEL FRACTIONATOR & data analysis

Week 4 : Difference in gel electrophoresis (DIGE) & Systems Biology
Lecture 16 : 2D-DIGE: Basics
Lecture 17 : 2D-DIGE: Data analysis
Lecture 18 : 2D-DIGE: Applications
Lecture 19 : Systems biology and proteomics – I
Lecture 20 : Systems biology and proteomics - II

Week 5 : Basics of mass spectrometry
Lecture 21 : Fundamentals of mass spectrometry
Lecture 22 : Chromatography technologies
Lecture 23 : Liquid chromatography
Lecture 24 : Mass spectrometry: Ionization sources
Lecture 25 : Mass spectrometry: Mass analyzers

Week 6 : Basics of mass spectrometry and sample preparation
Lecture 26 : MALDI sample preparation and analysis
Lecture 27 : Hybrid mass spectrometry configurations
Lecture 28 : Lab session - Demonstration of Q-TOF MS technology
Lecture 29 : In-gel & in-solution digestion
Lecture 30 : Lab session - Sample preparation: tissue sample preservation technology

Week 7 : Quantitative proteomics
Lecture 31 : Introduction to quantitative proteomics
Lecture 32 : SILAC: In vivo labelling
Lecture 33 : iTRAQ: In vitro labelling
Lecture 34 : TMT: In vitro labelling

Lecture 35 : Quantitative proteomics data analysis

Week 8 : Advancement in Proteomics
Lecture 36 : Proteomics applications
Lecture 37 : Challenges in proteomics
Lecture 38 : OMICS and translational research
Lecture 39 : Lab session – Targeted proteomics using triple quadrupole mass spectrometry
Lecture 40 : Lab session – Targeted proteomics: multiple reaction monitoring

9. *Human Molecular Genetics*

***Credits : 1***

**Level: Undergraduate/Postgraduate**

INTENDED AUDIENCE : Students interested in pursuing research in human molecular genetics.
Medical students and practicing clinicians interested in understanding the principles and complexities of human genetics.
Students interested in careers in genetic counselling and DNA diagnostics.
Scientists working in public health service, counselling centres, and diagnostic laboratories.
PRE- REQUISITES:Participants are expected to have at least class 12 level understanding in genetics.

**Course layout**

Week 1: Fundamentals of central dogma (DNA, RNA and proteins; mutations), Chromosome structure and function (organization; structure-function relationship; chromosome abnormalities).
Week 2: Genes in pedigree (Mendelian pedigree patterns, complications to pedigree patterns), DNA cloning and hybridization techniques (vector based cloning; nuclei acid hybridizations; PCR-based DNA analyses)
Week 3: Mutation and instability of human DNA (mutation and polymorphism; pathogenic mutations, repeat expansions), Molecular pathology (types of mutations; animal models for human disease)
Week 4: Identifying human disease genes (functional cloning versus positional cloning; mutation screening), Complex diseases; The Human Genome and HapMap projects

**Books and references**

Strachan T, Read A; Human Molecular Genetics; Science/Taylor & Francis Group, 2011; 4 th Edition

***10-Cell Culture Technologies***

***Credit=2***

**Level : Postgraduate**

INTENDED AUDIENCE : UG and PG students pursuing biology, biotechnology, zoology and bio-engineering.

***Course layout***

Week 1: Introduction & biology of cultured cells

Week 2: Equipments, aseptic techniques, safety protocols
Week 3: Culture vessels & media development
Week 4: Serum-free medium development & sterilization
Week 5: Primary culture, secondary culture, cloning & selection
Week 6: Cell separation, characterization, differentiation & transformation
Week 7: Contamination, cryo-preservation & cyto-toxicity
Week 8: Organo-typic culture & specialized cell culture techniques

***Books and references***

1. Freshney I; Culture of Animal Cells; Wiley; 2016; 7th edition.
2. Bruserud Ø, Englezou A; Cell culture technology: Recent advances and future prospects Euroscicon Meeting Reports; Honnao publishing; 2012; 1st edition.
3. Bückmann A, Carrea G, et al; Vertebrate Cell Culture II and Enzyme Technology: Volume 39 Advances in Biochemical Engineering/ Biotechnology; Springer; 2013.
4. Butler M; Animal Cell Culture and Technology: The Basics; Garland Science, 2003, 2nd edition.
5. Skloot R; The Immortal Life of Henrietta Lacks; Crown; 2011.

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***11- Tissue Engineering***
***Credit=2***

**Level : Postgraduate**
**INTENDED AUDIENCE** : Masters/Doctoral students and faculty interested in teaching Tissue Engineering

***Course layout***

Week 1: Introduction to tissue engineering
Week 2: Scaffolds: extracellular matrix, natural and synthetic polymers
Week 3: Hydrogels, bioceramics, scaffold fabrication
Week 4: Material characterization
Week 5: Cell source, isolation, growth, differentiation
Week 6: Cell adhesion, migration, signaling, bioreactors and challenges in tissue engineering
Week 7: Host integration, bioethics, Applications: Skin tissue engineering
Week 8: Applications: Bone tissue engineering, Vascular tissue engineering, and Corneal tissue engineering

***Books and references***

1-Palsson O B, Bhatia S N; Tissue Engineering; Pearson; 2004
2-Brown R A; Extreme Tissue Engineering: Concepts and Strategies for Tissue Fabrication; Wiley Blackwell; 2013
3-Saltzman W M; Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues; Oxford University Press; 2004
4-Fisher J P, Mikos A G, Bronzino J D; Tissue Engineering; CRC Press; 2006
5-Lanza R, Langer R, Vacanti J; Principles of Tissue Engineering; Elsevier Academic Press; 2007; 3rd Edition

***12-Bioreactors***
***Credit=1***

**Level : Undergraduate/postgraduate**

***Course layout***

**Week 1:** Introduction
**Week 2:** Two important outcomes of a bioprocess: biomass (cells) and bio-products
**Week 3:** Common bioreactor operation modes, factors that affect bioreactor performance
**Week 4:** The cell view of a bioreactor

***Books and references***

1. Shuler, M.L. and Kargi, F. 2002. Bioprocess Engineering: Basic Concepts, Prentice Hall, 2. Englewood Cliffs, NJ J. Bailey and D. Ollis, Biochemical Engineering Fundamentals; McGraw Hill, 1986.

In addition, the students would be directed to specific sources during the course – they will become available during the course on the course page.

***13-Functional Genomics***
***Credit=1***

**Level : Undergraduate/postgraduate**
**INTENDED AUDIENCE :**

- Students interested in pursuing research in genomics and biotechnology field.
- Medical students and practicing clinicians interested in genomics and molecular medicine.
- Students interested in careers in biotechnology and biopharma fields.
- Technical staff /scientists working in biotechnology, biopharma and molecular diagnostic laboratories/industry

***COURSE LAYOUT***

Week 1: [2.5 hrs; 4 lectures]
Introduction to Functional Genomics:
Pre- and post-genomic era; major advancements in genomic approaches; epigenetics and metagenomics; forward versus reverse genetics

Week 2: [2.5 hrs; 4 lectures]
Genome Analyses - Part 1
Genome editing approaches and their applications; gene expression analyses and applications

Week 3: [3 hrs: 4 lectures and 2 tutorial sessions]
Genome Analyses - Part 2
Methods for DNA/RNA sequencing, sequence analysis and their applications

Week 4: [2.5 hrs: 3 lectures and 2 laboratory sessions]
Comparative Genomics
Genomic insight into evolution; power of comparative genomic analysis

***Books and references***

1. Mostly publically available literature. Will be shared with the participants during the launch of the course.

***14- Advanced Microbiology***
***Credit=4***

**Level : Undergraduate/postgraduate**

Course layout
Week1
Module 1: Morphology, Disease and Holmes Classification.
Module 2: Classification of viruses-I
Module 3: Classification of viruses II

Week 2
Module 4: Classification of fungi: Classical Concept -I
Module 5: Classification of fungi: Classical Concept -II
Module 6: Modern Classification of fungi: Modern Concept – I
Week 3
Module 7:Classification of fungi: Modern Concept - II
Module 8:Classification of fungi: Modern Concept – III
Module 9:Classification of yeast-I

Week 4
Module 10:Classification of yeast-II
Module 11: Application of microbes
Module 12:Antibiotics: The secondary Metabolites

Week 5
Module 13:Role of Staphylococcus in infection
Module 14:Nitrogen fixation & Role of Nif and Nod genes.
Module15:Microbiology & Human Health

Week 6
Module 16: Bacterial Diseases
Module 17.The pathogenesis of Vibrio cholerae
Module 18: Introduction to Salmonella

Week 7
Module 19: Preparation of Culture Media: Liquid Medium
Module 20: Preparation of Culture Media: Solid Medium
Module 21: Sterilization Techniques (Practical)

Week8
Module 22: Isolation of single colony on solid media (Practical)
Module 23: Enumeration of bacterial numbers by serial dilution & plating (Practical)

Module 24: Measurement of fungal bio-mass

Week 9
Module 25: Animal Handling (Practical)
Module 26: Staphylococcus aureus
Module27: Isolation of protozoa from soil

Week 10
Module 28: Antibiotic sensitivity assay: natural products
Module 29: Preparation of cultu re media for pathogenic bacteria – Part 1
Module 30: Preparation of culture media for pathogenic bacteria – Part 2

Week 11
Module 31: Albert and Giemsa Staining
Module 32: Determination of Growth Phase of E. coli by Measurement of OD & cfu

Week 12
Module 33: Preparation of Buffer Solution

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