# School of Basic Sciences and Research

## Department of Chemistry and Biochemistry

## Program Structure
## AY-2019-22

## B.Sc. (Hons) Biochemistry
## Program Code: SBR0103

**1. TITLE:** Bachelor of Science (Hons.) in Biochemistry

**2. DURATION OF THE COURSE: 3** YEARS

**3. YEAR OF IMPLIMENTATION**

This syllabus will be implemented for the session 2018-2021 onwards.

**4. PREAMBLE**

Total Credits- 145

Total Number of Semesters – 6 (Two semesters per year)

Total Number of Theory Papers – 31

Total Number of Practical courses – 12

Total Number of Minor Projects/Dissertations- 02

Number of papers (theory) per semester – 05/06

Number of Laboratory courses per semester – 03/02

## 1.1 Vision, Mission and Core Values of the University

| Semester 1 | | | | | Semester 2 | | | |
|---|---|---|---|---|---|---|---|---|
| **No.** | **Code** | **Course** | **Credit** | | **No.** | **Code** | **Course** | **Credit** |
| 1 | BBC102 | Biomolecules | 4 | | 1 | BBC 103 | Tools and Techniques in Biochemistry | 4 |
| 2 | CSE115 | Introduction to "C" programming | 2 | | 2 | BBC104 | Cell Biology | 4 |
| 3 | BCH101 | Physical Chemistry-I | 4 | | 3 | MTH215 | Biostatistics | 4 |
| 4 | MSM101 | Foundation Course in Mathematics | 4 | | 4 | BCH102 | Organic Chemistry-I | 4 |
| 5 | ARP101 | Communicative English-1 | 2 | | 5 | EVS106 | Environmental Studies | 3 |
| 6 | BCH151 | Chemistry Lab-I | 1 | | 6 | BCH152 | Chemistry Lab-II | 1 |
| 7 | BBC151 | Biological Science Lab-1 | 1 | | 7 | BBC152 | Biological Science Lab-2 | 1 |
| 8 | CSP115 | "C" Programming Lab | 2 | | | | | |
| **Total Credit** | | | **20** | | **Total Credit** | | | **21** |
| **Semester 3** | | | | | **Semester 4** | | | |
| **No.** | **Code** | **Course** | **Credit** | | **No.** | **Code** | **Course** | **Credit** |
| 1 | BBC201 | Metabolism of Carbohydrates and Lipids | 4 | | 1 | BBC204 | Human Physiology | 4 |
| 2 | BBC202 | Molecular Biology-I | 4 | | 2 | BBC205 | Enzymology | 4 |
| 3 | BCH302 | Organic Chemistry-III | 4 | | 3 | BBC206 | Metabolism of Amino acids and nucleotides | 4 |
| 4 | BBC203 | Introduction to microbiology | 4 | | 4 | BBC207 | Molecular biology-II | 4 |
| 5 | BCH201 | Inorganic Chemistry-I | 4 | | 5 | BBC208 | Introduction to Cancer Biology | 4 |
| 6 | ABCXXX | University elective | 2 | | 6 | BBC252 | Molecular Biology Lab | 2 |
| 7 | CCU401 | Community Connect | 2 | | 7 | BBC253 | Enzymology Lab | 2 |
| 8 | BBC251 | Biological Science Lab-3 | 1 | | | | | |
| 9 | BCH251 | Chemistry Lab-III | 1 | | | | | |
| **Total Credit** | | | **26** | | **Total Credit** | | | **24** |
| **Semester 5** | | | | | **Semester 6** | | | |
| **No.** | **Code** | **Course** | **Credit** | | **No.** | **Code** | **Course** | **Credit** |
| 1 | BBC301 | Genetics | 4 | | 1 | BBC306 | Genetic Engineering and Biotechnology | 4 |
| 2 | BBC302 | Hormonal Biochemistry | 4 | | 2 | BBC307 | Cell Signaling | 4 |
| 3 | BBC303 | Immunology | 4 | | 3 | BBC308 | Bioinformatics | 4 |
| 4 | BBC304 | Proteins | 4 | | 4 | BBC309 | Membrane Biochemistry and Bioenergetics | 4 |
| 5 | BBC305 | Medical Biochemistry | 4 | | 5 | BBC310/ BBC311 | Virology/ Plant Physiology | 4 |
| 6 | BBC351 | Genetics Lab | 2 | | | BBC354 | Genetic Engineering Lab | 2 |
| 7 | BBC352 | Immunology Lab | 2 | | 6 | BBC355 | Bioinformatics Lab | 2 |
| 8 | BBC353 | Project/Dissertation | 3 | | 7 | BBC356 | Project/Dissertation | 3 |
| **Total Credit** | | | **27** | | **Total Credit** | | | **27** |
| | **Total credits of the B.Sc. (Hons) Biochemistry program: 145** | | | | | | | |

## Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship

## Mission of the University

1. Transformative educational experience
2. Enrichment by educational initiatives that encourage global outlook
3. Develop research, support disruptive innovations and accelerate entrepreneurship
4. Seeking beyond boundaries

## Core Values

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

## 1.2 Vision and Mission of the School

### School of Basic Sciences and Research

## Vision of the School

**Achieving excellence in the realm of basic and applied sciences to address the global challenges of evolving society**

## Mission of the School

1. To equip the students with knowledge and skills in basic and applied sciences
2. Capacity building through advanced training and academic flexibility.
3. To establish center of excellence for ecologically and socially innovative research.
4. To strengthen interinstitutional and industrial collaboration for skill development and global employability.

## 1.3 Vision and Mission of Department of Chemistry and Biochemistry

### Vision of Department of Chemistry and Biochemistry

Strive to achieve excellence in teaching and research in the field of Chemistry and Biochemistry and to build human resource for solving contemporary problems

### Mission of Department of Chemistry and Biochemistry

- Providing distinctive and relevant education in Chemistry and Biochemistry to students.
- Motivating young minds through innovative teaching methods, to acquire theoretical knowledge and practical skills in different disciplines of chemistry and empowering them with problem solving skills.
- Nurturing innovation by carrying out world class research and scholarly work
- Promoting interdisciplinary research in collaboration with national/international laboratories/Institutions.

### 1.4.1 Programme Educational Objectives (PEO)

**PEO 1:** To provide students the comprehensive knowledge base in biochemistry and applied sciences through analytical and application based learning.

**PEO 2:** To inculcate in students the critical analysis skills, questioning and reasoning power and train them for a future career in higher studies and research.

**PEO 3:** To provide students high quality teaching through innovative methods and empowering them with hands on training on various aspects of biochemistry and allied biological subjects.

**PEO 4:** To encourage students to build their potential in scientific knowledge and inter-disciplinary research to serve or contribute to the society

## 1.4.3Program Outcomes (PO's)

**PO 1: Knowledge-** Students will be able to gain in-depth and detailed functional knowledge of the fundamental concepts and experimental methods of biochemistry and allied sciences

**PO 2: Proficiency-** Students will demonstrate competence in the analysis and critique of scholarly work in their area of expertise in biochemistry

**PO 3: Research-** Students will demonstrate their academic skills necessary to take up higher education on core or interdisciplinary research issues**.**

**PO 3: Skills-** Students will be able to design, conduct, analyze, and interpret data for a biochemistry and interdisciplinary research study

**PO 4: Communication-** Students will be capable to demonstrate their skills necessary for scientific communication/ oral and poster presentation/ Journal club / mini projects / Dissertation.

**PO 6: Responsibility-** Students shall have a clear understanding of professional and ethical responsibility

| MESTER | COURSE OPTED | COURSE NAME | Credits |
|---|---|---|---|
| I | Ability Enhancement Compulsory Course-I | Communicative English-1 | 2 |
| | Core course-I | Biomolecules | 4 |
| | Core course-I Practical | Biological Science Lab-I | 1 |
| | Generic Elective-I | Physical Chemistry-I | 4 |
| | Generic Elective-I Practical | Chemistry Lab-I | 1 |
| | Generic Elective-II | Foundation course in mathematics | 4 |
| | Ability Enhancement Elective Course-I | Introduction to “c” Programming | 4 |
| II | Ability Enhancement Compulsory Course-II | Environmental Studies | 3 |
| | Core course-II | Tools and Techniques in Biochemistry | 4 |
| | Core course-III | Cell Biology | 4 |
| | Core course-III Practical | Biological Science Lab-2 | 1 |
| | Generic Elective-III | Biostatistics | 4 |
| | Generic Elective-IV | Organic Chemistry-I | 1 |
| | Generic Elective-IV Practical | Chemistry Lab-II | 4 |
| III | Core course-IV | Metabolism of Carbohydrates and Lipids | 4 |
| | Core course-V | Molecular. Biology-I | 4 |
| | Core course V Practical | Biological Science Lab-3 | 1 |
| | Discipline Specific Elective-I | Introduction to microbiology | 4 |
| | Ability Enhancement Elective Course-II | From University List | 2 |
| | Generic Elective-V | Inorganic Chemistry-I | 4 |
| | Generic Elective-V Practical | Chemistry lab-3 | 1 |
| | Generic Elective-VI | Organic Chemistry-III | 4 |
| | Ability Enhancement Compulsory Course- III | Community Connect | 2 |
| IV | Core course-VI | Human Physiology | 4 |
| | Core course-VII | Enzymology | 4 |
| | Core course VII Practical | Enzymology Lab | 2 |
| | Core course-VIII | Metabolism of Amino acids and Nucleotides | 4 |
| | Core course VIII Practical | Molecular Biology lab | 2 |
| | Core course-IX | Molecular Biology-II | 4 |
| | Discipline Specific Elective-II | Introduction to Cancer Biology | 4 |
| V | Core course-X | Genetics | 4 |
| | Core course X Practical | Genetics Lab | 2 |
| | Core course-XI | Hormonal Biochemistry | 4 |
| | Core course-XII | Immunology | 4 |
| | Core course XII Practical | Immunology Lab | 2 |
| | Core course-XIII | Proteins | 4 |
| | Discipline Specific Elective-III | Medical Biochemistry | 4 |
| | Discipline Specific Elective-IV | Project-1/ Dissertation | 3 |
| VI | Core course-XIV | Genetic Engineering and Biotechnology | 4 |
| | Core course XIV Practical | Genetic Engineering Lab | 2 |
| | Core course-XV | Cell Signaling | 4 |
| | Core course-XVI | Bioinformatics | 4 |
| | Core course XVI Practical | Bioinformatics Lab | 2 |
| | Core course-XVII | Membrane Biochemistry and Bioenergetics | 4 |
| | Discipline Specific Elective-V | Virology/ Plant Physiology | 4 |
| | Discipline Specific Elective-VI | Project-2/ Dissertation | 3 |

**Core Course (C):**

1. Biomolecules
2. Tools and Techniques in biochemistry
3. Cell Biology
4. Metabolism of Carbohydrates and Lipids
5. Molecular Biology.-I
6. Human Physiology
7. Enzymology
8. Metabolism of Amino acids and Nucleotides
9. Molecular Biology-II
10. Genetics
11. Hormonal Biochemistry
12. Immunology
13. Proteins
14. Genetic Engineering and biotechnology
15. Cell Signalling
16. Bioinformatics
17. Membrane Biochemistry and Bioenergetics

**Discipline Specific Elective Course (DSE):**

1. Introduction to microbiology
2. Introduction to cancer biology
3. Medical Biochemistry
4. Dissertation/Project-I
5. Virology/ Plant Physiology
6. Dissertation/Project-II

**General Elective course (GE-I to GE-VI):**

1. Physical Chemistry-I
2. Foundation course in Mathematics
3. Biostatistics
4. Organic Chemistry-I
5. Inorganic Chemistry-I
6. Organic Chemistry-III

**Ability Enhancement Compulsory Course (AECC):**

1. Basic /Intermediate English
2. Environmental Studies
3. Community Connect

**Ability Enhancement Elective Course (AEEC)**

1. Introduction to "C" Programming
2. From University List

| ester | CORE COURSE (CC): (17) | | Ability Enhancement Compulsory Course (AECC) (2) | Ability Enhancement Elective Course (AEEC) (Skill Based) (2) | Elective: Discipline Specific DSE (6) | Elective: Generic (GE) (6) |
|---|---|---|---|---|---|---|
| **I** | Biomolecules | | AECC-1 | AEEC-1 | | GE-1<br>GE-2 |
| **II** | Tools and technique in biochemistry | Cell Biology | AECC-2 | | | GE-3 |
| | | | | | | GE-4 |
| **III** | Metabolism of Carbohydrates and lipids | Molecular Biology-1 | AECC-3 | AEEC-2 | DSE-1 | GE-5<br>GE-6 |
| **IV** | Human Physiology | Enzymology | | | DSE-2 | |
| | Metabolism of amino acids and nucleotides | Molecular Biology-2 | | | | |
| **V** | Genetics | Hormonal Biochemistry | | | DSE-3<br>DSE-4 | |
| | Immunology | Proteins | | | | |
| **VI** | Genetic Engineering and Biotechnology | Cell Signaling | | | DSE-5 | |
| | Bioinformatics | Membrane Biochemistry and Bioenergetics | | | DSE-6 | |
| **Credits** | 83 | | 7 | 6 | 22 | 27 |

**Program Structure**
**School of Basic Sciences & Research**
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**TERM: I**

| S. No. | Subject Code | Subjects | Teaching Load | | | Credits | Core/ Elective |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **Theory Subjects** | | | | | | | |
| **1** | BBC102 | Biomolecules | 3 | 1 | 0 | 4 | CC |
| **2** | CSE115 | Introduction to "C " Programming | 2 | 0 | 0 | 2 | AEEC |
| **3** | BCH101 | Physical Chemistry-I | 3 | 1 | 0 | 4 | GE |
| **4** | MSM101 | Foundation Course in Mathematics | 3 | 1 | 0 | 4 | GE |
| **5** | ARP101 | Communicative English-1 | 1 | 0 | 0 | 2 | AECC |
| **Practical** | | | | | | | |
| **1** | BBC151 | Biological science Lab- I | 0 | 0 | 2 | 1 | CC |
| **2** | BCH 151 | Chemistry Lab-1 | 0 | 0 | 2 | 1 | GE |
| **3** | CSP115 | "C" Programming Lab | 0 | 0 | 3 | 2 | AEEC |
| **TOTAL CREDITS** | | | | | | **20** | |

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**TERM: II**

| S. No. | Course Code | Course | Teaching Load | | | Credits | Core/Elective |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **Theory Subjects** | | | | | | | |
| **1** | BBC 103 | Tools and Techniques in Biochemistry | 3 | 1 | 0 | 4 | CC |
| **2** | BBC104 | Cell Biology | 3 | 1 | 0 | 4 | CC |
| **3** | MTH215 | Biostatistics | 3 | 1 | 0 | 4 | GE |
| **4** | BCH102 | Organic Chemistry-I | 3 | 0 | 0 | 4 | GE |
| **5** | EVS106 | Environmental Studies | 3 | 0 | 0 | 3 | AECC |
| **Practical** | | | | | | | |
| **1** | BBC152 | Biological science Lab-II | 0 | 0 | 2 | 1 | CC |
| **2** | BCH 152 | Chemistry Lab-2 | 0 | 0 | 2 | 1 | GE |
| | | | | | **TOTAL CREDITS** | **21** | |

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**TERM: III**

| S. No. | Paper ID Course Code | Course | Teaching Load | | | Credits | Core/Elective |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **Theory Subjects** | | | | | | | |
| **1** | BBC201 | Metabolism of Carbohydrates and Lipids | 3 | 1 | 0 | 4 | CC |
| **2** | BBC202 | Molecular Biology-1 (Gene organization, replication and repair) | 3 | 1 | 0 | 4 | CC |
| **3** | BCH302 | Organic Chemistry-III | 3 | 1 | 0 | 4 | GE |
| **4** | BBC203 | Introduction to microbiology | 3 | 1 | 0 | 4 | DSE |
| **5** | BCH201 | Inorganic Chemistry-I | 3 | 1 | 0 | 4 | GE |
| **6** | ABCXXX | University Elective | 2 | 0 | 0 | 2 | AEEC |
| **7** | CCU401 | Community Connect | 0 | 0 | 4 | 2 | AECC |
| **Practical** | | | | | | | |
| **1** | | BBC 251 Biological science Lab-III | 0 | 0 | 2 | 1 | CC |
| **2** | | BCH 251 Chemistry Lab-3 | 0 | 0 | 2 | 1 | GE |
| | | | | | **TOTAL CREDITS** | **26** | |

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**TERM: IV**

| S. No. | Course Code | Course | Teaching Load | | | Credits | Core/Elective |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **Theory Subjects** | | | | | | | |
| **1** | BBC204 | Human Physiology | 3 | 1 | 0 | 4 | CC |
| **2** | BBC205 | Enzymology | 3 | 1 | 0 | 4 | CC |
| **3** | BBC206 | Metabolism of Amino acids and nucleotides | 3 | 1 | 0 | 4 | CC |
| **4** | BBC207 | Molecular biology-II | 3 | 1 | 1 | 4 | CC |
| **5** | BBC208 | Introduction to Cancer Biology | 3 | 1 | 0 | 4 | DSE |
| **Practical** | | | | | | | |
| **1** | BBC252 | MolecularBiologyLab | 0 | 0 | 3 | 2 | CC |
| **2** | BBC253 | EnzymologyLab | 0 | 0 | 3 | 2 | CC |
| | | | | | **TOTAL CREDITS** | **24** | |

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**TERM: V**

| S. No. | Course Code | Course | Teaching Load | | | Credits | Core/Elective |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **Theory Subjects** | | | | | | | |
| **1** | BBC301 | Genetics | 3 | 1 | 0 | 4 | CC |
| **2** | BBC302 | Hormonal Biochemistry | 3 | 1 | 0 | 4 | CC |
| **3** | BBC303 | Immunology | 3 | 1 | 0 | 4 | CC |
| **4** | BBC304 | Proteins | 3 | 1 | 0 | 4 | CC |
| **5** | BBC304 | Medical Biochemistry | 3 | 1 | 0 | 4 | DSE |
| **Practical/ Project** | | | | | | | |
| **1** | BBC351 | Genetics Lab | 0 | 0 | 3 | 2 | CC |
| **2** | BBC352 | Immunology Lab | 0 | 0 | 3 | 2 | CC |
| **3** | BBC353 | Project/Dissertation-I | 0 | 0 | 3 | 3 | DSE |
| **TOTAL CREDITS** | | | | | | **27** | |

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**TERM: VI**

| S. No. | Course Code | Course | Teaching Load | | | Credits | Core/Elective |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| **Theory Subjects** | | | | | | | |
| **1** | BBC306 | Genetic Engineering and Biotechnology | 3 | 1 | 1 | 4 | CC |
| **2** | BBC307 | Cell Signaling | 3 | 1 | 0 | 4 | CC |
| **3** | BBC308 | Bioinformatics | 3 | 1 | 1 | 4 | CC |
| **4** | BBC309 | Membrane Biochemistry and Bioenergetics | 3 | 1 | 0 | 4 | CC |
| **5** | BBC310/ BC311 | Virology/ Plant Physiology | 3 | 1 | 0 | 4 | DSE |
| **Practical/ Project** | | | | | | | |
| **1** | BBC354 | Genetic Engineering Lab | 0 | 0 | 3 | 2 | CC |
| **2** | BBC355 | BioinformaticsLab | 0 | 0 | 3 | 2 | CC |
| **3** | BBC356 | Project/Dissertation | 3 | 0 | 0 | 3 | DSE |
| | | | | | **TOTAL CREDITS** | **27** | |
| | | | | | **GRAND TOTAL** | **145** | |

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## Core Theory Courses:

## 2.1.1: Biomolecules (BBC 102)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program:B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term I** |
| 1 | Course Code | BBC102 |
| 2 | Course Title | Biomolecules |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 3-1-1 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Recognize monosaccharides and their derivatives, understand how monosaccharides cyclize to form two different anomers and how a glycosidic bond links two monosaccharides.<br>2. Know the overall structure of an amino acid and the structures of the 20 different 'R' groups, understand how peptide bonds link amino acid residues in a polypeptide.<br>3. Understand that the planar character of the peptide group limits the conformational flexibility of the polypeptide chain, become familiar with the different structures form of protein.<br>4. Become familiar with the structures and nomenclature of the major classes of lipids,including fatty acids, triacylglycerols, glycerophospholipids, sphingolipids, and steroids.<br>5. Become familiar with the structures and nomenclature of the eight common nucleotides, understand how nucleotides are linked together to form nucleic acids and become familiar with the structural features of the DNA double helix. |
| 6 | Course Outcomes | Having successfully completed this module students will be able to;<br><br>**CO 1:** Discuss chemical and molecular processes take place in and between cells related to carbohydrate, recognize the structure and properties of simple carbohydrates, oligosaccharides and polysaccharides.<br>**CO 2:** Write the different structure and learn the function of different amino acids.<br><br>**CO 3:** Understand the different levels of proteins structure and its importance and principles, concepts and facts of the structure and their related functions of proteins. |

| | | |
|---|---|---|
| | | **CO 4:** Discuss the structure, functions of different lipids and its importance as energy storage, understand of structure properties and biological functions of lipids and biological membranes.<br>**CO 5:** Understand why DNA is genetic material, DNA functions, Watson and Crick structure, understand of structure properties and biological roles heterocyclic bases nucleotides and nucleic acids in living organism.<br>**CO 6:** Understand structure, function and importance of all macromolecules necessary for human beings. |
| 7 | Course Description | This course covers basic structures and functions of carbohydrates, amino acids, proteins, lipids and nucleic acids. |
| 8 | **Outline syllabus : Biomolecules** | |
| | **Unit 1** | **Carbohydrates and glycobiology** |
| | A | Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives. |
| | B | Disaccharides - reducing and non-reducing disaccharides. Polysaccharides – homo and hetero polysaccharides, structural and storage polysaccharides. |
| | C | Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). |
| | **Unit 2** | **Amino acids** |
| | A | Structure and classification, physical, chemical and optical properties of amino acids. |
| | B | Amino acids and their properties - hydrophobic, polar and charged. |
| | C | Essential and non-essential amino acid. |
| | **Unit 3** | **Protein and its structure** |
| | A | Organization of protein structure into primary, secondary, tertiary and quaternary structures. |
| | B | fibrous and globular proteins; elementary ideas onprotein denaturation and renaturation |
| | C | Structure and function of Insulin, glutathione, antidiuretic hormone, hemoglobin and myoglobin<br>. |
| | **Unit 4** | **Lipids** |
| | A | Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. |
| | B | Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. |
| | C | Plant steroids. Lipids as signals, cofactors and pigments |
| | **Unit 5** | **Nucleic acids** |

| | | | | |
|---|---|---|---|---|
| | A | Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. | | |
| | B | Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. | | |
| | C | Other functions of nucleotides - source of energy, component of coenzymes, second messengers. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Principle of Biochemistry by Nelson and Cox, 3rd edition.<br>2. Fundamentals of Biochemistry by Voet and Voet, 3rd edition.<br>3. Biochemistry ByLubertStryer, 5th Edition. | | |
| | Other References | Nil | | |

## 2.1.2: Tools and Techniques (BBC103)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester: Term II** |
| 1 | Course Code | BBC103 |
| 2 | Course Title | TOOLS AND TECHNIQUES IN BIOCHEMISTRY |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 3-1-1 |
| | Course Status | Compulsory |
| 5 | Course Objective | **1.** To introduce the students about the basic concepts making of various kinds of solution and the use of buffer<br>**2.** To discuss about the role of electric current in the movement of biomolecules through polymer and the various application of the technique<br>**3.** To make the student understand about the centrifugal and centripetal forces which is necessary for the rotation of biomolecules at a very high speed at very low temperature<br>**4.** To make the students aware of the fact of separation techniques using various chromatographic procedures<br>**5.** To study the role and application of various spectroscopic techniques used in research<br>**6.** |
| 6 | Course Outcomes | **CO 1:** Understand the effectiveness of preparing a solution in the laboratory classes and the importance of buffer in the experiment.<br>**CO 2:** Able to correlate the role of applied current in the movement of biomolecules<br>**CO 3:** Explain the centrifugation process in detail thereby will help them in doing research<br>**CO 4:** Under the various separation techniques of biomolecules like protein, nucleic acid etc.<br>**CO 5:** Explain the concept of spectroscopic method and other technique<br>**CO 6:** Understand all basic concept of techniques given and apply them in problem solving in research/projects |
| 7 | Course Description | This course describes the importance of the tools and techniques and their working principle for the use in experimental purpose. |

| | | |
|---|---|---|
| 8 | Outline syllabus | |
| | **Unit 1** | **Biochemical reagents and solutions** |
| | A | Safety practices in the laboratory. Preparation and storage of solution |
| | B | Concentration and storing of the solutions. Quantitative transfer of liquids. Concept of a buffer |
| | C | Henderson-Hassel batch equation, Working of a pH meter |
| | **Unit 2** | **Electrophoresis** |
| | A | Basic Principle of electrophoresis, Factors affecting electrophoretic mobility, Agarose gel electrophoresis, |
| | B | PAGE, SDS-PAGE, Native gels, Blotting techniques: Southern Blotting |
| | C | Northern Blotting and Western Blotting, Iso-electric focusing of proteins |
| | **Unit 3** | **Centrifugation** |
| | A | Principle of sedimentation, sedimentation coefficient, Principle of centrifugation |
| | B | Various types of centrifuges, different types of rotors for centrifuges |
| | C | Differential centrifugation, density gradient centrifugation |
| | **Unit 4** | **Chromatography and Separation technique** |
| | A | Methods of protein precipitation and purification, Salting out, Isoelectric Dialysis, Ultrafiltration |
| | B | Mobile and immobile phase, Basic principle of chromatography, Partition coefficient, paper chromatography, Thin layer chromatography |
| | C | Gel permeation chromatography, Affinity chromatography, Ion-exchange chromatography |
| | **Unit 5** | **Spectroscopic Techniques and applications** |
| | A | Design of spectrophotometer, principle, Beer's Lambert's Law |
| | B | UV, IR, NMR and ESR |

| | | | | |
|---|---|---|---|---|
| | C | Applications of techniques | | |
| | Mode of examination | **Theory** | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | **1.** Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.<br>**2.** Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8<br>**3.** The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8. | | |
| | Other References | 1. Physical Biochemistry (2009) 2nd Edition., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN:9780470856024 / ISBN: 9780470856031 | | |

## 2.1.3: Cell Biology (BBC104)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program:B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term II** |
| 1 | Course Code | BBC104 |
| 2 | Course Title | Cell Biology |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | **1.** To introduce the students about the basic understanding of unit of life.<br>**2.** To discuss about concepts of prokaryotic and eukaryotic cell and its organization.<br>**3.** To make the student understand about nucleus and various nuclear components and their chemical and structural organization<br>**4.** To make the students aware of the plasma membrane and importance of it being semipermeable and the transport mechanism involved across the membrane.<br>**5.** To study the cell division and the process of cell to cell interactions |
| 6 | Course Outcomes | **CO 1:** Understand the minute facts about cell and the overall structural and organization.<br>**CO 2:** Correlate the role of various cell organelles and nuclear components involved.<br>**CO 3:** Understand the role of various cell organelles<br>**CO 4:** Explain the transport of biomolecules across the membrane in detail and thereby help them to carry over the facts in doing research<br>**CO 5:** Understand the cell division and various cell to cell interactions involving tight and gap junctions<br>**CO 6:** Understand the importance, organization and basic functions of cell and apply the concepts to enhance research understanding and presentation skills |
| 7 | Course Description | This course describe the importance and better understanding of unit of life-Cell and its organization |
| 8 | Outline syllabus | |
| | **Unit 1** | **Cell** |
| | A | Cell as a basic unit of living systems- cell theory, |
| | B | structure, function, and biosynthesis of cellular organelles |

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| | C | Differences between prokaryotic and eukaryotic cells and animal and plant cells | | |
| | **Unit 2** | **Cell organelle** | | |
| | A | Ribosomes, Golgi apparatus, | | |
| | B | endoplasmic reticulum, lysosomes, mitochondria, | | |
| | C | chloroplasts, peroxisomes | | |
| | **Unit 3** | **Nucleus and nuclear components** | | |
| | A | Ultra structure of nucleus and its components, | | |
| | B | structural organisation, centromeres, telomeres, euchromatin and heterochromatin, | | |
| | C | polytene and lampbrush chromosomes | | |
| | **Unit 4** | **Plasma Membrane** | | |
| | A | Structure and function of plasma membrane | | |
| | B | Transport across membranes | | |
| | C | Active and passive transport, ion channel | | |
| | **Unit 5** | **Cell cycle and Cell-to Cell Interaction** | | |
| | A | Cell division- Mitosis and meiosis | | |
| | B | cytoskeleton, cell movements and | | |
| | C | Cell-cell interactions, tight & gap junctions | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | **1.** Cooper G.M., and Hausman R.E., The Cell: A Molecular Approach, 5th Edition. Sinauer Associates (2009).<br>**2.** Karp G., Cell and Molecular Biology: Concepts and Experiments, 6th Edition. Wiley (2009). | | |
| | Other Ref | - | | |

## 2.1.4:Metabolism of Carbohydrates and Lipids (BBC201)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program:B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term III** |
| 1 | Course Code | BBC201 |
| 2 | Course Title | **Metabolism of Carbohydrates and Lipids** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Understand that different organisms use different strategies for capturing free energy from their environment and can be classified by their requirement for oxygen.<br><br>2. Understand that glycolysis involves the breakdown of glucose to pyruvate while using the free energy released in the process to synthesize ATP from ADP and Pi.<br><br>3. Understand that the pathway provides NADPH for reductive biosynthesis and ribose-5-phosphate for nucleotide biosynthesis in the quantities that the cell requires.<br><br>4. Understand that the citric acid cycle is a multistep catalytic process that converts acetyl groups derived from carbohydrates, fatty acids, and amino acids to $CO_2$, and produces NADH, $FADH_2$, and GTP.<br><br>5. Understand that triacylglycerols are broken down by lipases, and the products are absorbed by the intestine. |
| 6 | Course Outcomes | Having successfully completed this module students will be able to;<br><br>**CO 1:** Employ the basic metabolic reactions and its mechanism that occur in our body and importance of control of metabolic reactions.<br>**CO 2:** Understand breakdown of glucose, generation of ATP, regulation of glycolysis and disorder related to pathway.<br>**CO 3:** Know the formation, degradation of glycogen and importance of glycogen storage as a source of energy.<br>**CO 4:** Discuss the significance, control of TCA cycle and differentiate TCA cycle steps among bacteria, human and other animals. |

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| | | **CO 5:** Understand the structure of fatty acid synthase, functions of different enzymes involved in fatty acid synthesis and degradation, differentiate between different oxidation of fatty acids.<br>**CO 6:** Understand how to control metabolic process, diseases associated with macromolecules of life and its significance. |
| 7 | Course Description | This course covers the metabolism of carbohydrates, Lipidsand their regulation. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Basic concept of metabolism** |
| | A | Autotrophs, heterorophs. |
| | B | Metabolic pathways, catabolism, anabolism. |
| | C | ATP as energy currency, reducing power of the cell |
| | **Unit 2** | **Glycolysis, Gluconeogenesis and pentose phosphate pathway** |
| | A | Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia. |
| | B | Regulation of glycolysis. Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis. |
| | C | Pentose phosphate pathway and its importance. |
| | **Unit 3** | **Glycogen metabolism** |
| | A | Glycogenesis and glycogenolysis |
| | B | Regulation of glycogen metabolism |
| | C | Glycogen storage diseases. |
| | **Unit 4** | **Citric acid cycle** |
| | A | Production of acetyl CoA, reactions of citric acid cycle. |
| | B | Anaplerotic reactions, amphibolic role, regulation of citric acid cycle |
| | C | Glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways. |
| | **Unit 5** | **Fatty acid synthesis and oxidation** |

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| | A | Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids | | |
| | B | Biosynthesis of cholesterol, triglycerides and phospholipid. β oxidation of saturated, unsaturated fatty acids, | | |
| | C | Regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Principle of Biochemistry by Nelson and Cox, 4TH ed.<br>2. Fundamentals of Biochemistry by VoetandVoet, 3rd ed.<br>3. Biochemistry ByLubertStryer, Fifth Edition. | | |
| | Other References | 1. Harper's Biochemistry | | |

## 2.1.5: Molecular Biology-I: Gene Organization, Replication and Repair (BBC202)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program:B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term III** |
| 1 | Course Code | BBC202 |
| 2 | Course Title | **Molecular Biology- I: Gene Organization, Replication and Repair** |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 4-0-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | **1.** Understand that a DNA helix can have the A, B, or Z conformation. Understand that DNA replication mechanism in Prokaryotes and Eukaryotes.<br>**2.** Explain why DNA polymerase requires a template and a primer and summarize the functions of the following proteins in *E. coli* DNA replication: DNA polymerase I, DNA polymerase III, DnaA, helicase, SSB, primase, the sliding clamp, clamp loader, DNA ligase, Tus, and topoisomerase.<br>**3.** Understand that DNA is susceptible to damage from a variety of sources and mutagenicity, which is related to carcinogenicity, can be tested. |
| 6 | Course Outcomes | Having successfully completed this module students will be able to;<br><br>**CO 1:** Understand the basic chemical structure of DNA, how ds-DNA converts into ss-DNA, vice versa and what factors affect these function.<br>**CO 2:** Differentiate organization of genes among viruses, bacteria, animals and plants, understand how histones protein are associated with DNA and its packing.<br>**CO 3:** Know DNA polymerase requires a template and primers to synthesize DNA and that double-stranded DNA is replicated semi-discontinuously by experiment proof.<br>**CO 4:** Explain how DNA topology and chromatin structure affects the processes of DNA replication, repair, and transcription. |

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| | | **CO 5:** Discuss mechanisms by which DNA can be damaged and describe the molecular mechanisms by which protein complexes repair or bypass different forms of DNA damage.<br>**CO 6:** Interpretate how DNA is organized in different species, function of different proteins/enzymes responsible for DNA replication and factors associated with DNA repair |
| 7 | Course Description | This course covers the Gene Organization, DNA Replication and Repair |
| 8 | Outline syllabus | |
| | **Unit 1** | **Structure of DNA** |
| | A | DNA structure, features of the double helix |
| | B | Various forms of DNA |
| | C | Denaturation and reassociation of DNA. |
| | **Unit 2** | **Genes and genomic organization** |
| | A | Genome sequence and chromosome diversity |
| | B | Definition of a gene, organization of genes in viruses, bacteria, animals and plants |
| | C | Nucleosome structure and packaging of DNA into higher order structures. |
| | **Unit 3** | **Replication of DNA** |
| | A | DNA polymerase, the replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication. |
| | B | Stages of replication of *E. coli* chromosome, replication in eukaryotes. Comparison of replication in prokaryotes and eukaryotes. |
| | C | Inhibitors of DNA replication and applications in medicine, topoisomerase inhibitors and their application in medicine. |
| | **Unit 4** | **Recombination of DNA and Molecular basis of mutations** |
| | A | Homologous recombination, proteins and enzymes in recombination, site-specific recombination, serine and tyrosine recombinases |
| | B | Biological roles of site-specific recombination. Importance of mutations in evolution of species. |
| | C | Types of mutations - transition, transversions, frame shift mutations, mutations induced by chemicals, radiation, transposable elements, Ames test |
| | **Unit 5** | **Various modes of DNA repair** |

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| | A | Replication errors and mismatch repair system, repair of DNA damage | | |
| | B | direct repair, base excision repair, nucleotide excision repair, | | |
| | C | recombination repair, translesion DNA synthesis | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Principle of Biochemistry by Nelson and Cox, fourth edition.<br>2. Fundamentals of Biochemistry by Voet and Voet, Third edition.<br>3. Biochemistry ByLubertStryer, Fifth Edition.<br>4. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia. | | |
| | Other References | 1. Harper's Biochemistry | | |

## 2.1.6: Introduction to Microbiology (BBC203)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch:Biochemistry** | | **Semester: Term III** |
| 1 | Course Code | BBC203 |
| 2 | Course Title | INTRODUCTION TO MICROBIOLOGY |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Discipline Specific Elective |
| 5 | Course Objective | 1. To introduce students to basic concepts in microbiology.<br>2. To elaborate the mode of reproduction, growth curve and the mechanism of gene transfer in bacteria<br>3. To understand the harmful bacteria and the role of beneficial bacteria in human welfare.<br>4. To study the application of various microbes in medical, beverage, agriculture, food and dairy industry |
| 6 | Course Outcomes | **CO 1:** Understand the history, basic concepts of microbial biochemistry with reference to bacteria and its classification.<br>**CO 2:** Introduce the concept of germination, sporulation, growth, growth curve and various factors affecting it.<br>**CO 3:** Understand the types of bacterial , as DNA reproduction, transposable elements and significance of plasmids as vector, in gene therapy etc and exploit the knowledge in research avenues.<br>**CO 4:** Understand the industrial applications of microorganism in human welfare , This will increase their exposure and help them to go for interdisciplinary research.<br>**CO 5:** This will give an idea to exploit microorganism and improve their industrial prospects of food, beverages, agriculture and dairy research<br>**CO 6:** Understand the history, ultra structure of microbes with special reference to bacteria nd its role in human welfare, reproduction and its applications in food industry, medical, beverage, agriculture and dairy industry and research. |
| 7 | Course Description | This course covers the basic introduction to microbes and its role in human welfare. Also various applications of microorganisms in food industry, medical, beverage, agriculture and dairy industry |
| 8 | Outline syllabus | |
| | **Unit 1** | **Introduction to Microbes** |
| | A | History of microbiology, five kingdom classification, Prokaryotic & Eukaryotic cell |
| | B | Ultra structure of bacteria,Nutritional Classification of bacteria, Gram positive and Gram negative bacteria |

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| | C | Cyanobacteria; Archaea; Mycoplasma, PPLO |
| | **Unit 2** | **Baterial Sporulation and Growth** |
| | A | Sporulation in Bacteria, endospore and its types, Spore germination, generation time |
| | B | Diauxi, continous, synchronus and asynchronus growth of bacteria |
| | C | Growth curve; Growth inhibitory substances (Temperature, acidity, alkalinity temperature, etc), measurement of bacterial growth (Direct and indirect method) |
| | **Unit 3** | **Bacterial Reproduction** |
| | A | Modes of reproduction, ,Mechanisms of gene transfer in bacteria |
| | B | Transposable genetic elements, Types of transposition (cut-and-paste, replicative and retrotransposons) |
| | C | Plasmids: Types, function and applications |
| | **Unit 4** | **Bacteria and Human Welfare** |
| | A | Beneficial and harmful bacteria; Soil microflora-like bacteria, fungi actinomycetes, algae, protozoa and viruses |
| | B | Role of microbes in weathering of minerals and soils formation, components of soil |
| | C | Biofertilizers BGA, Rhizobia, Biopesticides, Mycorriza. |
| | **Unit 5** | **Applied Microbiology** |
| | A | Important microorganisms in Food industry; preservation |
| | B | Microbial production of food (Indian food, fermented meat, preparation of bread, fermented protein, single cell protein) |

## 2.1.7: Human Physiology (BBC204)

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| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Hons)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester: Term IV** |
| 1 | Course Code | BBC204 |
| 2 | Course Title | HUMAN PHYSIOLOGY |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 3-1-0 |
| | Course Status | Compulsory |
| 5 | Course Objectives | **1.** To familiarize students with the principles and basic facts of Animal Physiology and with some of the laboratory techniques and equipment used in the acquisition of physiological data.<br>**2.** The course will focus on organ-system physiology, however, cellular and molecular mechanisms will be discussed in order to present a current view of physiological principles.<br>**3.** To emphasize more on nervous, respiratory, renal, digestive, and nervous physiology<br>**4.** To introduce students to many of the key concepts of Human `physiology related diseases through a survey in different hospitals |
| 6 | Course Outcomes | Having successfully completed this module students will be able to-<br>**CO 1:** Describe, identify, and/or explain: the various physiological organ-systems and their importance to the integrative functions, fundamentals of digestive enzymes secretion , reactions of enzymes of the human body.<br>**CO 2:** Explain the mechanism of respiration, transport of $O_2$ and $CO_2$, function of hemoglobin.<br>**CO 3:** Apply their knowledge in how kidney works as blood pressure measuring device and how urine concentrate by counter current multiplier system.<br>**CO 4:** Understand heart pumping mechanism , execute the principle of EEG.<br>**CO 5:** Describe endocrine system with focus on classic endocrine glands, including the hypothalamus and the pituitary glands, thyroid and parathyroid glands, adrenal glands, endocrine pancreas, their hormones and it mechanism of action and mechanism of action potential generation.<br>**CO 6:** Demonstrate an in-depth understanding of human physiology, identify how changes in normal physiology lead to diseases. |

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| 7 | Course Description | This course covers the basic information of Animal/ Human physiology and various diseases of particular organ. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Digestive System** |
| | A | Structure and functions of different components, digestion andabsorption of carbohydrates, lipids and proteins, |
| | B | role of various enzymes andhormones involved in these processes, mechanism of HCl formation in stomach, |
| | C | role of bile salts in lipid digestion and absorption.Neural and hormonal regulation of gastro-intestinal tract (GI) tract. |
| | **Unit 2** | **Respiration** |
| | A | Organization of respiratory system. Exchange of gases, Transport of oxygen |
| | B | role ofhaemoglobin, oxyhaemoglobin dissociation curve and its significance, Transport of$CO_2$: Bohr's effect, isohydric transport of $CO_2$ and chloride shift |
| | C | Acid-base balance:acidosis and alkalosis, role of lung and kidney in regulation of acid-base balance |
| | **Unit 3** | **Renal physiology** |
| | A | Anatomy of the; nephron and its organization, functions of glomerular membrane,glomerular filtration rate (GRF), |
| | B | structural and functional characteristics of tubulesselective reabsorption and secretion by active and passive transports of varioussubstances (sugars, amino acids, urea & creatinine), |
| | C | concentrating phenomenon ofurine, role of aldosterone and antidiuretic hormone |
| | **Unit 4** | **Blood and Circulatory system** |
| | A | Blood components and their functions genesis of erythrocytes and leukocytes,granular and agranular system and inflammation, phagocytosis by neutrophils andmacrophages |
| | B | Functions of T & B lymphocytes: Mechanism of blood clotting byIntrinsic and Extrinsic pathways, |
| | C | structure of heart, the origin and propagation ofheart beat, cardiac cycle and electrocardiogram |
| | **Unit 5** | **Neurochemistry, neurophysiology and Introduction to Endocrine glands** |
| | A | Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. |
| | B | Membrane potentials. Synaptic transmission, Neurotransmitters |
| | C | Glands and hormones, Secretory mechanisms, Endocrine and neuroendocrine systems, Cellular mechanism of hormone action, Physiological effects of hormones |
| | Mode of examination | Theory |

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| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Text book of Medical Physiology by Guyton and Hall, 11th Edition.<br>2. Human Physiology by Stuart Ira Fox, 12th Edition.<br>3. Harper's Biochemistry- Victor W. Rodwell, David A, Bender, Kathleen M. Botham, Peter J. Kennelly and P.Anthony Weil. McGraw Hill Education, Lange Medical Books, 30th Edition. | | |
| | Other References | 1. Animal Physiology by Jain. | | |

## 2.1.8: Enzymology (BCC205)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester : Term IV** |
| 1 | Course Code | BBC205 |
| 2 | Course Title | ENZYMOLOGY |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-1 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To introduce the concept and importance of enzyme in the human body and living cell<br>2. To have a deep understanding of the classification and identification of enzyme<br>3. To familiarize with the factors effecting the enzyme velocity, like the temperature, p H and substrate<br>4. To introduce the concept of enzyme kinetics and the equation given by Michaelis and Menton<br>5. To introduce the various enzyme isolation and purification techniques from various sources. |
| 6 | Course Outcomes | **CO 1:** Understand the mechanism of action of enzyme<br>**CO 2:** Understand the various enzyme kinetics and will be able to corelate the Vmax, Km in the Michaelis Menton equation<br>**CO 3:** Correlate the isolation technique of plant cell from that of animal and microbial cells<br>**CO 4:** Explain the regulation strategies of allosteric enzyme and the mechanism of various inhibition process<br>**CO 5:** Elaborate the various application of enzyme in different fields<br>**CO 6:** Apply the overall concepts of enzymology in different field of biochemistry |
| 7 | Course Description | This course describe the importance, isolation, purification of biocatalyst, role of biocatalyst in the catalysis of biochemical reaction and the regulation of metabolic pathways, also the various application of enzyme in different fields |
| 8 | Outline syllabus | |
| | **Unit 1** | **Enzyme Classification** |
| | A | Classification; Nomenclature and EC number of enzymes |
| | B | Co-enzyme and Co-factors; NAD/NADH, FAD/FADH2, pyridoxal phosphate, thymine pyrophosphate, |

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| | C | Isoenzymes-Lactate dehydrogenase and alkaline phosphatase, Allosteric enzymes: positive and negative regulation |
| | **Unit 2** | **Enzyme Kinetics** |
| | A | Enzyme substrate complex and mechanism of enzyme action: Lock and key hypothesis, induced fit theory and acid base catalysis |
| | B | Factors affecting rates of enzymatic reactions (pH, temperature, substrate concentration), |
| | C | Overview of Michaelis-Menten equation and Line Weaver Burk equation. |
| | **Unit 3** | **Enzyme Kinetics** |
| | A | Irreversible inhibition with examples, reversible inhibition with examples: |
| | B | Competitive, non-competitive and un-competitive inhibition. |
| | C | Methanol poisoning, transpeptidase inhibition and nerve gas, catalytic antibody. |
| | **Unit 4** | **Isolation and Localization of Enzymes** |
| | A | Isolation of enzymes from various sources, Homogenization and centrifugation technique. |
| | B | Purification of enzymes: Ammonium sulphate precipitation, dialysis |
| | C | Gel filtration chromatography, ion exchange chromatography, affinity chromatography. |
| | **Unit 5** | **Industrial Applications of enzyme** |
| | A | Applications of enzyme in beverage industry and leather industry |
| | B | Food processing industry and dairy industry |
| | C | Pharmaceutical industry, medicine/drug, health and biosensor industry |
| | Mode of examination | Theory |

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|---|---|---|---|---|
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Palmer T., Bonner P. L., Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, Woodhead Publishing (2007).<br>2. Copeland R. A., Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. Wiley (2000). | | |
| | Other Refer | | | |

## 2.1.9 : Metabolism of Amino Acids and Nucleotides (BBC206)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term IV** |
| 1 | Course Code | BBC206 |
| 2 | Course Title | **Metabolism of Amino Acids and Nucleotides** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Understand that proteins to be degraded are taken up by lysosomes or conjugated to the protein ubiquitin.<br>2. Understand that transamination reaction of an amino acids during amino acid catabolic process.<br>3. Understand that five reactions incorporate ammonia and an amino group into urea and that the rate of the urea cycle changes with the rate of amino acid breakdown.<br>4. Understand the mechanisms that regulate purine nucleotide synthesis and that salvage reactions convert purines to their nucleotide forms.<br>5. Understand what steps are the major control points for pyrimidine nucleotide synthesis. |
| 6 | Course Outcomes | Having successfully completed this module students will be able to-<br>**CO 1: D**iscuss transamination interconverts an amino acid and an keto acid and that oxidative deamination of glutamate releases ammonia for disposal, employ the reaction mechanism of urea cycle and role of ammonia toxicity.<br>**CO 2:** Know the enzymes associated with amino acids catabolism, responsible for causing various disorders.<br>**CO 3:** Discuss the reactions of formation of various amino acids, neurotransmitters and disorder associated with these.<br>**CO 4:** Understand how multiple amino acids are involved in formation of nucleotide and functions of different inhibitors (chemotherapeutic drugs/ anticancer drug) of nucleotide biosynthesis at particular steps.<br>**CO 5:** Differentiate between purine and pyrimidines degradation and how it is linked to cause diseases. |

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| | | **CO 6: U**nderstand synthesis, degradation and diseases linked to amino acids and nucleotides. |
| 7 | Course Description | This course covers the Metabolism of Amino Acids and Nucleotides |
| 8 | Outline syllabus | |
| | **Unit 1** | **Overview of amino acid metabolism** |
| | A | Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups |
| | B | Protein calorie malnutrition - Kwashiorkar and Marasmus. |
| | C | Nitrogen balance, transamination, role of pyridoxal phosphate, urea cycle and inherited defects of urea cycle. |
| | **Unit 2** | **Catabolism of amino acids** |
| | A | Catabolic pathways of amino acids |
| | B | Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease |
| | C | methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease |
| | **Unit 3** | **Biosynthesis of amino acids and precursor functions of amino acids** |
| | A | Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation. |
| | B | Biosynthesis of creatine and creatinine, catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). |
| | C | Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism. |
| | **Unit 4** | **Biosynthesis of purine and pyrimidine nucleotides** |
| | A | *De novo* synthesis of purine and pyrimidine nucleotides |
| | B | Regulation and salvage pathways |
| | C | Biosynthesis of deoxyribonucleotides , conversion to triphosphates |
| | **Unit 5** | **Degradation of purine and pyrimidine nucleotides** |
| | A | Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. |
| | B | Inhibitors of nucleotide metabolism. |
| | C | Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency |

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| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Principle of Biochemistry by Nelson and Cox, fourth edition.<br>2. Fundamentals of Biochemistry by Voet and Voet, Third edition.<br>3. Biochemistry ByLubertStryer, Fifth Edition. | | |
| | Other References | 1. Harper's Biochemistry | | |

## 2.1.10: Molecular Biology-II: Gene Expression & Regulation (BBC207)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program:B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term IV** |
| 1 | Course Code | BBC207 |
| 2 | Course Title | **Molecular Biology-II:Gene Expression & Regulation** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-1 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Understand that transcription process in Prokaryotes and Eukaryotes and able to compare it.<br>2. Understand that as the polymerase processively extends an RNA chain, another polymerase can initiate transcription.<br>3. Understand that transcription termination is a complex multistep process.<br>4. Understand the Why RNA processing/ modification is required in Prokaryotes and Eukaryotes.<br>5. Understand the importance of protein targeting, degradation and how gene expression can be regulated in Prokaryotes and Eukaryotes. |
| 6 | Course Outcomes | Having successfully completed this module students will be able to;<br><br>**CO 1:** Understand that the genetic code is based on codons that are read sequentially, and that each codon represents one amino acid or a stop signal and that the genetic code is degenerate,nonrandom, and nearly universal, discuss RNA polymerase has a structure and mechanism similar to those of DNA polymerases and that bacterial transcription begins with the RNAP holoenzyme binding to a promoter to melt apart the DNA and differentiate RNA synthesis between prokaryotes and eukaryotes.<br>**CO 2:** Know that initiation factors help to assemble the ribosomal subunits, deliver the initiator tRNA, and in eukaryotes, locate the initiation codon and that the ribosome selects the correct aminoacyl–tRNA, catalyzes the transpeptidation reaction, and then translocates along the mRNA during the elongation phase of protein synthesis also that a release factor and ribosome recycling factor participate in terminating polypeptide synthesis.<br>**CO 3:** Know that eukaryotic mRNAs are modified by a 5' cap and a 3' poly(A) tail, that eukaryotic genes include introns that must be spliced out by the action of snRNPs in the spliceosome. |

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| | | **CO 4:** Know that a single gene can generate several protein products through alternative mRNA splicing and that prokaryotic and eukaryotic rRNA and tRNA precursors are variously processed by endonucleolytic cleavage, covalent modification, splicing, and nucleotide addition, understand how proteins are degraded by proteosomal machinery, and also by another pathway<br>**CO 5:** Differentiate gene expression between prokaryotes and eukaryotes and importance of gene regulation.<br>**CO 6:** Understand the phenomenon of transcription, how RNA is involved in protein synthesis , importance of protein targeting and its modification. |
| 7 | Course Description | This course covers the Gene expression, regulation and protein targeting in Prokaryotes and Eukaryotes. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Biosynthesis of RNA in prokaryotes** |
| | A | RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters. |
| | B | Three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. |
| | C | Inhibitors of transcription. |
| | **Unit 2** | **Biosynthesis of RNA in eukaryotes** |
| | A | Comparison between prokaryotic and eukaryotic transcription. |
| | B | Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, transcription by RNA polymerase I and III. |
| | C | Inhibitors of eukaryotic transcription and their applications. Various types of RNA processing. |
| | **Unit 3** | **RNA splicing** |
| | A | Chemistry of RNA splicing, the spliceosome machinery, |
| | B | splicing pathways, group I and group II introns, alternative splicing, |
| | C | exon shuffling, RNA editing. |
| | **Unit 4** | **Biosynthesis of proteins , protein targeting and degradation** |
| | A | Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation. |
| | B | Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis. |
| | C | Post translational modifications, glycosylation, signal sequences for nuclear transport, bacterial signal sequences, import of proteins by receptor mediated endocytosis, specialized systems for protein degradation. |
| | **Unit 5** | **Regulation of gene expression in Prokaryotes and Eukaryotes** |

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|---|---|---|---|---|
| | A | Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon | | |
| | B | Heterochromatin, euchromatin, chromatin remodeling, regulation by phosphorylation of nuclear transcription factors, | | |
| | C | regulatory RNAs , RNA interference, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A.et.al<br>2. .Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H.<br>3. Biochemistry by Voet and Voet. | | |
| | Other Ref. | 1. Harper's Biochemistry | | |

## 2.1.11: Introduction to Cancer Biology (BBC208)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch:Biochemistry** | | **Semester: Term IV** |
| 1 | Course Code | BBC208 |
| 2 | Course Title | INTRODUCTION TO CANCER BIOLOGY |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Discipline Specific Elective |
| 5 | Course Objective | **1.** To introduce students to many of the key concepts of cancer biology. To promote the understanding of basic facts, mechanism, concepts and to inculcate interest in clinical research in the field of cancer.<br>**2.** To elaborate various types of carcinogenesis and the mechanism involved to understand chemical, physical and X-ray induced carcinogenesis.<br>**3.** To discuss the key characteristics of normal and malignant cell and understanding of spread of disease.<br>**4.** To explain, classify different treatment modalities involved in cancer.<br>**5.** To elaborate on mechanisms for various cell death pathways |
| 6 | Course Outcomes | **CO 1:** Understand the principles and the mechanism of various cancer causing chemicals, and radiations used in day to day life which will be an eye opener to their scientific knowledge and aspire them in interdisciplinary research.<br>**CO 2:** Understand the characteristics of cancer, process of spread of cancer (Metastasis), angiogenesis and factors leading to epithelial to mesenchymal transition and vice versa.<br>**CO 3:** Understanding the molecular cell biology of cancer involving Oncogenes, identification of oncogenes, oncogene-protooncogene activity. All these concepts enhance their curiosity in subject, enhancing their reasoning ability and aspiring them to go for higher studies and serve the society.<br>**CO 4:** Introduce the various emerging markers and therapeutic modalities of cancer.<br>**CO 5:** Understand the various cell death pathways<br>**CO 6:**Understand the principles and types of carcinogenesis, characteristics of tumor and the molecular biology of cancer including the biomarkers and various cell death pathways and exploit the above knowledge for research and presentations |

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| 7 | Course Description | This course covers the basic steps and principles of carcinogenesis. It also provides the in-depth knowledge of biochemistry of cancer and the various therapeutic modalities |
| 8 | Outline syllabus | |
| | **Unit 1** | **Principles of carcinogenesis** |
| | A | Chemical carcinogenesis, Metabolism of carcinogenesis, Targets of chemical carcinogenesis |
| | B | Principles of physical carcinogenesis |
| | C | X-ray radiation: mechanism of radiation carcinogenesis |
| | **Unit 2** | **Characteristics of tumor** |
| | A | Metastasis; Migration and Invasion, various steps involved in metastasis |
| | B | Epithelial to Mesenchymal Transition (EMT) and its types |
| | C | Angiogenesis: Hypoxia and vascular endothelial growth factor(VEGF) induced angiogenesis |
| | **Unit 3** | **Molecular cell biology of cancer** |
| | A | Oncogenes, Discovery and Identification of oncogenes |
| | B | Retroviruses and oncogenes, strategy for detecting nonviral Oncogenes (Transfection assay) |
| | C | Oncogenes/Proto-oncogene activity |
| | **Unit 4** | **Therapeutic modalities of cancer** |
| | A | Emerging markers of cancer |
| | B | Cancer detection with biomarkers, problems of early detection |
| | C | Different forms of therapy, Chemotherapy, Radiation Therapy and Immunotherapy |
| | **Unit 5** | **Cell death pathway** |
| | A | Introduction to Necrosis, Senescence and Programmed cell death |
| | B | Mechanisms of apoptosis, Apoptosis triggered by mitochondria (Intrinsic pathway), Apoptosis mediated by membrane death receptors (Extrinsic pathway), Cross talk between intrinsic and extrinsic pathways, Apoptosis inducing factors |
| | C | Apoptosis in cancer, mutations that affect extrinsic pathway and regulators of intrinsic pathway, Alternative death pathway (Autophagy) |

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| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Weinberg R.A., The Biology of Cancer, 2nd Edition. Garland Science (2007).<br>2. Pecorino L., Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, 2nd Edition. Oxford University (2008)<br>3. Pardee A.B. and Stein G.S., The Biology and Treatment of Cancer: Understanding Cancer. Wiley-Blackwell (2009) | | |
| | Other References | Review articles | | |

## 2.1 .12: Genetics (BBC301)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester: Term V** |
| 1 | Course Code | BBC 301 |
| 2 | Course Title | GENETICS |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-1 |
| | Course Status | Core Subject |
| 5 | Course Objective | 1. To introduce the students about the concepts of Mendelian genetics, his laws of inheritance and application of genetics<br>2. To discuss the other non mendelian traits and the mechanism of formation of that traits and the condition like epistasis.<br>3. To understand the theory of chromosomal inherence and the mechanism behind the inheritance process<br>4. To have a deep understanding and effect of change in chromosome number and chromosome structure, their consequences and the disease associated with it.<br>5. To introduce about the gene mutation, their effect in the environment and the various disorders associated with it. |
| 6 | Course Outcomes | **CO 1:** Understand not only mechanism behind both the Mendelian and non mendelian genetics but also the various application of genetics in the field of agriculture<br>**CO 2:** Discuss the various abnormalities associated with the change in chromosome number and structure and to deduce some methods for rectification<br>**CO 3:** Correlate the effect of gene mutation with environment and other external and spontaneous events<br>**CO 4:** Understand the genetics in the bacteria and how gene from a dead bacteria finally forms a new bacteria<br>**CO 5:** Explain how population plays a role in genetics and genetics are applied in the field of agriculture.<br>**CO 6:** Apply the basic concepts of genetics in doing field related projects or lab based projects. |
| 7 | Course Description | This course describes the various laws governing Mendelian and non Mendelian genetics and how these principles and laws and applied in the different field of agriculture and plants. |

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| 8 | Outline syllabus | | | |
| | **Unit 1** | **Mendelian Genetics** | | |
| | A | History of Genetics; Concept of Genes, Mendelian genetics, monohybrid and dihybrid cross | | |
| | B | Mendelian genetics- different type epistasis, | | |
| | C | Multiple alleles, sickle cell anemia, hemophilia and other genetic disorder | | |
| | **Unit 2** | **Chromosomal Theory of Inheritance** | | |
| | A | Chromosome Structure; Chromosomal anomalies- changes in chromosome number. | | |
| | B | Non dysjunction mechanism and changes in chromosome structure. | | |
| | C | Sex Chromosomes and sex linkage mechanism in drosophila. | | |
| | **Unit 3** | **Gene Mutation** | | |
| | A | Gene fine structure and Molecular concept of gene | | |
| | B | Mutation and its type: Somatic and germinal mutation | | |
| | C | Spontaneous and induced mutation, Molecular basis of gene mutation | | |
| | **Unit 4** | **Microbial Genetics and Extranuclear Genome** | | |
| | A | Microbial genetics- conjugation, transformation, transduction | | |
| | B | Extra-nuclear inheritance in Higher plants; transposable element and its role in agriculture | | |
| | C | An overview of Mitochondrial genome and chloroplast genome. | | |
| | **Unit 5** | **Population Genetics** | | |
| | A | Effect of gene and allelic frequencies in a population (Hardy-Weinberg Principle and equation); | | |
| | B | Natural Selection: Stabilizing, disruptive and directive selection, | | |
| | C | Bottle neck effect and founder effect, balanced polymorphism | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |

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|---|---|---|
| | Text book/s* | 1. Snustad D.P., and Simmons M.J., *Principles of Genetics*, 6th Edition. John Wiley & Sons (2011).<br>2. Griffiths A.J.F., Wessler S.R., Carroll S.B., and Doebley J., *Introduction to Genetic Analysis, 10th Edition.* W. H. Freeman (2010).<br>3. Genetics: A conceptual approach,4th edition by Benjamin A Pierce. |
| | Other References | 1. Genetics: A conceptual approach,4th edition by Benjamin A Pierce. |

## 2.1.13: Hormonal Biochemistry (BBC302)

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| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester:Term V** |
| 1 | Course Code | BBC302 |
| 2 | Course Title | HORMONAL BIOCHEMISTRY |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Core Subject |
| 5 | Course Objective | 1. To introduce the mechanism of various types of signaling involved with hormones and their classification<br>2. To discuss the role of various receptors where various hormones bind so as to know the sensitization and de sensitization process.<br>3. To elaborate the functions and working mechanism of various hormones released from various endocrine glands of our body<br>4. To explain the pathophysiology and biochemical actions of hormones of pancreas and adrenal cortex<br>5. To introduce the various hormones of male and female reproductive tract and their role in the human body. |
| 6 | Course Outcomes | **CO 1:** Understand the role, function and importance of hormones inside our body and will be able to differentiate them from a biocatalyst<br>**CO 2:** Correlate hormonal regulation with the metabolic pathways<br>**CO 1:** Evaluate the various pathophysiological condition of over secretion and under secretion of hormones so as to formulate some solution to the problem<br>**CO 3:** Recognize the factors associated with the release of hormones and their dependence on sex,age etc<br>**CO 4:** Understand the mechanism of action of hormones from the various endocrine glands<br>**CO 5:** Under the function and regulation of all the hormones and their physiology, pathophysiology in clinical diagnosis and clinical biochemistry |
| 7 | Course Description | This course covers the information about the role of regulating molecule, hormone in all the signaling aspects and the overall expression of these signals in various organs of our body |
| 8 | Outline syllabus | |

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| | **Unit 1** | **Introduction to endocrinology** | | |
| | A | Functions of hormones and their regulations. Chemical signaling-endocrine, paracrine, autocrine, intracrine | | |
| | B | Classification of Hormones and their function | | |
| | C | Transport of hormones in the blood circulation. | | |
| | **Unit 2** | **Hormones and receptors** | | |
| | A | Endocrine glands and their Receptor. Sensitization and Desensitization of receptors | | |
| | B | G protein linked hormone receptors and their Structures | | |
| | C | Physiological and Biochemical actions of hormones | | |
| | **Unit 3** | **Hypothalmic, Pituitary, thyroid and pancreatic Hormones** | | |
| | A | CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH | | |
| | B | Growth hormone, T3, T4, TSH | | |
| | C | Vasopressin, Oxytocin, Insulin and Glucagon | | |
| | **Unit 4** | **Hormones of Adrenal Cortex** | | |
| | A | Aldosterone (renin angiotensin system) and cortisol | | |
| | B | Epinephrine and nor epinephrine. Flight , fight and fear response. | | |
| | C | Pathophysiology and biochemical action of diabetes type I and type II. | | |
| | **Unit 5** | **Reproductive Hormones** | | |
| | A | Male and female Sex hormones, LH, FSH | | |
| | B | Prolactin, Interplay of hormones during Reproductive cycle, | | |
| | C | Pregnancy, Parturition, & Lactation; Hormone based Contraception | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Cox, M.M. and Nelson, D.L. ( 2008) Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York,<br>2. Widmaier, E.P.,Raff, H. and Strang, K.T.(2008).Vander,Sherman, Luciano's<br>3. Human Physiology, McGraw- Hill Higher Education | | |
| | Other References | Darnell, J.,Lodish, H. and Baltimore, D.( 2008). Molecular Cell Biology, Scientific American Books. | | |

## 2.1.14: Immunology (BBC303)

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| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester: Term V** |
| 1 | Course Code | BBC303 |
| 2 | Course Title | IMMUNOLOGY |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-1 |
| | Course Status | Core Subject |
| 5 | Course Objective | 1. To introduce to the students about the various cells, tissues ,organs, and organ system involved in the defense mechanism of human and the role of B cells an T cells<br>2. To explain the functions of B cells and the role of antibody in eliminating the pathogens and the mechanism of compliment system<br>3. To discuss about the major histocompatibility, the genes and the proteins involved in the complex and how these complex play an essential role in differentiating own antigen from foreign<br>4. To elaborate the various mechanism involved in the killing of bacteria or virus using T cell and the activation of these cells<br>5. To introduce about the various immunological techniques involved in the identification of unknown antigen in the given sample like immunoprecipitation etc. |
| 6 | Course Outcomes | **CO 1:** Understand the importance of immunology in biochemistry and the mechanism of elimination of virus and bacteria from the human cells<br>**CO 2:** Recognize the difference between our antigen from the foreign antigen by knowing the mechanism of MHC complex<br>**CO 3:** Evaluate and correlate the immunological techniques with that of other biological techniques so as to know the different ways of estimating the unknown antigens<br>**CO 4:** Understand the real mechanism behind the Tcell and B cell mediated killing of virus and bacteria<br>**CO 5:** Understand the working principle of various tissues and organs of immune system<br>**CO 6:** Understand the overall fundamentals behind immulogy and how this is linked with the development of new drugs |

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| 7 | Course Description | This course covers the mode of action and functions of various immune cells like B, T and antibody in killing of pathogenic bacteria and viruses which enters in our body after crossing the first line of defense |
| 8 | Outline syllabus | |
| | **Unit 1** | **Organs and Cells of Immune System** |
| | A | Types of immunity-innate, acquired, active and passive. Elements of immune system |
| | B | Primary and secondary lymphoid organs and tissues, |
| | C | T-helper cell, T-cytotoxic cell, B-cells, antigen presenting cell. |
| | **Unit 2** | **Antibody and compliment system** |
| | A | Types of antibodies and their structures: isotypes, allotypes, and idiotypes |
| | B | Structure and function of immunoglobulins, organization and expression of Ig genes; Immunoglobulin |
| | C | and T-cell receptor genes; Complement activation by classical and alternate pathways. |
| | **Unit 3** | **MHC complex and antigen presentation** |
| | A | General organization and inheritance of MHC |
| | B | Distribution and role of MHC class I and class II proteins |
| | C | Different pathways of antigen processing and presentation |
| | **Unit 4** | **Regulation of Immune ResponseBioinfor and cytotoxicity** |
| | A | Generation of humoral cell and cell mediated immune responses, mechanism of activation of B cell |
| | B | Mechanism of activation of B cell and T cell lymphocyte |
| | C | Cell mediated cytotoxicity**;** antibody-dependent cel mediated cytotoxicity |
| | **Unit 5** | **Immune technology** |

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|---|---|---|---|---|
| | A | Basic concept of vaccination and different types of vaccines and their mechanism, modes of vaccination, | | |
| | B | Hypersensitivity type I and type II with examples | | |
| | C | Hybridoma technology, monoclonal antibodies and their applications. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Delves P.J., Martin S.J., Burton D.R., and Roitt I.M., Roitt's Essential Immunology, 12th Edition. Wiley-Blackwell (2011).<br>2. Owen J., Punt J., and Stranford S., Kuby Immunology, 7th Edition. W. H. Freeman (2013). | | |
| | Other References | 1. Paul W.E., *Fundamental Immunology, 7th Edition.* LWW (2012). 26 | | |

## 2.1.15: Proteins (BBC304)

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| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Hons.)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester: Term V** |
| 1 | Course Code | BBC304 |
| 2 | Course Title | Proteins |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 3-1-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Understand protein extraction method.<br>2. Know the different structure of proteins.<br>3. Understand diseases associated with protein structure.<br>4. Basic knowledge biological functions of different proteins. |
| 6 | Course Outcomes | Having successfully completed this module students will be able to;<br><br>1. extract and purify proteins for downstream processing.<br>2.describe the chemical nature of enzymes and their function in biochemical reactions.<br>3.understand primary, secondary, tertiary and quaternary structure in proteins and identify the types of interactions important in each case.<br>4. know the importance of protein folding and its disadvantage in relation to human beings.<br>5. understand about protein databases and important tool to study protein structures..<br>6. know about protein extraction methods for downstream processing, structure of proteins, protein folding and its associated disorder and important tool to study protein structures. |
| 7 | Course Description | This course covers the structure, function and folding of proteins. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Extraction of proteins for downstream processing** |
| | A | Solubilization of proteins from their cellular and extracellular locations. |

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| | B | Use of simple grinding methods, homogenization, ultrasonication |
| | C | French press and centrifugation. |
| | **Unit 2** | **Covalent structure of proteins** |
| | A | Organization of protein structure into primary, secondary, tertiary and quaternary structures. |
| | B | N-terminal and C-terminal amino acid analysis. Sequencing techniques - Edman degradation. |
| | C | Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. |
| | **Unit 3** | **Three dimensional structures of proteins** |
| | A | Nature of stabilizing bonds - covalent and non covalent. Importance of primary structure in folding. |
| | B | The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. |
| | C | Helices, sheets and turns. Ramachandran map. Techniques used in studying 3-D structures - X-ray diffraction. |
| | **Unit 4** | **Protein folding and conformational diseases** |
| | A | Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. |
| | B | Assisted folding by molecular chaperones, chaperonins, Defects in protein folding |
| | C | Diseases, Alzheimer's and Prion based. |
| | **Unit 5** | **Introduction to protein structure databases** |
| | A | Protein sequence and structure databases (PDB) |
| | B | Use of sequence and domain information |
| | C | Viewing protein structures using *in silico* tools |
| | Mode of examination | Theory |

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| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.<br>2. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.<br>3. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.<br>4. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (NewDelhi), ISBN: 978-81-265-3016-8. | | |
| | Other References | - | | |

## 2.1.16: Medical Biochemistry (BBC305)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch:Biochemistry** | | **Semester: Term V** |
| 1 | Course Code | BBC305 |
| 2 | Course Title | MEDICAL BIOCHEMISTRY |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Discipline Specific Elective |
| 5 | Course Objective | 1. To introduce students to basic concepts of clinical and nutritional biochemistry.<br>2. To understand the diagnostic significance of various organ function tests like liver, renal and gastric function tests.<br>**3.** To elaborate on significance of serum enzymes and the deranged enzyme pattern in various diseases in comparison to normal profile.<br>**4.** To study the concept of caloric value of foods and energy as regards to diet<br>5. To understand the concept of balanced diet and its implications to nutrition |
| 6 | Course Outcomes | **CO 1:** Understand the basic concepts of clinical biochemistry and its diagnostic value.<br>**CO 2:** Understand the various metabolic and nutritional diseases related which will increase their scientific knowledge and help them to go for interdisciplinary research.<br>**CO 3:** Understanding the significance of enzymes as diagnostic tool<br>**CO 4:** Application based learning will broaden their potential and help them to explore the wide world of clinical and nutritional biochemistry for research.<br>**CO 5:**Understanding of concept of diet and nutrition<br>**CO 6:** Understanding of clinical and nutrition biochemistry which will open new vistas for research to serve the society.<br><br>Understanding of basic concepts of clinical and nutritional biochemistry |
| 7 | Course Description | This course covers the basic concepts of clinical and nutritional biochemistry. The knowledge of metabolic diseases, various organ function tests and enzyme |

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| | | patterns used in diagnostic analysis will provide the understanding and will enhance their interest in interdisciplinary research |
| 8 | Outline syllabus | |
| | **Unit 1** | **Basic concepts of clinical biochemistry** |
| | A | Standard solutions, Specimen collection and processing (Blood, urine, faeces) |
| | B | Anti-coagulant preservatives for blood and urine |
| | C | Transport of specimens |
| | **Unit 2** | **Disease related to carbohydrate metabolism** |
| | A | Regulation of blood sugar, Glycosuria and its types. |
| | B | Oral glucose tolerance test in normal, prediabetic and diabetic conditions. |
| | C | Hyperglycemia, hypoglycemia, ketonuria |
| | **Unit 3** | **Organ function test** |
| | A | lipoproteins: Classifications, composition, mode of action,.Dyslipoproteinemias, atherosclerosis |
| | B | fatty liver; Liver function test |
| | C | Renal function test : Clearance test – Urea, Creatinine, Inulin, PAH test, Gastric function test : Collection of gastric contents, examination of gastric residuum, FTM, stimulation test, tubeless gastric analysis |
| | **Unit 4** | **Clinical Enzymology** |
| | A | Functional and non- Functional plasma enzymes, significance and sources of plasma/ serum enzymes. |
| | B | Isoenzymes, Lactate dehydrogenase (LDH), Creatinine Phosphokinase (CPK), Alkaline phosphatase (ALP) |
| | C | Enzyme patterns in acute pancreatitis, myocardial infarction, and muscle wasting. |
| | **Unit 5** | **Diet and Nutrition** |
| | A | Basal Metabolic rate (BMR), Respiratory quotient (RQ), Biological functions of Vitamin A, D, E, K, Vitamin B complex and Vitamin C |

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| | B | Role of carbohydrates, protein, lipids and minerals in diet, concept of balanced diet, protein Energy Malnutrition (PEM) and its types, Obesity | | |
| | C | Food additives, Food preservatives standard, adulteration of food | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Text book of Clinical Biochemistry - Carl A. Burdis and Edward R Ashwood<br>2. Text book of Medical Biochemistry - Dr. M.N. Chatterjee and Rane Shinde<br>3. Clinical chemistry in diagnosis and treatment - Philip D. Mayne<br>4. Clinical chemistry – William Hoffman | | |
| | Other References | 1. Clinical Biochemistry with clinical correlation – Devin, Wiley<br>2. Practical clinical biochemistry – Harold Varley, CBS, New Delhi | | |

## 2.1 .17: Genetic Engineering and Biotechnology (BBC306)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program:B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term VI** |
| 1 | Course Code | BBC306 |
| 2 | Course Title | **Genetic Engineering & Biotechnology** |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 4-0-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Understand how molecular machines are constructed and regulated so that they can accurately copy, repair, and interpret genomic information.<br>2. Appreciate that molecular biology/ recombinant DNA technology is a dynamic and ever-changing experimental science.<br>3. Understand the cloning criteria, screening, selection, identification and their expression.<br>4. How to prepare genomic and c DNA library, understand the different techniques of genetic engineering, PCR, microarray etc<br>5. Become comfortable with reading and critiquing primary research papers. |
| 6 | Course Outcomes | Having successfully completed this module students will be able to;<br><br>**CO 1:** Distinguish between different recombinant DNA technology related restriction enzymes, modified enzymes and their functions.<br>**CO 2:** Understand the criteria for cloning, selection and expression vectors based on E.coli, plasmids, plants, animals and mammals.<br>**CO 3:** Discuss the differences among different types of gene transfer method and its advantage and disadvantage.<br>**CO 4:** Explain how to make c-DNA and genomic DNA library, its advantage and disadvantage, know about preparation of probes and clone identification.<br>**CO 5:** Understanding the gene amplification/ expression by PCR (Polymerase Chain Reaction), also gene expression by micro array technique, principle of southern, northern and western blotting, polymorphism study by different markers, importance of DNA sequencing. |

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| | | **CO 6:** Understand different types and functions of restriction enzymes, cloning vectors, gene delivering mechanism, methods of clone identification and important tools in genetic engineering. |
| 7 | Course Description | This course covers the how to make recombinant DNA molecule with different types of tools and technique and its application. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Introduction to recombinant DNA technology** |
| | A | Overview of recombinant DNA technology. |
| | B | Restriction and modification systems |
| | C | restriction endonucleases and other enzymes used in manipulating DNA molecules. |
| | **Unit 2** | **Cloning vectors for prokaryotes and eukaryotes** |
| | A | Plasmids and bacteriophages as vectors for gene cloning. |
| | B | Cloning vectors based on *E. coli* plasmids, pBR322, pUC18, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. |
| | C | Vectors for yeast, higher plants and animals. |
| | **Unit 3** | **Introduction of DNA into cells and selection for recombinants** |
| | A | Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. |
| | B | Identification for recombinants - insertional inactivation, blue-white selection. |
| | C | Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Various gene transfer mechanism. |
| | **Unit 4** | **Methods for clone identification** |
| | A | The problem of selection, direct selection, marker rescue. |
| | B | Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, |
| | C | methods based on detection of the translation product of the cloned gene. |
| | **Unit 5** | **Techniques in Genetic Engineering** |
| | A | Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. |
| | B | Cloning PCR products. Real time PCR. Different types of blotting techniques. |
| | C | Micro array. Nucleic acid sequencing, RFLP, RAPD |

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| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.<br>2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.<br>3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed.,Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC). | | |
| | Other References | 1. Biochemistry by Nelson and Cox. | | |

## 2.1.18: Cell Signalling (BBC307)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch:Biochemistry** | | **Semester: Term VI** |
| 1 | Course Code | BBC307 |
| 2 | Course Title | Cell Signaling |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 3-1-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To introduce students to concepts of cell signalling.<br>2. To elaborate the mechanism of cell signalling, cellular communicate and the various pathways involved in it.<br>3. To understand the role of kinases, receptors, secondary messengers and modulation of different signaling.<br>4. To study the role of signalling in cell proliferation and apoptosis. |
| 6 | Course Outcomes | **CO 1:** Understand the main principles of signalling, concept of a good signal, different ways in which the cell signal to each other and the coordination of signalling. This will inculcate the knowledge and research avenues for students.<br>**CO2:** Understand the applications of signalling in cellular proliferation and apoptosis to raise their interest in interdisciplinary research.<br>**CO3:** Understand the significance of cell signalling and signal transduction.<br>**CO4:** Understanding of various pathways involved in signal transduction. This will give them a vision and provide them an option for higher studies.<br>**CO5:** Understanding of signal transduction pathways involved in therapeutics for cure of cancer. This learning will increase their research potential to serve the society.<br>**CO6:** Understanding of concept of cell signaling involving intracellular communication for the coordination of a good signal. In addition the role of various signaling pathways involved in cellular proliferation, apoptosis and therapeutics for the cure of cancer and introducing this knowledge for betterment of society. |
| 7 | Course Description | This course covers the concept of cell signaling involving intracellular communication for the coordination of a good signal. In addition the role of various signaling pathways involved in cellular proliferation, apoptosis and therapeutics for the cure of cancer. |
| 8 | Outline syllabus | |

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| | **Unit 1** | **Overview of signaling** | | |
| | A | Basic introduction of cell signaling, description of good signal | | |
| | B | Different ways in which the cell signal to each other, coordination of signaling | | |
| | C | Brief history and techniques of cell signaling | | |
| | **Unit 2** | **Cellular communication** | | |
| | A | Main principles of cell signaling | | |
| | B | Intracellular communication; various ways of intracellular communication | | |
| | C | Extracellular matrix; Neurotransmitters; Neurohormones; Regulation by neurotransmitters and neurohormones | | |
| | **Unit 3** | **Signal transduction** | | |
| | A | Transcription factors | | |
| | B | Receptors, Involvement of receptors in signaling, Types of receptors in signaling, G-protein coupled receptor mediated signaling | | |
| | C | Secondary messengers and modulation of different signalling | | |
| | **Unit 4** | **Serine/Threonine and Tyrosine Specific Protein Kinases** | | |
| | A | Classification and regulation of protein kinases | | |
| | B | Protein kinase pathway | | |
| | C | Regulation of P13K and Akt pathway | | |
| | **Unit 5** | **Map kinases and their regulation** | | |
| | A | Concept of kinases and their function | | |
| | B | MAPK cascades, Regulation of MAPK pathway, Role of MAPK in cell proliferation | | |
| | C | Possible roles of phosphatises and inhibitory proteins | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Hancock J.T., "Cell Signalling", Oxford University Press, 2010.<br>2. Gomperts B.D., Kramer I.M. and Tatham P.E.R., "Signal Transduction", Academic Press, 2009.<br>3. Krauss G., "Biochemistry of Signal Transduction and Regulation", Wiley-VCH, 2008. | | |

## 1.19: Bioinformatics (BBC308)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester:Term VI** |
| 1 | Course Code | BBC308 |
| 2 | Course Title | BIOINFORMATICS |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-1 |
| | Course Status | Core Subject |
| 5 | Course Objective | 1. To acquire a fundamental knowledge of basic computational biology<br>2. To study, design and analyze in silico experiments.<br>3. To learn the procedure of sequence alignment and its application in molecular phylogenetics.<br>4. To understand different techniques used for gene prediction and creation of biological databases |
| 6 | Course Outcomes | **CO 1:** Review different biological databases and softwares required for computational biology.<br>**CO 2:** Integrate data, perform DNA sequencing and interpret the results.<br>**CO 1:** Predict protein structure, function and folding, Compute DNA-protein interaction and apply the information in drug designing.<br>**CO 3:** Design and predict the function of proteins and genes by different algorithms. Apply different techniques for gene prediction and motifs identification. Design experiments to find ESTs and SNPs.<br>**CO 4:** Perform genomic sequencing and determine transcription factor computational biology. Retrieve date using different databases (NCBI, EMBL, SwissPort).<br>**CO 5:** Understanding of artificial intelligence and computational biology for research avenues |
| 7 | Course Description | This course will introduce the artificial intelligence and computation biology |
| 8 | Outline syllabus | |
| 1 | **Unit 1** | **Introduction to Bioinformatics** |

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|---|---|---|---|---|
| | A | Introduction to bioinformatics; Scope and importance; | | |
| | B | Large scale generation of molecular biology data; | | |
| | C | Quality of data; metadata; Summary and reference systems | | |
| | **Unit 2** | **Genome** | | |
| | A | Genomic sequencing and gene expression, proteomics, Transcription factor binding sites, single nucleotide polymorphism | | |
| | B | Computational representation of molecular biological data, Storage techniques, | | |
| | C | Databases and controlled vocabularies, Boolean search, Fuzzy search. | | |
| | **Unit 3** | **Database analysis** | | |
| | A | Biological database and their special requirements sequences | | |
| | B | Macromolecular structures; Chemical Compounds, Genetic variability | | |
| | C | Phylogenetic analysis | | |
| | **Unit 4** | **Expression of data** | | |
| | A | Representation pattern and relationship, alignment, regular expression, hierarchies, (Markov Chains & Bayes Note) | | |
| | B | Methods of presenting large quantities of biological data; | | |
| | C | Anatomical visualization and database driven websites | | |
| | **Unit 5** | **Pattern analysis in Sequences** | | |
| | A | Motif representation: consensus, regular expressions; PSSMs; Markov models | | |
| | B | Regulatory sequence identification using Meme; | | |
| | C | Gene finding: composition based finding, sequence motif-based finding | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Lesk A., Introduction to Bioinformatics, 3rd Edition. Oxford University Press (2008).<br>2. Peyzner P., and Shamir R., Bioinformatics for Biologists. Cambridge University Press (2011).<br>3. Xiong J., Essential Bioinformatics. Cambridge University Press (2006). | | |
| | Other References | NIL | | |

## 2.1.20: Membrane Biochemistry and Bioenergetics (BBC309)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch: Biochemistry** | | **Semester: Term VI** |
| 1 | Course Code | BBC309 |
| 2 | Course Title | MEMBRANE BIOCHEMISTRY AND BIOENERGETICS |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 3-1-0 |
| | Course Status | Core Subject |
| 5 | Course Objective | 1. To introduce the students with the concepts of membrane and how membranes are classified<br>2. To enable the students to learn about the various types and categories of proteins, their function in the human body<br>3. To explain the different types of junctions, their role in transport system and the concept of liposomal model<br>4. To elaborate the various mechanism of transport and importance of ssuch transport in day to day life's physiological processes.<br>5. To discuss about the various receptors involved in the transport system and the mode of regulation |
| 6 | Course Outcomes | **CO1:** Understand the complex transport mechanism in a more simplified manner by the use of various diagrams and models<br>**CO2:** Discuss the overall classification and composition of membranes and their role in the human body<br>**CO3:** Understand the concept behind the liposome and the ways to deliver drugs in the tissues of affected organs<br>**CO4:** Differentiate between porous and non porous membrane and their methods of transport through them<br>**CO5:** Understand the role receptors, protein pumps an other junctions in the transport<br>**CO6:** Understand the fundamentals of membrane and its importance to life, different proteins and lipids associated withthe membrane. |
| 7 | Course Description | This course covers the role of various proteins and receptors in the membranes and their mode of action and function, also the thermodynamics involved in it. |
| 8 | Outline syllabus | |

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| | **Unit 1** | **Membranes** | | |
| | A | Membranes and their biological and non-biological classification | | |
| | B | Different models of lipid bilayer, synthetic membrane, types and their role | | |
| | C | reverse osmosis, functions of membranes | | |
| | **Unit 2** | **Composition of Biological Membranes** | | |
| | A | Integral proteins, their types and functions, peripheral proteins, their types and functions | | |
| | B | Channel proteins, protein pumps | | |
| | C | Membrane lipids, classification and structure | | |
| | **Unit 3** | **Introduction to bioenergetics** | | |
| | A | Laws of thermodynamics, Mitochondrial membrane and Electron transport chain - its organization and function | | |
| | B | Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure | | |
| | C | Mechanism of ATP synthesis. Metabolite transporters in mitochondria. ROS production and antioxidant mechanisms. | | |
| | **Unit 4** | **Membrane transport** | | |
| | A | Active and passive diffusion, Fick's law; Transport through porous, non-porous, and ion exchange membranes | | |
| | B | Symport, antiport and uniport; Anion and glucose transporter | | |
| | C | Sodium-potassium pumps- examples and metabolic significance | | |
| | **Unit 5** | **Membrane receptors** | | |
| | A | Structure and functions of GPCR, Methods for studying membrane receptors | | |
| | B | Functions and mechanism of adrenergic and cholinergic receptors | | |
| | C | Neural receptors and its significance. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |

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|---|---|---|
| | Text book/s* | **1.** Cox, M.M. and Nelson, D.L. ( 2008) Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, USA<br>**2.** Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA.<br>35 |
| | Other References | **1.** Cox, M.M. and Nelson, D.L. ( 2008) Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, USA<br>**2.** Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA |

## 2.1.21: Virology (BBC 310)

| School: SBSR | | Batch : 2019-22 |
|---|---|---|
| Program: B.Sc. (Honours) | | Current Academic Year: 2019-20 |
| Branch:Biochemistry | | Semester: Term VI |
| 1 | Course Code | BBC310 |
| 2 | Course Title | VIROLOGY |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Discipline Specific Elective course |
| 5 | Course Objective | 1. To introduce students to basic knowledge of term virology and the salient features of viruses.<br>2. To elaborate the methods of isolation, purification and cultivation of viruses<br>3. To understand the importance of viruses, their mode of transmission, taxonomy, classification and life cycle.<br>**4.** To study the application of viruses in recombinant DNA Technology |
| 6 | Course Outcomes | **CO1:** Understand the basic structure and salient features of viruses including its isolation, purification cultivation, role in causing cancer and various ways of its transmission as it is hot topic of research in current scenario<br>**CO2:** Understanding of nomenclature and viral taxonomy<br>**CO3:** Understanding of multiplication and replication strategies of virus<br>**CO4:** Understanding of mode of transmission in plants and animals<br>**CO5:** Introducing the importance of viruses like in industrial applications for synthesis of antiviral compounds, viral vaccines for prevention and control of viral diseases as well as expose their young brain towards interdisciplinary research in medical biochemistry. Undestanding the significance of viruses as vector in recombinant DNA technology. This will open vistas for higher studies.<br>**CO6:** Understanding of basic knowledge of viruses, taxonomy, and their importance in industrial applications |
| 7 | Course Description | This course gives the basic knowledge of viruses, taxonomy, and classification, methods for isolation, purification and cultivation of viruses. In addition, will cover the industrial application of viruses in recombinant DNA Technology |

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| 8 | Outline syllabus | |
| | **Unit 1** | **Introduction to Virology** |
| | A | Discovery of viruses; General properties of viruses |
| | B | Morphology and ultra structure of viruses, Isolation, purification and cultivation of viruses |
| | C | Viroids and prions |
| | **Unit 2** | **Viral Taxonomy** |
| | A | **Di**versity of viruses; Salient features of viral genomes |
| | B | Classification and nomenclature of viruses infecting microbes |
| | C | Classification and nomenclature of viruses infecting plants and animals |
| | **Unit 3** | **Multiplication and Replication Strategies** |
| | A | Replication strategies of viruses as per Baltimore classification |
| | B | Assembly, maturation and release of virions; Concept of early and late proteins |
| | C | Multiplication curve, lytic and lysogenic phages (lambda and P1 phage) |
| | **Unit 4** | **Transmission** |
| | A | **M**ode of transmission in plant and animals |
| | B | Cell to cell transmission, Viremia |
| | C | Persistent and non-persistent mode of transmission |
| | **Unit 5** | **Importance of viruses** |
| | A | Concepts of oncogenes; DNA and RNA oncogenic viruses |
| | B | Prevention and control of viral diseases; Antiviral compounds, interferons and viral vaccines |
| | C | Application of viral vectors in cloning and expression |

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| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Dimmock N.J., Easton A.L., and Leppard K.N., Introduction to Modern Virology, 6th Edition. Wiley-Blackwell (2007).<br>2. Carter J. and Saunders V., Virology: Principles and Applications. Wiley (2007).<br>3. Acheson N.H., Fundamentals of Molecular Virology, 2nd Edition. Wiley (2011) | | |
| | Other References | Nil | | |

## 2.1.22: Plant Physiology (BBC311)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: Term VI** |
| 1 | Course Code | BBC311 |
| 2 | Course Title | **Plant Physiology** |
| 3 | Credits | 4 |
| 4 | Contact Hours(L-T-P) | 3-1-0 |
| | Course Status | Disci[pline Specific Elective |
| 5 | Course Objective | 1. Introduce the students to the structural organization of plant cells. Understand the cell wall structure formation and growth give an overview of photosynthesis and its significance to plant and human environment. Introduce the students to the biochemistry of plant developments.<br>2. Understand and explain secondary metabolites and their potential therapeutic and nutritional uses<br>3. Explain the biosynthetic pathway of plant hormones.<br>4. Discuss the roles of biochemists and allied scientists in the development of medicinal plants |
| 6 | Course Outcomes | Having successfully completed this module students will be able to;<br><br>**CO1:** Understand nitrogen metabolism, functions of nitrogenase, nitrate and nitrite reductase in nitrogen assimilation.<br>**CO2:** Explain and understand the biochemistry of photosynthetic process and its relation to man and it's environment.<br>**CO3:** Know the enzymatic pathway of glycolysis ,TCA cycle, ATP synthesis mechanism by oxidative phosphorylation pathway and role of mitochondria in respiration.<br>**CO4:** Explain the structure and functions on xylem, phloem, transport mechanism in plants.<br>**CO5:** Understand the biochemical events associated with growth regulatorsand herbicides,know the importance of plant hormones and secondary metabolites to plant growth and development and also its significance in human nutrition and health.explain and understand the biochemistry of plant growth and development. |

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| | | **CO6:** Understand plant physiology and biochemistry processes by nitrogen metabolism, respiration, photosynthesis, transport mechanism and significance of plant growth hormones and metabolites. |
| 7 | Course Description | This course covers the plant physiology and biochemistry. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Nitrogen metabolism** |
| | A | Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. |
| | B | Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; |
| | C | ammonia assimilation by Glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals. |
| | **Unit 2** | **Photosynthesis** |
| | A | Chloroplast structure and photosynthetic pigments; Photosystem I and II; |
| | B | Light absorption, emission; Energy transfer; Z-scheme of photosynthesis, |
| | C | Electron transport across thylakoids; Photophosphorylation, $CO_2$ fixation, C2, C4, CAM plants |
| | **Unit 3** | **Respiration** |
| | A | Aerobic and anaerobic respiration; Respiration quotient |
| | B | Overview of glycolysis, Regulation of plant glycolysis, Mitochondrial structure and respiration; TCA cycle |
| | C | Structure and function, Oxidative phosphorylation. |
| | **Unit 4** | **Transport Processes in Plant** |
| | A | Root as absorbing surface; Ion traffic in root; Xylem and phloem: structure and function; Nature of membranes |
| | B | Active and passive transport systems, Carrier and Ion channels, driving forces and flow, transport through phloem |
| | C | transport of organic solutes; Transport system; Transpiration Pull theory |
| | **Unit 5** | **Regulation of plant growth and Secondary metabolites** |
| | A | Introduction to plant hormones (Auxin, Cytokinins, Gibberellins, Abscisic acid, Jasmonic acid) and their effect on plant growth and development |

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|---|---|---|---|---|
| | B | Function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, | | |
| | C | Classification of terpenoids and representative examples from each class, biological functions of terpenoids. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garlandscience ISBN 978-0-8153-4121-5.<br>2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.<br>3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press | | |
| | Other References | 1. Biochemistry by Nelson and Cox. | | |

## ELECTIVE COURSES FOR DIFFERENT DEPAERMENTS

## 2.1,23 : Introduction to Life Science (BBC101)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch: Chemistry** | | **Semester:1** |
| 1 | Course Code | BBC 101 |
| 2 | Course Title | Introduction to life Science |
| 3 | Credits | 4 |
| 4 | Contact Hours<br><br>(L-T-P) | 3-1-0 |
| | Course Status | Elective course (For other disciplines) |
| 5 | Course Objective | **1.** To introduce the students about the concept of biology and how it is used in day to day life<br>**2.** To explain the formation of earth and the rise of life thereafter and also to discuss about the abiotic and biotic condition existing about that time<br>**3.** To introduce about the classification system adopted in diversity of life<br>**4.** To explain the genetics of Mendel's period and it has influence life there after<br>**5.** To discuss about the molecular role of genetic variation and the central dogma of life. |
| 6 | Course Outcomes | **CO1:** Learn how biology is used in day to day life. How field of biology is useful in all field of science to provide basic biology knowledge<br>**CO2:** Elaborate the scientific theory of the formation of earth and how exist evolve after the formation of earth.<br>**CO3:** Discuss the diversification of life and the classification system involved in this diversification<br>**CO4:** Learn the various law in Mendel's genetics and the role of genetics in agriculture and all other fields and introducing the ethic and reponsibilty of biology in combination with inter disciplinary research to serve the society |

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| | | **CO5:** Explain the mechanism of genetic variation and the molecular genetics involved in it.<br>**CO6:** Introduces the information about the early evolution and the diversification of life, patterns of inheritance and the molecular basis of transmission of genetic information. | | |
| 7 | Course Description | This course covers the information about the various early evolution of earth and life after that and how the life has diversified thereafter and lead to various changes in the planet. | | |
| 8 | Outline syllabus | | | |
| | **Unit 1** | **Biological System** | | |
| | A | Introduction to concepts of biology; | | |
| | B | Themes in the study of biology; | | |
| | C | A closer look at the ecosystem and cell; Biology in everyday life | | |
| | **Unit 2** | **Evolutionary history of biological diversity** | | |
| | A | Early earth and the origin of life; Major events in the history of life; | | |
| | B | Phylogeny and the tree of life; | | |
| | C | Concepts of species; Mechanisms of speciation. | | |
| | **Unit 3** | **Classification and diversity** | | |
| | A | Classifying the diversity of life | | |
| | B | Kingdoms of life, Prokaryotes, Eukaryoyes | | |
| | C | Archae, Concepts of taxa | | |
| | **Unit 4** | **Mendelian Genetics** | | |
| | A | Patterns of inheritance and question of biology | | |
| | B | Mendel's law and genetic variation | | |
| | C | phenotype and genotype | | |
| | **Unit 5** | **Modern Genetics** | | |
| | A | The molecular basics of genetic information | | |
| | B | Flow of genetic information from DNA to RNA | | |
| | C | Flow of genetic information from RNA to protein | | |
| | Mode of examination | Theory | | |
| | | CA | MTE | ETE |

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|---|---|---|---|---|
| | Weightage Distribution | 30% | 20% | 50% |
| | Text book/s* | 1. Cox, M.M. and Nelson, D.L. ( 2008) : Lehninger Principles of Biochemistry, W.H. Freeman<br>2. and Company, New York<br>3. Reginald H. Garrett • Charles M. Grisham(2010) : Biochemistry, 4th edition<br>4. Raven, Johnson, Mason, Losos, Singer: Biology, 9th edition, Mc Graw Hill Publication<br>5. Reece, Urry, Cain, Wasserman and Minosky, Jackson: Campbell Biology, 10th edition, Pearson Group Publication. | | |
| | Other References | 1. Sadava, Hillis, Heller and Berenbam : Life the science of biology, 9th edition, W.H Freeman and Company.<br>2. Donald T Hynie : Biological thermodynamics,2nd edition, Cambridge University Press | | |

## 2.1 .24: Human health and Disease (BBC312)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc. (Honours)** | | **Current Academic Year: 2019-2020** |
| **Branch:Biochemistry** | | **Semester:** |
| 1 | Course Code | BBC312 |
| 2 | Course Title | HUMAN HEALTH AND DISEASE |
| 3 | Credits | 2 |
| 4 | Contact Hours<br><br>(L-T-P) | 2-0-0 |
| | Course Status | Elective course (for other disciplines) |
| 5 | Course Objective | **1.** To introduce students to basic knowledge of biology, concept of balanced diet and healthy lifestyle<br>**2.** To understand the composition of balanced diet and basic food groups, malnutrition, metabolic and lifestyle related diseases. |
| 6 | Course Outcomes | **CO1:** Understand the basic biology including the role of balanced diet and its composition . Also introducing the professional ethical responsibility<br>**CO2:** Understand the life style related , metabolic, nutrition related and metabolic disorders, which they can pursue further for higher studies to add on their research value to it<br>**CO3:** Give them idea about nutrition, diet and its implications in healthy life.<br>**CO4:** Understand the clinical implications of disease and the research avenues<br>**CO5:** Provide updates on heart disease, AIDS, addiction etc<br>**CO6:** Understand the significance of health and disease |
| 7 | Course Description | This course will give concepts about basic human biology and the knowledge of how human body maintains a healthy balance whereas disturbances of this balance underlie diseases |
| 8 | Outline syllabus | |
| | **Unit 1** | **Basics of health and clinical implications of diseases** |
| | A | Concept of health and disease, factors influencing health and risk factors for developing disease, Immunity and immunization |
| | B | Importance of Hygiene practices for disease prevention, metabolic and lifestyle related diseases (Diabetes), |
| | C | Multifactorial diseases (Cancer, Heart disease, mental illness, addiction), Human Immunodeficiency Disease (HIV-AIDS) |
| | **Unit 2** | **Metabolic and lifestyle disorders** |

| | | | | |
|---|---|---|---|---|
| | A | Balanced diet and its composition, Elements of nutrition (macro and micro nutrients), | | |
| | B | Factors affecting food and nutrition (Like socioeconomic, cultural, traditional etc), Diet and its types, FAD Diet and its pros and cons | | |
| | C | Classification of Food, Food additives, Preservatives, Impact of food preservatives and adulterants on health, Deficiency diseases: Malnutrition | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | Krause's Food and nutrition care process by L Kathleen et al | | |
| | Other References | Nil | | |

## ELECTIVE COURSES (THEORY)

## E1. Syllabus of Introduction to 'C' Programming (CSE115)

| | | |
|---|---|---|
| **School: SET** | | **Batch : 2019-22** |
| **Program: BSc** | | **Current Academic Year:2019-2020** |
| **Branch:** | | **Semester: I** |
| 1 | Course Code | CSE115 Course Name: |
| 2 | Course Title | Introduction to 'C' Programming |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 2-0-0 |
| | Course Status | |
| 5 | Course Objective | To understand and demonstrate how to solve logical and scientific problems using programming. |
| 6 | Course Outcomes | On successful completion of this module students will be able to:<br>**1.** Identify and understand the working of key components of a computer system.<br>**2.** Apply and practice logical ability to solve the problems.<br>**3.** Generate efficient and schematic solution to the problems. |
| 7 | Course Description | To understand and demonstrate how to solve logical and scientific problems using programming. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Basics of computers** |
| | A | Introduction to computers: Von- Neumann's Model, Components, Devices. |
| | B | Data representation in computers (Number,Character). |
| | C | Introduction to Softwares: System, Application |
| | **Unit 2** | **Fundamental of Logic Buildings (Algorithms)** |
| | A | Problem Solving Aspects: Input, Output, Process(relationships between input and output), Verification, solve real life problems, case study examples. |
| | B | Type of constructs in algorithm to solve problem: Declaration, assignment, decision and control. |
| | C | Implementation of Algorithms: Computer Programming Evolution, Translators: Assembler, Compiler, Interpreter |
| | **Unit 3** | **Basics of Flowcharts** |
| | A | Flowchart: Elements, need of input and output. |
| | B | Identifying and understanding input/output, branching and iterations in flowchart. |

| | | | | |
|---|---|---|---|---|
| | C | Conversion of algorithms in flowchart. | | |
| | **Unit 4** | **C Language-I** | | |
| | A | Introduction to C programming language: Structure of a C program. | | |
| | B | Compilation and execution of C program.<br>Data types, Variables, Constants, Identifiers and keywords, Operators. | | |
| | C | Types of Statements: Assignment, Control, jumping. | | |
| | **Unit 5** | **C Language-II** | | |
| | A | Control statements: Decisions, Loops, break, continue | | |
| | B | Nesded Loop | | |
| | C | Arrays: One dimensional Array, Sorting, Searching | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Yashavant Kanetkar, “Let Us C”, BPB. | | |
| | Other References | 1. Byron Gottfried, “Programming with C”,TMH.<br>2.R. G. Dromey, “How to Solve It by Computer”,Pearson. | | |

## E2. Syllabus of Communicative English-1 (ARP101)

| | | |
|---|---|---|
| **Schools:**SBSR | | **Batch :** 2019-22 |
| | | **Current Academic Year:** 2019-20 |
| | | **Semester:** 1st (One) |
| 1 | Course Code | **ARP101** |
| 2 | Course Title | Communicative English-1 |
| 3 | Credits | 2 |
| 4 | Contact Hours(L-T-P) | 1-0-2 |
| 5 | Course Objective | To minimize the linguistic barriers that emerge invaried socio-linguistic environments through the use of English. Help students to understand different accents and standardise their existing English. Guide the students to hone the basic communication skills - listening, speaking, reading and writing while also uplifting their perception of themselves, giving them self-confidence and building positive attitude. |
| 6 | Course Outcomes | CO1 Learn to use correct sentence structure and punctuation as well as different parts of speech. CO2 Learning new words its application and usage in different contexts helpful in building meaning conversations and written drafts.Develop over all comprehension ability, interpret it and describe it in writing. Very useful in real life situations and scenarios.<br><br>CO2 A recognition of one's self and abilities through language learning and personality development training leading up to greater employability chances. Learn to express oneself through writing while also developing positive perception of self.To be able to speak confidently in English<br><br>CO3 To empower them to capitalise on strengths, overcome weaknesses, exploit opportunities, and counter threats. To ingrain the spirit of Positive attitude in students through a full length feature film followed by a storyboarding activity. Create a Self Brand, identity and self esteem through various interesting and engaging classroom activity<br><br>CO4 Exposing students to simulataions and situations wherein students learn to describe people and situations and handle such situations effectively and with ease.Teaching students how to engage in meaningful dialogues and active conversational abilities to navigate through challenging situations in life and make effective conversations. CO12 Learn how to transform adverse beginnings into positive endings – through writing activities like story completion. |
| 7 | Course Description | The course is designed to equip students, who are at a very basic level of language comprehension, to communicate and work with ease in varied workplace environment. The course begins with basic grammar structure |

| | | |
|---|---|---|
| | | and pronunciation patterns, leading up to apprehension of oneself through written and verbal expression as a first step towards greater employability. |
| 8 | Outline syllabus – ARP 201 | |
| | **Unit A** | **Sentence Structure** |
| | Topic 1 | Subject Verb Agreement |
| | Topic2 | Parts of speech |
| | Topic3 | Writing well-formed sentences |
| | **Unit B** | **Vocabulary Building & Punctuation** |
| | Topic 1 | Homonyms/ homophones, Synonyms/Antonyms |
| | Topic2 | Punctuation/ Spellings (Prefixes-suffixes/Unjumbled Words) |
| | Topic3 | Conjunctions/Compound Sentences |
| | **Unit C** | **Writing Skills** |
| | Topic 1 | Picture Description – Student Group Activity |
| | Topic2 | Positive Thinking - Dead Poets Society-Full-length feature film -Paragraph Writing inculcating the positive attitude of a learner through the movie \| SWOT Analysis – Know yourself |
| | Topic3 | Story Completion Exercise –Building positive attitude - The Man from Earth (Watching a Full length Feature Film ) |
| | **Unit D** | **Speaking Skill** |
| | Topic 1 | Self-introduction/Greeting/Meeting people – Self branding |
| | Topic2 | Describing people and situations - To Sir With Love ( Watching a Full length Feature Film ) |
| | Topic3 | Dialogues/conversations (Situation based Role Plays) |
| 9 | Evaluations | Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem Solving Scenarios/GD/Simulations ( 60% CA and 40% ETE |
| 10 | Texts & References \| Library Links | • Blum, M. Rosen. How to Build Better Vocabulary. London: Bloomsbury Publication<br>• Comfort, Jeremy(et.al). Speaking Effectively. Cambridge University Press |

**Observations**:

1. A Single Consolidated Syllabus has now replaced the Previous Functional English Beginners -1 and Functional English Intermediate -1
2. Credits previously allocated to FEN 01 Lab Sessions have been dissolved
3. The Pearson Voice Labs have been completely eliminated

## E3. FOUNDATION COURSE IN MATHEMATICS (MSM 101)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019- 2022** |
| **Program: B.Sc. (H)** | | **Current Academic Year: 2019-20** |
| **Branch: Maths, Physics, Chemistry** | | **Semester: I** |
| 1 | Course Code | MSM 101 |
| **2** | Course Title | FOUNDATION COURSE IN MATHEMATICS |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | **1.** To familiarise the students with basic concepts of matrices, determinants and solving the system of linear equations.<br>**2.** To understand the basic concept of sets theory, co-ordinate geometry, complex number and vector algebra. |
| 6 | Course Outcomes | CO1: Explain the concept of matrices and solve systems of linear equations and determinants. (K2,K3, K4)<br>CO2: Explain the concept of complex numbers and calculate the nth roots of complex numbers and illustrate the solutions of simple Polynomial equations. (K2, K3, K4)<br>CO3:Memorize the basic of Cartesian coordinate system anduse algebraic techniques to explain intercepts and explore equations of lines on the number plane. (K1, K3, K4)<br>CO4: Describe and differentiate the symmetries from graphs of conic sections. (K1, K2)<br>CO5: Describe and use the concepts of set theory, relation and functions. (K1,K2,K3)<br>CO6: Explain the basic concepts of vector algebra and use to find area of parallelogram and quadrilateral, Vector triple product.(K2,K 3,K4) |
| 7 | Course Description | This course is an introduction to the fundamental of Mathematics. The primary objective of the course is to develop the basic understanding of linear algebra, complex number, co-ordinate geometry, sets theory and vector algebra. |
| 8 | **Outline syllabus** | **Foundation course in Mathematics** |
| | **Unit 1** | **Matrices** |
| | A | Evaluation of determinants, Properties of determinants, |
| | B | Matrices: types of matrices, addition, subtraction and multiplication of matrices, symmetric and skew symmetric matrix. Inverse of matrix. |

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|---|---|---|---|---|
| | C | Rank of a matrix, Consistency of system of equations, Characteristic equation, Cayley -Hamilton theorem. | | |
| | **Unit 2** | **Complex Numbers** | | |
| | A | Representation of complex number in Argand plane, Modulus and argument of complex number | | |
| | B | Algebraic operations, De- Moivre's theorem | | |
| | C | Nth root of complex number, Euler's formula | | |
| | **Unit 3** | **Co-ordinate geometry** | | |
| | A | Cartesian coordinate system, Distance between two points Equations of line in various forms | | |
| | B | Equation of circle in various forms, Equation of tangent and normal to the circle. | | |
| | C | Equation of ellipse, parabola and hyperbola | | |
| | **Unit 4** | **Sets Theory** | | |
| | A | Definition of set, types of sets, Union and intersection of sets, Venn diagram, De-Morgan's law. | | |
| | B | Relation and functions. | | |
| | C | Composite function and inverse function. | | |
| | **Unit 5** | **Vector Algebra** | | |
| | A | Addition and subtraction of vectors and their geometric application. | | |
| | B | Scalar and vector product, their physical application, Projection of vector on another vector, area of triangle. | | |
| | C | Area of parallelogram and quadrilateral, Vector triple product. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons Inc.<br>1. Jain, M.K., and Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa Publications | | |
| | Other References | 1. Thomas, B.G., and Finny R.L., "Calculus and Analytical geometry", Pearson Education Asia, AdisonWisley.<br>2. Simmons, G.F., "Differential Equations with applications with applications", Tata McGraw-Hill. | | |

## E4: PHYSICAL CHEMISTRY-I (BCH 101)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B. Sc** | | **Current Academic Year: 2019-20** |
| **Branch: Chemistry** | | **Semester: 01** |
| 1 | Course Code | BCH 101 |
| 2 | Course Title | **PHYSICAL CHEMISTRY-I (C)** |
| 3 | Credits | 4.0 |
| 4 | Contact Hours (L-T-P) | (3 1 0) |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To provide the understanding of physical states of matter and how they are related to daily life application<br>2. To define how the initially primitive models of real gases in physical chemistry are elaborated to take into account more detailed observations.<br>3. To understand the laws of solid state chemistry and the arrangement of ions/atoms/molecules in a crystal lattice<br>4. To list different properties of liquids involving surface tension and viscosity coefficients.<br>5. To extend the concept of solutions from Raoult's Law to industrial application processes.<br>6. To provide the introduction and application of solid, liquid and gaseous states. |
| 6 | Course Outcomes | CO1: The structural features of solid-state material by having the knowledge of packing arrangements.<br>CO2: Different properties of liquids and their application in daily life.<br>CO3: The separation processes of steam distillation and solvent extraction.<br>CO4: Ideal and Non ideal gas behaviour and their properties.<br>CO5: The basics of thermodynamics to the lab-scale heat exchange processes.<br>CO6: Fundamental properties, thermodynamical properties and application of all states of mater |
| 7 | Course Description | Course emphasizing on the various solid state structures and its correlation to atomic coordinated, distinguishing properties of liquid state, physical properties of molecule's in solutions and gaseous state, thermochemistry aspects of chemical process. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Solid State** |
| | A | Crystalline and amorphous solids, crystal lattices and unit cell, Crystal systems, types, close packing, |
| | B | Packing fraction, crystal density, Ionic Radii, radius ratio. X–Ray diffraction: Bragg's law, |

| | | | | |
|---|---|---|---|---|
| | C | Structures of NaCl, KCl and CsCl (qualitative treatment only). Point Defects. Glass and liquid crystals. | | |
| | **Unit 2** | **Liquid State** | | |
| | A | Qualitative treatment of the structure of the liquid state, Radial distribution function | | |
| | B | Physical properties of liquids: vapour pressure, surface tension, coefficient of viscosity and their determination. | | |
| | C | Effect of addition of various solutes on surface tension and viscosity. Temperature variation of viscosity of liquids and comparison with that of gases. | | |
| | **Unit 3** | **Solution** | | |
| | A | Deviations from Raoult's law – non-ideal solutions. Colligative properties: vapour pressure-composition and temperature composition curves of ideal and non-ideal solution, azeotropes, distillation of solutions. | | |
| | B | Partial miscibility of liquids: critical solution temperature, effect of impurity on partial miscibility of liquids. | | |
| | C | Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. | | |
| | **Unit 4** | **Gaseous State** | | |
| | A | Kinetic theory of gases, derivation of Ideal gas equation, Maxwell distribution of molecular velocities and molecular energies, principle of equipartition of energy, | | |
| | B | Deviation of gases from ideal behaviour, compressibility factor (Z) and expansitivity factor, van der Waal's equation of state and its application to explain deviation of gases. | | |
| | C | Critical constant of gas in terms of van der Waal's constant: derivation of $P_c$, $T_c$ and $V_c$, principle of corresponding states. | | |
| | **Unit 5** | **Thermodynamics and Thermochemistry** | | |
| | A | Recapitulation of Laws of Thermodynamics, Entropy changes in reversible and irreversible processes, Entropy changes for an ideal gas in isothermal, isobaric and isochoric processes, | | |
| | B | Physical significance of entropy, Helmholtz free energy (A) and Gibbs free Energy (G), variation of Free Energy with pressure and temperature, Maxwell relations, Gibbs-Helmholtz equ. | | |
| | C | Relation between Enthalpy of reaction at constant volume and pressure, Enthalpy of formation, Kirchhoff equation, Hess's Law and application, measuring the enthalpy of combustion. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. P.W. Atkins and Julio de Paula, "Physical Chemistry", 8th Ed., W. H. Freeman Publication, 2006.<br>2. G.M. Barrow, "Physical Chemistry" Tata McGraw-Hill Education, 2008.<br>3. Puri, Sharma and Pathania, "Principles of Physical Chemistry" Vishal Publishing Co.<br>4. Bahl Arun, Bahl B.S. and J.D Tuli, "Essentials of Physical Chemistry", S.Chand & Co.<br>5. KL Kapoor , "Textbook of Physical Chemistry" Volume 1 and 2, Macmillan Publishers | | |

## E5. Syllabus of Bio-Statistics (MTH215)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Program: B. Sc.** | | **Current Academic Year: 2019-20** |
| **Branch: Chemistry/Bio-chemistry** | | **Semester: Even** |
| 1 | Course Code. | MTH215 |
| 2 | Course Title | BIO-STATISTICS |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-0 |
| | Course status | Elective |
| 5 | Course Objectives | To make students familiar with the concept of Probability and Statistics with emphasis on some standard probability distributions and sampling distributions. |
| 6 | Course Outcomes | CO1:Describe the concept of Statistics and statistical inference and calculate find the measures of central tendency and dispersion of a data. (K1,K2,K3)<br>CO2: Explain the concept of probability and evaluate the probability of various events in a random experiment, theorem on probability, conditional probability. (K2,K4,K5)<br>CO3: Discuss the concept of normal distributions for evaluate relevant probabilities. (K1,K2,K5)<br>CO4: Discuss about confidence interval and evaluate population parameters from the statistics of samples.(K1,K2,K5)<br>CO5: Explain and evaluate statistical hypothesis using large and small samples. (K2,K4,K5)<br>CO6: Describe and evaluate coefficient of correlation, rank correlation and regression lines relating two variables. (K1,K2,K5) |
| 7 | Course Description | In this introductory statistics course we will explore the use of statistical methodology in designing, analyzing, interpreting, and presenting biological experiments and observations. We will cover descriptive statistics, probability, and hypothesis testing and statistical inference, correlation and regression techniques. |
| 8 | Outline syllabus: | |
| **UNIT 1** | **Introduction and descriptive statistics.** | |
| A | Some basic concepts – sampling and statistical inference | |
| B | Frequency distribution. Measures of central tendency – mean, median, mode, mean of the combined data. | |
| C | Dispersion – mean deviation, variance, standard deviation, quartiles. | |
| **UNIT 2** | **Probability.** | |

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|---|---|---|---|---|
| A | Objective and subjective views on probability. Random experiment, sample space, events, mutually exclusive events, independent events, axioms of probability, conditional probability. | | | |
| B | Calculation of probabilities using addition theorem and conditional probability theorems. | | | |
| C | Normal distribution: use of tables to calculate probabilities and also the mean and SD of normal distribution with given probabilities. | | | |
| **UNIT 3** | **Estimation.** | | | |
| A | Confidence interval of a population mean. | | | |
| B | Use of the t distribution in the estimation of population mean in the small sample cases. | | | |
| C | Estimation of proportions. | | | |
| **UNIT 4** | **Testing of hypothesis.** | | | |
| A | Testing of hypothesis: single population mean and difference of two population means. | | | |
| B | Testing of hypothesis: single population proportion. | | | |
| C | Chi – square test – goodness of fit. | | | |
| **UNIT 5** | **Correlation and regression.** | | | |
| A | Carl Pearson's Coefficient of correlation. | | | |
| B | Rank correlation. | | | |
| C | Regression lines. | | | |
| | Mode of Examination | Theory | | |
| | Weightage distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text books | 1. Gupta,S.C and Kapoor,V.K, "Fundamental of Mathematical Statistics". | | |
| | Other references | 1. Daniel,WayneW.,"Biostatistics": Basic concept and Methodology for Health Science.<br>2. Grewal,B.S, "Higher Engineering Mathematics". | | |

## E6. Syllabus of Environmental Science (EVS106)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B. Sc** | | **Current Academic Year: 2019-20** |
| **Branch: Maths** | | **Semester: I** |
| 1 | Course Code | EVS-106 |
| 2 | Course Title | Environmental Science |
| 3 | Credits | 03 |
| 4 | Contact Hours (L-T-P) | 3-0-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Enable students to learn the concepts, principles and importance of environmental science<br>2. Provide students an insight of various causes of natural resource depletion and its conservation<br>3. Provide detailed knowledge of causes, effects and control of different types of environmental pollution and its effect on climate change, global warming and ozone layer depletion.<br>4. Provide knowledge of different methods of water conservation<br>5. Provide and enrich the students about social issues such as R&R, population and sustainability. |
| 6 | Course Outcomes | CO1.Understand the principles and scope of environmental science and natural resource management and conservation<br>CO2. Study about pollution causes, effects and control<br>CO3. Effect of global warming and ozone layer depletion<br>CO4. Study the methods of water conservation<br>CO5. Understand sustainable development, resettlement and rehabilitation, impact of population explosion on environment<br>CO6.Overall understanding of the various elements of environment and factors affecting environmental process and its related issues. |
| 7 | Course Description | Environmental Science emphasises on various factors as<br>1. Importance and scope of environmental science<br>2. Natural resource conservation<br>3. Pollution causes, effects and control methods<br>4. Social issues associated with environment |
| 8 | Outline syllabus | |
| | **Unit 1** | **General Introduction** |
| | A | Definition, principles and scope of environmental science |
| | B | Land resources, Forest Resources |
| | C | Water Resources ,Energy Resources |
| | **Unit 2** | **Environmental Pollution (Cause, effects and control measures)** |
| | A | Air pollution |

| | | | | |
|---|---|---|---|---|
| | B | Water Pollution | | |
| | C | Soil and Noise pollution | | |
| | **Unit 3** | **Climate Change and its impact** | | |
| | A | Concept of Global Warming and greenhouse effect | | |
| | B | Ozone layer Depletion and its consequences | | |
| | C | Climate change and its effect on ecosystem, Kyoto protocol and IPCC concerns on changing climate | | |
| | **Unit 4** | **Water Conservation** | | |
| | A | Need of Water Conservation | | |
| | B | Rain Water Harvesting | | |
| | C | Watershed management | | |
| | **Unit 5** | **Social Issues and the Environment** | | |
| | A | Concept of sustainable development | | |
| | B | Resettlement and rehabilitation of people; its problems and concerns, Case studies | | |
| | C | Population explosion and its consequences | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | **1.** Joseph, Benny, "Environmental Studies", Tata Mcgraw-Hill. | | |
| | Other References | | | |

## E7: Organic Chemistry-1 (BCH102)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B. Sc** | | **Current Academic Year: 2019-20** |
| **Branch: Chemistry** | | **Semester: 02** |
| 1 | Course Code | BCH 102 |
| 2 | Course Title | **Organic Chemistry-1 (C)** |
| 3 | Credits | 4.0 |
| 4 | Contact Hours (L-T-P) | (3 1 0) |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To introduce students to many of the key concepts of organic chemistry through a survey of the basic reactions types.<br>2. To promote understanding of basic facts and concepts and to inculcate interest in Organic chemistry.<br>3. To elaborate various electronic factors, an understanding of nucleophiles, electrophiles, electronegativity, and resonance, reaction intermediates and their effect on the course of organic reactions.<br>4. To discuss the theories of organic acids/bases, the concept of Formal charges and Curley Arrow rule.<br>5. To explain, classify and apply fundamental organic reactions such as SN2, SN1, E2, E1, alkene addition, electrophilic aromatic substitution, 1,2/1,4-additions to organic molecules.<br>6. To elaborate logical and detailed mechanisms for various fundamental reactions which involves nomenclature, physical properties, synthesis, reactions, of alkanes, alkenes, dienes, and alkynes.<br>7. To demonstrate the basics of Stereochemistry, Classify molecules as chiral or achiral, identify chiral carbons as (R) or (S), identify relationships between pairs of molecules as enantiomers, diastereomers, or equivalent, and identify when a solution is racemic versus optically active.<br>8. To provide knowledge of basics of organic chemistry, alkanes and cycloalkanes, alkenes and dienes, alkynes and stereochemistry. |
| 6 | Course Outcomes | Students will be able to:<br>CO1: explain many concepts like electronic displacement, bond fission, Reaction intermediates, curly arrow rule, nucleophilicity etc.<br>CO2: understand the synthesis, reactions of alkanes, cycloalkanes and their mechanism<br>CO3: explain the synthesis, reactions of alkenes and dienes<br>CO4: summarize the physical and chemical properties of alkynes<br>CO5: explain and apply the concept of stereoisomerism and conformation<br>CO6: apply the basic concept of organic chemistry in synthesis & reactions of hydrocarbons and analyze the stereochemistry of hydrocarbons |

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| 7 | Course Description | Course emphasizing basic organic chemistry which encompasses various types of electronic displacement, reaction intermediates. Further this course enables the students to generalize the structure properties relationship of Alkanes, alkenes, alkynes and cycloalkane. It also gives in-depth idea to prepare various above compounds by different methods. It also covers the basic information about stereoisomerism. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Basics of Organic Chemistry** |
| | A | Electronic Displacements- Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Homolytic and Heterolytic fission with suitable examples, |
| | B | Reaction Intermediates types, shape and relative stability of carbocations, carbanions, free radicals and carbenes Dipole moment; Organic acids and bases; their relative strength.. |
| | C | Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity.<br>Introduction to types of organic reactions and their mechanism: Addition, Elimination, Substitution and rearrangement reactions. |
| | **Unit 2** | **Alkanes and Cycloalkanes** |
| | A | Alkanes- Methods of synthesis (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids & their salts) |
| | B | Chemical reactions: Nitration, Halogenation, Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity. |
| | C | Cycloalkanes- Nomenclature, synthesis, relative stability-Baeyer Strain Theory, physical properties & Chemical properties. |
| | **Unit 3** | **Alkenes and Dienes** |
| | A | Methods of synthesis, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration, The Saytzeff rule, Hofmann elimination, |
| | B | Relative stabilities of alkenes Chemical reactions – hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration, oxidation, oxymercuration-reduction. |
| | C | Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, polymerization.<br>Dienes, Relative stability of dienes, Conjugated dienes, 1,2 and 1,4 additions. |
| | **Unit 4** | **Alkynes** |
| | A | Methods of synthesis, chemical reactions, acidity of terminal alkynes, |
| | B | Mechanism of electrophilic and nucleophilic addition reactions |
| | C | Hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization. |
| | **Unit 5** | **Stereochemistry** |

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|---|---|---|---|---|
| | A | Concept of isomerism and its types, Projection: Newman projection and Sawhorse formulae, Fischer and flying wedge formulae and their interconversion, Difference between conformation and configuration. | | |
| | B | Conformational isomerism in ethane, n-butane and unsubstituted cyclohexane (axial and equatorial bonds),<br>Optical isomerism –Molecular chirality, enantiomers, stereogenic center, optical activity, chiral and achiral molecules with one & two stereogenic centers | | |
| | C | Disasteromers, meso compounds, Absolute configuration, sequence rules, R & S systems of nomenclature.<br>Geometric isomerism – cis/trans, E/Z system of nomenclature, geometric isomerism in alicyclic compounds. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1. Organic Chemistry by Solomon & Fryhle.<br>2. Advanced Organic Chemistry by Bahl and Bahl.<br>3. Organic Chemistry by Morrison and Boyd.<br>4. Stereochemistry of carbon compounds; E. L. Eliel.<br>5. Stereo Chemistry: Conformation and Mechanism; D. Nasipuri.<br>6. Stereochemistry: conformation and Mechanism; P. S. Kalsi.<br>7. Conformational analysis; Eliel, Allinger, Angyal and Morrison. | | |

# E8: Organic Chemistry-III (BCH 302)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc.** | | **Current Academic Year: 2019-20** |
| **Branch: Chemistry** | | **Semester: 5** |
| 1 | Course Code | **BCH302** |
| 2 | Course Title | **ORGANIC CHEMISTRY-III (C)** |
| 3 | Credits | 4.0 |
| 4 | Contact Hours (L-T-P) | (3-1-0) |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Cultivate an appreciation of the role of organic chemistry in everyday life and in biological systems. Particular emphasis will be placed upon identification and core properties of oxygen, sulfur and nitrogen organic functional group chemistry.<br>2. Understand name reactions and their mechanisms of oxygen, sulfur and nitrogen organic functional groups.<br>3. Discuss the physical and chemical properties and main reactions of oxygen containing carbonyl group compounds.<br>4. Identify mono/di carboxylic group, discuss physical properties and characteristic reactions of carboxylic acids. To illustrate synthesis of an ester using Fischer esterification.<br>5. Discuss the structure and reactivity of nitrogen-containing organic compounds.<br>6. Create fundamental and critical analysis about carbonyl compounds, carboxylic acids and their derivatives, sulphur containing functional groups, nitrogen containing functional groups and heterocyclic compounds. |
| 6 | Course Outcomes | CO1: Employ the chemical reactions of all above functional groups to propose multistep syntheses of a wide variety of organic compounds.<br>CO2: Learn nucleophilic reactions of carbonyl compounds.<br>CO3: Compare the structures, functions, and key chemical reactions of the principal groups of carbonyl compounds, carboxylic acids, thiols, amines, nitrile, isonitriles and sulphonic acids.<br>CO4: Applications of carbonyl compounds, carboxylic acids, thiols, amines, nitrile, isonitriles and sulphonic acids.<br>CO5: Contrast structure and properties of heterocyclic compounds pyrrole, furan, thiophene and pyridine. |

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| | | CO6: Develop understanding and critical thinking about carbonyl compounds, carboxylic acids and their derivatives, sulphur containing functional groups, nitrogen containing functional groups and heterocyclic compounds. |
| 7 | Course Description | Organic Chemistry-III includes chemistry of carbonyl compounds, carboxylic acids and their derivatives, sulphur and nitrogen containing functional groups and heterocyclic compounds. It provides details knowledge of synthesis, structure and chemical properties. It gives detailed understanding of various mechanism of transformation of substrate into the product. It also discusses the synthesis, reaction and mechanism of substitution reaction of Furan, Pyrrole, Thiophene, Pyridine. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Carbonyl Compounds** |
| | A | Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism. Mechanisms of Aldol and Benzoin condensation, |
| | B | Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions |
| | C | Oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. |
| | **Unit 2** | **Carboxylic Acids and their Derivatives** |
| | A | Preparation, physical properties and reactions of monocarboxylic acid, Preparation and reactions of acid chlorides, anhydrides, esters and amides, Acetoacetic ester: keto-enol tautomerism, preparation by Claisen condensation, Acid hydrolysis and ketonic hydrolysis |
| | B | Comparative study of nucleophilic sustitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions |
| | C | Hofmann-bromamide degradation and Curtius rearrangement. Preparation of Dicarboxylic acid (succinic acid and adipic acid), Typical reactions of dicarboxylic acids. |
| | **Unit 3** | **Sulphur containing functional groups** |
| | A | Preparation and reactions of thiols, thioethers, Structure & preparation sulphonic acids |
| | B | Physical & Chemical properties. Derivatives of sulphonic acids. |
| | C | Uses: Benzene Sulphonamide, Saccharin. |
| | **Unit 4** | **Nitrogen Containing Functional Groups** |
| | A | Preparation and important reactions of nitro compounds, nitriles and isonitriles, Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis |
| | B | Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive, Curtius & Schimidt, methylation, Hofmann-elimination reaction |

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| | C | Distinction between 1°, 2°and 3°amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications. | | |
| | **Unit 5** | **Heterocyclic Compounds** | | |
| | A | Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom | | |
| | B | Synthesis, reactions and mechanism of substitution reactions of: Furan | | |
| | C | Synthesis, reactions and mechanism of substitution reactions of: Pyrrole, Thiophene, Pyridine. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |
| | Text book/s* | 1.Organic Chemistry by Solomon & Fryhle.<br>1.Advanced Organic Chemistry by Bahl and Bahl.<br>2.Organic Chemistry by Morrison and Boyd.<br>3.Organic Chemistr, Vol.I by Finar.<br>4.Heterocyclic Chemistry by Joule & Mills. | | |

## E9: Inorganic Chemistry-I (BCH 201)

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|---|---|---|
| **School: SBSR** | | **Batch : 2019-22** |
| **Program: B.Sc** | | **Current Academic Year: 2019-20** |
| **Branch:Chem (H)** | | **Semester:3rd** |
| 1 | Course Code | BCH201 |
| 2 | Course Title | Inorganic Chemistry-I |
| 3 | Credits | 4 |
| 4 | Contact Hours (L-T-P) | 3-1-2 |
| | Course Status | Compulsory /Elective/Open Elective |
| 5 | Course Objective | 1. To provide the basics of structure of atoms and the basics of theories involve there in.<br>2. To introduce the concept of ionic bonding of solids and the different factors that affect ionic bonding.<br>3. To illustrate the importance of covalent bonding and its usefulness in predicting fundamental properties of the molecules.<br>4. To explain to the student about shapes of a covalent molecule<br>5. To provide an introduction to the basic concepts in Molecular Orbital Theory and apply them to understand and compare the stability and reactivity of the molecules.<br>6. To introduce other types of non-covalent interaction that could be present in a molecule. |
| 6 | Course Outcomes | The student will be able to<br>CO1 :understand the various theories to describe atomic structure<br>CO2 :know about ionic bonding, significance and factors affecting the strength of ionic bonding<br>CO3: explain the basis of covalent bonding in molecules<br>CO4 : explain the basics of M.O Theory<br>CO5: explain about band theory of solids and non-covalent interactions present in them<br>CO6 :gain insight about various ionic, covalent and non-covalent interactions that are present in the molecule and their structural studies |
| 7 | Course Description | This course describes the basic theories involved in atomic structure and chemical bonding. This course satisfies the requirement of B.Sc chemistry honors' programme. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Atomic Structure** |
| | A | Bohr's theory, its limitations and atomic spectrum of hydrogen atom. |
| | B | Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of $\psi$ and $\psi^2$. Quantum |

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| | | numbers and their significance. Radial and angular wave functions for hydrogen atom. | | |
| | C | Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, | | |
| | **Unit 2** | **Chemical Bonding-I** | | |
| | A | Ionic bond and factors affecting ionic bond; lattice energy and its calculation by Born-Haber cycle.Madelung constant, | | |
| | B | solvation energy, factors affecting solvation energy and solubility of ionic solids. | | |
| | C | Polarizing power and polarizability; Ionic Potential, Fajan's rules. | | |
| | **Unit 3** | **Chemical Bonding-II** | | |
| | A | Covalent bonding: Concept of Hybridization, Extent of d-orbital participation in molecular bonding ($SO_2$, $PCl_5$, $SO_3$). | | |
| | B | Bent's Rule, Resonance in Inorganic molecules and ions, VSEPR theory, Shortcomings of VSEPR theory, | | |
| | C | Prediction of structures and variation of bond angles on the basis of VSEPR theory, prediction of hybridization and shapes of simple inorganic molecules and ions such as $NH_3$, $H_3O^+$, $SF_4$, $ClF_3$, $ICl_2^-$, and $H_2O$ by valence shell electron pair repulsion (VSEPR) theory. | | |
| | **Unit 4** | **Chemical Bonding-III** | | |
| | A | Valence bond theory - A mathematical approach and its limitations, directional characteristics of covalent bond. Molecular orbital theory (LCAO method) | | |
| | B | Symmetry of molecular orbitals, Applications of MOT to homo- and hetero-nuclear diatomic molecules, | | |
| | C | Molecular orbital energy level diagrams ($He_2$, $B_2$, $C_2$, $Be_2$, $N_2$, $O_2$, $F_2$, NO, CO, HF, $CN^-$), Applications of MO theory to explain the stability of homo and hetero dinuclear diatomic molecules. | | |
| | **Unit 5** | **Chemical Bonding-IV** | | |
| | A | Polar covalent bonds, Dipole moment. | | |
| | B | Hydrogen bonding and its effect on the physical and chemical properties of compounds of the main group elements. van der Waal's forces (dipole-dipole interactions, ion-dipole interactions, ion-induced dipole interactions) | | |
| | C | Metallic bonding: Band theory and its illustration. | | |
| | Mode of examination | Theory | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 30% | 20% | 50% |

| | | |
|---|---|---|
| | Text book/s* | **References**<br>1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991. |
| | Other References | 1. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970<br>2. Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.<br>3. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.<br>5. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002. |

## 2.2.1 Template A2: Biological Science Lab-1 (Practical)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: I** |
| 1 | Course Code | BBC151 |
| 2 | Course Title | Biological Science Lab-I |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 0-0-2 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. The goal of this course is to introduce students to the fundamental knowledge of preparation of solutions, buffers.<br>2. Understand the principles of routine instruments in use.<br>3. The course will cover the qualitative estimations of biomolecules including carbohydrates, proteins, amino acids<br>4. Enhance the practical knowledge and result analysis skills |
| 6 | Course Outcomes | After completing the course the students will be-<br>CO1:Able to use lab instruments independently.<br>CO2: Able to prepare stock solutions, buffers etc .<br>CO3: Understand the basics of biomolecules and become familiar with qualitative estimations of carbohydrates.<br>CO4: Able to understand the biochemistry of reactions.<br>CO5: Able to analyse the results and understand the biochemical reactions involved.<br>CO6: Enhance the practical skills |
| 7 | Course Description | The course will give the fundamental knowledge and practical abilities in qualitative estimations of biomolecules. |
| 8 | Outline syllabus | |
| | **Unit 1** | **Practical based on lab instruments** |
| | | Preparation of stock solution, buffer etc |
| | **Unit 2** | **Practical related to –** carbohydrate estimations |
| | **Unit 3** | **Practical related to---** amino acid estimations. |
| | **Unit 4** | **Practical related to---** protein estimation |

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|---|---|---|---|---|
| | **Unit 5** | **Practical related to---**lipid estimation. | | |
| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |

## 2.2.2: Biological Science Lab-2 (Practical)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: II** |
| 1 | Course Code | BBC152 |
| 2 | Course Title | Biological Science Lab-2 |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 0-0-2 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To understand the basic concepts and methods behind Lambert-Beer's Law.<br>2. To undergo some quantitative estimation of proteins using standard methods<br>3. To apply some basic principle behind the quality control experiments of lipids(oils and fats)<br>4. To understand the principle and methods behind the isolation technique of proteins from different sources<br>5. To quantify unknown carbohydrates form different food sample. |
| 6 | Course Outcomes | After the completion of this course students will be able to<br>CO1.Know the importance of Beer Lamberts Law and how to use this graphical notation in different methods<br>CO2 .Understand and analyse the role of standard calibration curve and to how to use it for the estimation of unknown protein concentration from different food samples<br>CO3.Use the same quality control method in determining the acid value of Butter, mustard oil, coconut oil and olive oil<br>CO4. Know the different isolation techniqueand how to apply it in simple research or projects.<br>CO5.Analyze the result and estimate the concentration of Glucose and starch from different food samples<br>CO6. Understand, analyse and corelate the different methods for the quantitative estimation of carbohydrate, proteins and fat and apply them thoroughly in small projects or in research |
| 7 | Course Description | The course will give the fundamental knowledge and practical abilities in qualitative estimations of biomolecules. |
| 8 | Outline syllabus | |
| | **Unit 1** | To demonstrate the working principle of spectrophotometer |

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| | | To determine the Lambda maximum of the given solution | | |
| | **Unit 2and 5** | To prove and verify Beer's lambert's law using different concentrations of $KMnO_4$ and Potassium Dichromate | | |
| | | To determine the unknown protein using Folin - Lowry's method | | |
| | | To estimate the reducing sugar by nitro salicylic acid (DNS) method | | |
| | | To quantify total sugars using anthrone method | | |
| | | To determine unknown protein using biuret method. | | |
| | **Unit 3** | To determine the acid value of mustard oil, coconut oil, olive oil and butter | | |
| | | To determine the saponification value of the given oil sample | | |
| | **Unit 4** | To isolate the crude protein extract from germinating seeds and leaf | | |
| 9 | Mode of examination | Practical &Viva | | |
| 10 | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |
| 11 | Text book | | | |

## 2.2 .3: Biological Science Lab-3 (Practical)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: I** |
| 1 | Course Code | BBC251 |
| 2 | Course Title | Biological Science Lab-3 |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 0-0-2 |
| | Course Status | Compulsory |
| 5 | Course Objective | To understand the working principle of various instruments use in laboratory.<br>2.To have a knowledge about the preparation of reagents, media and PAGE and agarose gel.<br>3. To understand the basic principle and method followed in paper chromatography.<br>4. To understand plasmid isolation, purification.<br><br>5. To understand the principle behind proteins, nucleic acid separation and isolation |
| 6 | Course Outcomes | After the completion of this course students will be able to;<br>1. explain the principle and how to use instrument in laboratory.<br>2. make any kind of solutions, reagents/ buffers, media, PAGE and agarose gel of their own.<br>3. apply and explain the principles of experiments in research or mini projects.<br>4. execute the biochemical reactions and methods of plasmid isolation and purification.<br><br>5.explain biochemical reactions and methods associated with amino acids, proteins and nucleic acid<br>6. students will demonstrate a proficiency in knowledge of concepts in chemistry and biochemistry necessary to understand the underpinnings of biology. |

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| 7 | Course Description | The course will give the fundamental knowledge and practical abilities in qualitative estimations of biomolecules. | | |
| 8 | Outline syllabus | | | |
| | **Unit 1** | To prepare reagent/buffers require for sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE). | | |
| | | To Prepare SDS-PAGE gel. | | |
| | **Unit 2** | To analyse protein by SDS-PAGE gel electrophoresis. | | |
| | **Unit 3** | To separate and indentify amino acids by paper chromatography and determine $R_f$ (retention factor) value. | | |
| | **Unit 4** | To prepare Luria-Bertani (LB) broth and pouring of LB agar plate. | | |
| | **Unit 5** | To isolate bacterial colonies using the Quadrant Method**:** Streak Plate Procedure | | |
| | **Unit 4** | To Isolate plasmid DNA from 1-3 ml of bacterial culture (*E. coli* DH5α) by boiling lysis method. | | |
| | **Unit 4** | To determine the presence of DNA and quantify the size (length of the DNA molecule) of the product by an agarose gel electrophoresis. | | |
| | **Unit 3** | To determine the total protein concentration in a given sample by Bradford method. | | |
| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |
| | Text book | | | |

## 2.2.4 Molecular Biology Lab (Practical)

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|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: IV** |
| 1 | Course Code | BBC252 |
| 2 | Course Title | Molecular Biology Lab |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 0-0-3 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1.To understand the working principle of various instruments use in molecular biology lab.<br>2.To have a knowledge about the preparation of reagents and buffer for PAGE and agarose gel and its functions.<br>3. To understand the basic principle and method followed polymerase chain reaction.<br>4. To have a knowledge of competent cell preparation, transformation and plasmid isolation/purification.<br>5. To understand the principle behind western blot and DNA estimation |
| 6 | Course Outcomes | After the completion of this course students will be able to;<br>CO1. prepare chemical solution and reagents to the precision appropriate to the task.<br>CO2. accurately, safely and appropriately use all the equipment regularly used in DNA manipulation, including balances, pipettes, electrophoresis and centrifuges.<br>CO3. demonstrate knowledge of the biochemical basis underpinning the molecular biology techniques teach in the class/ workshop.<br>CO4. independently handle RNA extraction, reverse transcription, polymerase chain reaction, ligation, bacterial transformation, to DNA extraction, DNA mapping and primer design.<br>CO5. transformation of plasmids, extract protein, assess and quantify expression using Western blotting.<br>CO6. carry out molecular biology experiments and interpret the results, designing a strategy to circumvent potential failed experiments. |
| 7 | Course Description | To make students well versed with the theoretical concepts with experimentation |
| 8 | Outline syllabus | |

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| | **Unit 1** | To familiarize with how cells are made competent: Preparation of calcium competent *Escherichia coli*. | | |
| | | To perform heat-shock transformation method of gene transfer. | | |
| | **Unit 2** | To extract and purify plasmid DNA using alkaline lysis method. | | |
| | Unit 3 | To determine the presence of plasmid DNA and quantify the size (length of the DNA molecule) of the product by an agarose gel electrophoresis. | | |
| | | To design primer for amplifying gene by polymerase chain reaction. | | |
| | Unit4 | To amplify gene *in vitro* by polymerase chain reaction (PCR). | | |
| | Unit 5 | To perform electro-blotting of proteins from SDS-polyacrylamide gel. | | |
| | Unit 5 | To determine the antigens qualitatively by immunoblotting (western blotting) technique. | | |
| | Unit 5 | To determine the concentration of a given DNA sample using diphenylamine method. | | |
| | Unit 4 | To determine the melting temperature (Tm) of a given DNA sample using ultraviolet absorption. | | |
| | Unit 2 | To determine the presence of plasmid DNA and quantify the size (length of the DNA molecule) of the product by an agarose gel electrophoresis. | | |
| | Unit4 | To design primer for amplifying gene by polymerase chain reaction. | | |
| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |
| | Text book | | | |

## 2.2.5 : Enzymology Lab (Practical)

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|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: IV** |
| 1 | Course Code | BBC253 |
| 2 | Course Title | Enzymology Lab |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 0-0-3 |
| | Course Status | Compulsory |
| 5 | Course Objective | To understand the basic knowledge/concept about the enzyme activity i.e, how many substrates are converted into how many products in one minute<br>2.To have a deep understanding about the effect of various concentration of substrates on the activity of enzymes<br>3. To understand the role of p H in the overall activity of the enzyme<br>4. To calculate the various enzyme activity using the formula and to make a standard calibration curve of different known concentration of products on X axis with the absorbance of the products at its Lambda max on Y axis<br>5. To know the effect of time course of the reaction catalysed by the enzyme. |
| 6 | Course Outcomes | After the completion of this course students will be able to<br>1. Determine the various ways of calculating enzyme activity of alkaline phosphatase, alpha and beta amylase etc<br>2. Draw standard calibration curve of known concentration Vs Absorbance and from that they can determine the product released from the graph<br>3.Find the optimum temperature and p H at which the enzyme activity is maximum |

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| | | 4. Able to draw and interpret the Michaelis Menton hyperbolic curve and know the importance of pseudo order kinetics<br>5. Explain the effect of different concentration of substrates on the enzyme activity of various enzymes | | |
| 7 | Course Description | To make students well versed with the theoretical concepts with experimentation | | |
| 8 | Outline syllabus | | | |
| | **Unit 1,** | To determine the salivary amylase activity of person using non spectrophotometric method | | |
| | | To isolate crude form of the beta amylase enzyme from sprouted seeds using mechanical treatment method | | |
| | **Unit 2** | To determine the maltose released by the crude beta amylase enzyme isolated from germinated seeds using spectrophotometric method | | |
| | | To determine the effect of starch (Substrate) concentration on the activity and velocity of alpha amylase | | |
| | **Unit 3** | To determine the lambda maximum of the salicylic acid in the given mixture of enzymatic solution. | | |
| | | To determine the amount of cholesterol in the serum using enzymatic method | | |
| | | To extract crude form of papain from Papaya fruit and determine its enzyme activity | | |
| | **Unit 4and 5** | To study the time course of reaction catalyzed by alkaline phosphatase(EC 3.1.3.1) | | |
| | | To determine the activity of the enzyme catalase in a solution and observe the effects of heat and cyanide inhibitor upon this activity**.** | | |
| | | To determine the effect of p H on the activity of alkaline phosphatase | | |
| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |
| | Text book | | | |

## 2.2 .6: Genetics Lab (Practical)

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|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: IV** |
| 1 | Course Code | BBC351 |
| 2 | Course Title | Genetics Lab |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 0-0-3 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To make students well versed with the working principles of instruments and the techniques used in the course lab.<br>2. To provide thorough knowledge of formula and calculations used for the preparation of reagents, buffer and stock solutions required for specific experiments.<br>3. To understand the basic principle and methodology used in respective experiment<br>4. To provide knowledge of genetics involved in experiments pooled out as per theory syllabus.<br>5. To enhance the practical skills, precautions involved and the result interpretation. |
| 6 | Course Outcomes | After the completion of this course students will be able to;<br>CO1. Prepare chemical solution and reagents to the precision appropriate to the task.<br>CO2. Accurately, safely and appropriately use all the equipment regularly used including balances, pipettes, electrophoresis and centrifuges.<br>CO3.understand the theoretical concepts dealt in classes/ workshops/ seminars with hands on experience<br>CO4.Able to understand the basic concept of genetics<br>CO5. Able to understand the concept of polymorphism, cell division<br>CO6. to carry out, design, and interpret the results of the experiments |
| 7 | Course Description | To make students well versed with the theoretical concepts with experimentation |
| 8 | Outline syllabus | |

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| | **Unit 1,** | To study the Mendelian Traits in humans | | |
| | | Smear technique to observe Barr Body (sex chromatin) in the buccal epithelial cells of human females | | |
| | **Unit 2** | Investigation of Human Karyotypes | | |
| | | | | |
| | **Unit 3** | Analysis of Variable Number of Tandem Repeat Polymorphism using gene specific primers<br>(A)-Genomic DNA isolation | | |
| | | Analysis of Polymorphism using Variable Number of Tandem Repeat specific primers in human genome<br>(B)-Quantification by electrophoresis/ spectrophotometer (Absorbance at 260nm) | | |
| | | Analysis of Polymorphism using Variable Number of Tandem Repeat specific primers in human genome<br>Analysis of polymorphism using gene specific primers in PCR | | |
| | **Unit 4and 5** | Microscopic study of human blood smear | | |
| | | To study the effect of colchicine on the mitotic division of the root tip cells of onion root tips | | |
| | | | | |
| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |

## 2.2.7 : Immunology Lab (Practical)

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|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: IV** |
| 1 | Course Code | BBC352 |
| 2 | Course Title | Immunology Lab |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 0-0-3 |
| | Course Status | Compulsory |
| 5 | Course Objective | To understand the difference in the collection technique adopted while collecting serum and plama<br>2.To know the concept and understanding of some very important immuno technology like radial immunodiffusion and immunoprecipitation<br>3.To have a deep understanding of immune electrophoresis techniques and the quantification of antibody thereafter.<br>4.To know the details of blood grouping and also to find out the blood group of each and every student who are performing the experiments<br>5.To understand the concept behind shape and size of RBC,WBS and also have clear concept of the technique of ELISA |
| 6 | Course Outcomes | After the completion of this course students will be able to<br>CO1.Understand what is the function of serum and plasma in our body and how these are separated from each other.<br>CO2.Corelate and also understand the application behind some of the most widely used immune techniques like radial immunodiffusion etc<br>CO3. Write and understand why electrophoresis is done with antibody amd what is the relevance out of it.<br>CO4.Able to find out very quickly about own;s blood group and the details of these blood grouping |

| | | | | |
|---|---|---|---|---|
| | | CO5.Corelate and understand enzyme linked immunosorbent assay and how to use this technique to determine the unknown antigen<br>CO6.Understand, analyse the overall technology behind immunology and use them in various other fields like clinical immunology and also in projects | | |
| 7 | Course Description | To make students well versed with the theoretical concepts with experimentation | | |
| 8 | Outline syllabus | | | |
| | **Unit 1,** | To separate plasma and serum from blood using anti-coagulant method | | |
| | | To determine the blood group of the given sample using antisera A, B and H | | |
| | **Unit 2** | To perform immunohistochemical staining for tissues | | |
| | | To demonstrate the DOT ELISA | | |
| | **Unit 3** | To observe the shape and morphology of white blood cells using light microscope | | |
| | | To count the number of red blood cells and white blood cells using haemo cytometer | | |
| | **Unit 4and 5** | To perform immune electrophoresis and quantify the antibody | | |
| | | To perform immunoprecipitation and determine protein A beads | | |
| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |

## 2.2.8: Genetic Engineering Lab (Practical)

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: IV** |
| 1 | Course Code | BBC354 |
| 2 | Course Title | Genetic Engineering Lab |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 0-0-3 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To understand the working principle of various instruments used in molecular biology lab.<br>2. To have a knowledge about the preparation of stock solutions, reagents and buffers.<br>3. To understand the background of each experiment for clear concepts of recombinant DNA technology<br>4. To enhance the practical skills amd understand the precautions involved with hands on experience.<br>5. To understand, design and analyse the results of experiments. |
| 6 | Course Outcomes | After the completion of this course students will be able to;<br>1. prepare chemical solution and reagents to the precision appropriate to the task.<br>2. accurately, safely and appropriately use all the equipment regularly used in DNA manipulation, including balances, pipettes, electrophoresis and centrifuges.<br>3. demonstrate the knowledge of the molecular biology and the tools and techniques in biochemistry to understand the recombinant DNA technology<br>4. independently handle RNA extraction, reverse transcription, polymerase chain reaction, ligation, bacterial transformation5. transformation of plasmids, extract protein, assess and quantify expression using Western blotting.<br>Carry out DNA and RNA isolation, quantification, agarose gel electrophoreses, advanced multiplex PCR, gradient PCR etc |

| | | | | |
|---|---|---|---|---|
| | | 6. carry out molecular biology experiments and interpret the results, designing a strategy to circumvent potential failed experiments | | |
| 7 | Course Description | To make students well versed with the theoretical concepts with experimentation | | |
| 8 | Outline syllabus | | | |
| | **Unit 1** | Extraction of proteins from bacterial sample (E. coli) | | |
| | | To extract and purify total human DNA from whole frozen blood | | |
| | **Unit 2** | To separate proteins on a denaturing Polyacrylamide gel and visualize the separated proteins by Coomassie Brilliant Blue stain. | | |
| | | To isolate total RNA from the given bacterial culture | | |
| | **Unit 3** | Separation of RNA using Formaldehyde-Agarose Gels | | |
| | | To digest the pUC18 DNA(or any plasmid) with BamH1 enzyme | | |
| | | To perform the ligation of linearized T-vector with DNA fragment or the ligation of any restriction enzyme digested DNA fragments using T4 DNA ligase | | |
| | **Unit 4and 5** | **Multiplex Polymerised Chain Reaction (PCR) using gene specific primers PART (A): Multiplex PCR** | | |
| | | **Multiplex Polymerised Chain Reaction (PCR) using gene specific primers PART (A): Visualization of bands by AGE** | | |
| | | | | |
| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |

### 2.2.9: Bioinformatics Lab

| | | |
|---|---|---|
| **School: SBSR** | | **Batch: 2019- 2022** |
| **Pogram: B.Sc.(H)** | | **Current Academic Year: 2019-20** |
| **Branch: Biochemistry** | | **Semester: IV** |
| 1 | Course Code | BBC355 |
| 2 | Course Title | BioinformaticsLab |
| 3 | Credits | 3 |
| 4 | Contact Hours (L-T-P) | 0-0-3 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. To acquire a fundamental knowledge of basic computational biology<br>2. To study, design and analyze in silico experiments.<br>3. To learn the procedure of sequence alignment and its application in molecular phylogenetics.<br>4. To understand different techniques used for gene prediction and creation of biological data bases |
| 6 | Course Outcomes | CO1: Review different biological databases and softwares required for computational biology.<br>CO2: Integrate data, perform DNA sequencing and interpret the results.<br>CO3: Predict protein structure, function and folding, Compute DNA-protein interaction and apply the information in drug designing.<br>CO4: Design and predict the function of proteins and genes by different algorithms. Apply different techniques for gene prediction and motifs identification. Design experiments to find ESTs and SNPs.<br>CO5: Perform genomic sequencing and determine transcription factor computational biology. Retrieve date using different databases (NCBI, EMBL, SwissPort).<br>CO6: Understanding of a computational biology for prediction analysis |
| 7 | Course Description | To make students well versed with the theoretical concepts with experimentation |
| 8 | Outline syllabus | |
| | **Unit 1,** | To review different biological database freely available online |
| | | |
| | **Unit 2** | Integrate data and perform DNA sequencing and interpret results |
| | | Primer designing |
| | **Unit 3** | To retrieve data using NCBL, EMBL, SwissPort |
| | | Gene prediction analysis and identification of motifs |
| | | Prediction of protein structure, function and folding |
| | **Unit 4and 5** | Design experiment to find ESTs and SNPs |
| | | To understand DNA-protein interaction and application in drug designing |

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| | Mode of examination | Practical &Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |

## E2.1: Chemistry Lab-1 (Practical)

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|---|---|---|---|
| **School: SBSR** | | **Batch: 2019-22** | |
| **Program: BSc. (H)** | | **Current Academic Year: 2019-20** | |
| **Branch: Chemistry** | | **Semester: 1** | |
| 1 | Course number | **BCH-151** | |
| 2 | Course Title | **Chemistry Lab-I** | |
| 3 | Credits | 1 | |
| 4 | Contact Hours (L-T-P) | 0-0-2 | |
| 5 | Course Objective | To learn methods for quantitative estimation of different chemical species by various volumetric methods and to understand calorimetric formula, heat capacity of calorimeter, water equivalent of calorimeter and enthalpy. | |
| 6 | Course Outcomes | 1. Able to prepare primary standard and secondary standard solutions.<br>2. Understand the importance of pH and pH meter.<br>3. Explain the cause of change in thermal energy of a system during any physical or chemical change.<br>4. Correlate the change in thermal energy with the heat lost or gained by the system.<br>5. Distinguish between heat capacity and water equivalent of calorimeter.<br>6. Able to understand the colligative properties.<br>7. Able to understand the concept Kinematic viscosity. | |
| 7 | Outline syllabus: | | |
| 7.01 | BCH151.01 | Task 1 | To prepare a standard solution of sodium carbonate ($Na_2CO_3$) and use it to standardise a given solution of HCl. |
| 7.02 | BCH151.02 | Task 2 | To determine the strength of given HCl solution by titrating it against 0.1 N $Na_2CO_3$ solution pH metrically. |
| 7.03 | BCH 151.03 | Task 3 | To determine the heat capacity of the calorimeter. |
| 7.04 | BCH 151.04 | Task 4 | To determine the enthalpy of neutralization of NaOH and HCl. |
| 7.05 | BCH 151.05 | Task 5 | To determine the enthalpy of hydration of anhydrous copper sulphate. |
| 7.06 | BCH 151.06 | Task 6 | Determination of integral enthalpy of solution of salts ($KNO_3$, $NH_4Cl$). |
| 7.07 | BCH 151.07 | Task 7 | Study the variation of viscosity of sucrose solution with the concentration of solute using Ostwald viscometer. |
| 7.08 | BCH 151.08 | Task 8 | To demonstrate the colligative property of elevation in boiling point. |
| 7.09 | BCH 151.09 | Task 9 | To demonstrate the colligative property of depression in freezing point. |

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|---|---|---|---|
| 7.10 | BCH 151.10 | Task 10 | To demonstrate the phenomenon of osmosis using semi permeable membrane. |
| 8 | **Course Evaluation** | | |
| 8.1 | Course work: 100% marks | | |
| 8.11 | Attendance | None | |
| 8.12 | Homework | None | |
| 8.13 | Quizzes | None | |
| 8.14 | Labs | Evaluation of work done on each lab turn in the lab notebook and feedback from oral quiz about the work done that day. Zero, if the student is absent. 0.75N best marks out of N such evaluations: 100 marks | |
| 8.15 | Presentations | None | |
| 8.16 | Any other | None | |
| 8.2 | MTE | None | |
| 8.3 | End-term examination: None | | |
| 9 | **References** | | |
| 9.1 | Text book | O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co. | |
| 9.2 | Other References | 1. Eastman. E.D. and Rollefson, G.K. *Physical Chemistry* 1947 ed. McGraw-Hill p307.<br>2. Pauling, Linus: *General Chemistry* 1970 ed. Dover Publications pp459-460.<br>3. Moore, Walter J. *Physical Chemistry* 1962 ed. Prentice Hall p132. | |

## E2.2: Chemistry Lab-II (BCH 152)

| | | | |
|---|---|---|---|
| **School: SBSR** | | **Batch: 2019-22** | |
| **Program: BSc. (H)** | | **Current Academic Year: 2019-20** | |
| **Branch: Chemistry** | | **Semester: 1I** | |
| 1 | Course number | **BCH-152** | |
| 2 | Course Title | **Chemistry Lab-II** | |
| 3 | Credits | 1 | |
| 4 | Contact Hours (L-T-P) | 0-0-2 | |
| 5 | Course Objective | • To learn methods for, purification and qualitative analysis of organic compounds<br>• To execute independently purification techniques to organic compounds like filtration, recrystallization, sublimation and distillation.<br>• To perform the qualitative test on unknown organic compounds i.e preliminary tests, tests for extra elements.<br>• To understand the basic concept of quantitative analysis for organic compounds<br>• To understand the concept of organic acid and perform the acid base titration to calculate their solubility in solvents at room temperature. | |
| 6 | Course Outcomes | Students are able to<br>• Understand the methods of separation and purification<br>• Understand the Qualitative analysis of organic compounds<br>• Prepare solutions of different strength and standardize them<br>• Execute the volumetric analysis experiments for organic compounds | |
| 7 | Outline syllabus: | | |
| 7.01 | **BCH-152**.01 | Task 1 | To check the solubility of organic compounds and Filtration/Purification of organic compounds by recrystallization using: Water solvent (Phthalic acid, Benzoic acid), Determination of the melting points of above compounds and report the yields of pure compounds. |
| 7.02 | **BCH-152**.02 | Task 2 | To check the solubility of organic compounds and Filtration/Purification of organic compounds by recrystallization using Alcohol (naphthalene), Determination of the melting points of above compounds and report the yields of pure compounds. |
| 7.03 | **BCH-152**.03 | Task 3 | To check the solubility of organic compounds and Filtration/Purification of organic compounds by recrystallization Alcohol-Water (Aspirin from tablet), |

| | | | |
|---|---|---|---|
| | | | Determination of the melting points of above compounds and report the yields of pure compounds. |
| 7.04 | **BCH-152**.04 | Task 4 | To perform the purification of crude naphthalene by sublimation method and calculate the percentage yield and M.P.. |
| 7.05 | **BCH-152**.05 | Task 5 | Purification of organic compounds(Water + acetone) by simple distillation. |
| 7.06 | **BCH-152**.06 | Task 6 | Elimination reaction of 2-pentanol |
| 7.07 | **BCH-152**.07 | Task 7 | Cycloaddition reaction of Cyclopentadiene and maleic anhydride |
| 7.08 | **BCH-152**.08 | Task 8 | To To Analyze the presence of extra elements (N, S, halogens) other than C, H, &O in the given organic compound. |
| 7.09 | **BCH-152**.09 | Task 9 | To To Analyze the presence of extra elements (N, S, halogens) other than C, H, &O in the given organic compound. |
| 7.10 | **BCH-152**.10 | Task 10 | To determine the solubility of given organic acid(oxalic acid |
| 8 | **Course Evaluation** | | |
| 8.1 | Course work: 100% marks | | |
| 8.11 | Attendance | None | |
| 8.12 | Homework | None | |
| 8.13 | Quizzes | None | |
| 8.14 | Labs | Evaluation of work done on each lab turn in the lab notebook and feedback from oral quiz about the work done that day. Zero, if the student is absent. 0.75N best marks out of N such evaluations: 100 marks | |
| 8.15 | Presentations | None | |
| 8.16 | Any other | None | |
| 8.2 | MTE | None | |
| 8.3 | End-term examination: None | | |
| 9 | References | | |
| 9.1 | Text book | O.P. Pandey, D.N. bajpai, S.Giri, " Practical Chemistry", S. Chand & Co. | |
| 9.2 | Other References | Vogel's "Textbook of quantitative Analysis", Pearson. | |

## E2.3: Chemistry Lab-III (BCH 251)

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|---|---|---|---|
| **School: SBSR** | | **Batch: 2019-22** | |
| **Program: BSc. (H)** | | **Current Academic Year: 2019-20** | |
| **Branch: Chemistry** | | **Semester: 1II** | |
| | Course number | **BCH-251** | |
| 2 | Course Title | **Chemistry Lab-III** | |
| 3 | Credits | 1 | |
| 4 | Contact Hours (L-T-P) | 0-0-2 | |
| 5 | Course Objective | 1. To learn the methods for calibration of laboratory glass wares used in experiments.<br>2. To understand the method of solutions of different normality and Molarity.<br>3. To understand the process of standardization of a given solution.<br>4. To understand the concept of redox titration and the reactions involved<br>5. To perform the qualitative analysis of inorganic compounds.<br>6. To identify cations and anions in a given mixture.<br>7. To execute independently the determination of flash point of a given oil.<br>8. To determine the calorific value of any given material by bomb calorimeter. | |
| 6 | Course Outcomes | Students will be able to<br>1. Calibrate the burette and pipette used to get the results with zero error.<br>2. Prepare the solutions of any given normality and strength.<br>3. Understand the estimation of mixture of salts.<br>4. Standardise NaOH with oxalic acid.<br>5. Understand the reactions involved in redox titrations.<br>6. Measure the calorific value of any given fuel.<br>7. Understand the process of determination of flash point and fire point. | |
| 7 | **Outline syllabus:** | | |
| 7.01 | BCH **251**.01 | Task 1 | To calibrate the lab apparatus and preparation of solutions of different Molarity/Normality of titrants. |
| 7.02 | BCH **251**.02 | Task 2 | To standardization of NaOH with standard Oxalic acid |
| 7.03 | BCH **251**.03 | Task 3 | To estimate the carbonate and hydroxide present together in mixture. |
| 7.04 | BCH **251**.04 | Task 4 | To estimate of Fe(II) and oxalic acid using standardized KMnO4 solution. |
| 7.05 | **BCH-251**.05 | Task 5-8 | **Semi-micro qualitative analysis using H2S of mixtures** - not more than two ionic species (one anion and one cation and excluding insoluble salts) out of the following: Cations : NH4+, Pb2+, Ag+, |

| | | | |
|---|---|---|---|
| | | | Bi3+, Cu2+, Cd2+, Sn2+, Fe3+, Al3+, Co2+, Cr3+, Ni2+, Mn2+, Zn2+,Ba2+, Sr2+, Ca2+, K+ Anions : CO32– , S2–, SO2–, S2O32–, NO3–, CH3COO–, Cl–, Br–, I–, NO3–,SO42-, PO43-, BO33- ,C2O42-, F- (Spot tests should be carried out wherever feasible**)** |
| 7.06 | BCH **251**.05 | Task 9 | To detect flash point and fire point of a lubricant. |
| 7.07 | BCH **251**.07 | Task 10 | To determine the calorific value of a fuel using Bomb Calorimeter. |
| 8 | **Course Evaluation** | | |
| 8.1 | Course work: 100% marks | | |
| 8.2 | Attendance | None | |
| 8.3 | Homework | Yes | |
| 8.4 | Quizzes | Yes | |
| 8.5 | Labs | Evaluation of work done on each lab turn in the lab, notebook and feedback from oral quiz about the work done that day, punctuality, interaction. Zero, if the student is absent. 0.75N best marks out of N such evaluations: 60 marks | |
| 8.6 | Presentations | None | |
| 8.7 | Any other | None | |
| 8.8 | MTE | None | |
| 8.9 | End-term examination: Yes, 40 marks | | |
| 9 | References | | |
| 9.1 | Text book | O.P. Pandey, D.N. bajpai, S.Giri, " Practical Chemistry", S. Chand & Co. | |
| 9.2 | Other References | Vogel's "Textbook of quantitative Analysis", Pearson. | |

## 3.1: Project I

| | | | | |
|---|---|---|---|---|
| **School: SBSR** | | **Batch :2019- 2022** | | |
| **Program: B.Sc. (Hons)** | | **Current Academic Year: 2019-20** | | |
| **Branch: Biochemistry** | | **Semester: V** | | |
| 1 | Course Code | BBC353 | | |
| 2 | Course Title | Project I | | |
| 3 | Credits | 3 | | |
| 4 | Contact Hours (L-T-P) | 0-0-3 | | |
| | Course Status | Compulsory/Elective | | |
| 5 | Course Objective | 1. Deep knowledge of a specific area of specialization by literature search<br>2. Develop research/ experimentation skills as well as enhancing project writing and oral presentation skills.<br>3. Inculcate team spirit and time management. | | |
| 6 | Course Outcomes | CO1: The course basically introduce the various levels of research within the subject including literature search , developing their deeper interest / inquisitiveness in biochemistry and interdisciplinary subjects<br>CO2: Cultivate the understanding of problem, study design, methodology/ experimentation , significance of reproducibility of results<br>CO3: Uunderstanding of ethics of science and research for supporting higher studies.<br>CO4: Learn effective project organizational skills along with discussions, result interpretation. and paper writing | | |
| 7 | Course Description | This course provides the applied knowledge of biochemistry and gives confidence and a solid foundation for future learning | | |
| 8 | Outline syllabus | | | |
| | **Unit 1** | **Introduction of subject / Literature search** | | |
| | **Unit 2** | **Concept building and Study designing** | | |
| | **Unit 3** | **Experimentation / Standardization of techniques** | | |
| | **Unit 4** | **Data collection, Discussions and result interpretation** | | |
| | **Unit 5** | **Report writing** | | |
| | Mode of examination | Presentation and Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |
| | Text book/s* | - | | |
| | Other References | Pubmed Search (NCBI)<br>Review and research articles of Indexed Journals | | |

## 3.2: Project II

| | | | | |
|---|---|---|---|---|
| **School: SBSR** | | **Batch :2019- 2022** | | |
| **Program: B.Sc.(Hons)** | | **Current Academic Year: 2019-20** | | |
| **Branch: Biochemistry** | | **Semester: VI** | | |
| 1 | Course Code | BBC356 | | |
| 2 | Course Title | Project II | | |
| 3 | Credits | 3 | | |
| 4 | Contact Hours (L-T-P) | 0-0-3 | | |
| | Course Status | Compulsory/Elective | | |
| 5 | Course Objective | 1. Deep knowledge of a specific area of specialization by literature search.<br>2. Develop research/ experimentation skills as well as enhancing project writing and oral presentation skills<br>3. Inculcate team spirit and time management. | | |
| 6 | Course Outcomes | CO1: The course basically introduce the various levels of research within the subject including literature search , developing their deeper interest / inquisitiveness in biochemistry and interdisciplinary subjects<br>CO2: Cultivate the understanding of problem, study design, methodology/ experimentation , significance of reproducibility of results<br>CO3: Uunderstanding of ethics of science and research for supporting higher studies.<br>CO4: Learn effective project organizational skills along with discussions, result interpretation. and paper writing | | |
| 7 | Course Description | This course inculcates the applied knowledge of biochemistry and provides a confidence and a solid foundation for future learning | | |
| 8 | Outline syllabus | | | |
| | **Unit 1** | **Introduction of subject/ literature search** | | |
| | **Unit 2** | **Concept building and study design** | | |
| | | | | |
| | **Unit 3** | **Experimentation/ Standardization of techniques** | | |
| | **Unit 4** | **Data collection, Discussions and result interpretation** | | |
| | **Unit 5** | **Report writing** | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |
| | Text book/s* | - | | |
| | Other References | Pubmed Search (NCBI)<br>Review and research articals of Indexed Journals | | |

## 2.23: Community Connect (CCU401)

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|---|---|---|---|---|
| **School: SBSR** | | **Batch :2019- 2022** | | |
| **Program: B.Sc.** | | **Current Academic Year: 2019-20** | | |
| **Branch: Biochemistry** | | **Semester: II** | | |
| 1 | Course Code | CCU401 | | |
| 2 | Course Title | Community Connect | | |
| 3 | Credits | 2 | | |
| 4 | Contact Hours (L-T-P) | 2-0-0 | | |
| | Course Status | Compulsory | | |
| 5 | Course Objective | 1. To expose our students to different social issues faced by the people in different sections of society.<br>2. To connect their class-room learning with problem solving skills in real life scenario. | | |
| 6 | Course Outcomes | After completion of this course students will be able to:<br>CO1. Recognise social problems prevailing in different sections of society and finding the solution in sustainable manner.<br>CO2. Get practical exposure of all round development which complements their class room learning<br>CO3. These activities will add value to students, faculty members, school and university.<br>CO4.Foster the development of a sense of caring for others.<br>CO5.Make valuable contributions to communities through active participation.<br>CO6.Structure time to think, talk, or write about their experiences with the service activity. | | |
| 7 | Course Description | In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc. | | |
| 8 | Outline syllabus | | | |
| | **Unit 1** | **Introduction to the Topic** | | |
| | **Unit 2** | **Drafting the questionnaire** | | |
| | **Unit 3** | **Survey** | | |
| | **Unit 4** | **Data collection, Discussions and result interpretation** | | |
| | **Unit 5** | **Report writing and Presentation** | | |
| | Mode of examination | Presentation and Viva | | |
| | Weightage Distribution | CA | MTE | ETE |
| | | 60% | 0% | 40% |
| | Text book/s* | - | | |
| | Other References | The entries in the list should be in alphabetical order. | | |

| | | |
|---|---|---|
| | | Journal article<br>Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995)<br>Article by DOI<br>Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z<br>Book<br>Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992)<br>Book chapter<br>Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002)<br>Online document<br>Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007<br>Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see<br>www.issn.org/2-22661-LTWA-online.php<br>For authors using End Note, Springer provides an output style that supports the formatting of in-text citations and reference list.<br>End Note style (zip, 2 kB) |