

**DELHI PHARMACEUTICAL SCIENCES AND
RESEARCH UNIVERSITY**

SCHOOL OF ALLIED HEALTH SCIENCES AND MANAGEMENT

**B.Sc.(Hons) Biomedical Science
(Effective from Academic Year 2022-23)**



Preamble

Any Higher Education Institute has an objective to prepare their students for serving the society at large. The DPSR University envisions all its courses and programs in the best interest of students. Continuous efforts are made to offer a new vision to all its Under-Graduate courses.

The course curriculum of newly proposed course of B.Sc. (Hons) Biomedical science offers a comprehensive skill and knowledge based for the students keeping in view the employability of the students. The syllabus of this proposed course will take the advantage of credit system to progressively make transition from simple to complex concepts relevant to the interdisciplinary nature of undergraduate programs in biomedical sciences. DPSRU is very much hopeful that the course curriculum of this new course of B.Sc. (Hons) Biomedical science will help the students in making informed decisions regarding goals that they wish to pursue in further education and life at large.

Introduction to B.Sc. (Hons) Course in Biomedical Science

The course will be structured to reinforce the basic exposure that students get in the higher secondary school and to gradually build on this knowledge-base. The course will comprise of core courses in the first two semesters which will provide introduction to courses in organic chemistry relevant to biology, cell biology, human physiology, and bird's eye view on the functioning of organ system and importance of genetic in nature.

In the second year, knowledge base of the students will be further enhanced based on the introductory courses of Semester I and II. Emphasis will be given on basic understanding of bioorganic chemistry and the students will understand about proteins, and understanding of biochemical functioning. At the end of the second year, a student will have basic knowledge of cell biology, genetics, bioorganic chemistry, human physiology, biochemistry, medicinal chemistry, basic molecular and immuno-biology.

Along with this they will have hands-on training in medical lab techniques, epidemiological data analysis, tools used in forensic science and modern biology under the Skill enhancement courses (SEC). The concepts in pharmacology, medicinal chemistry, toxicology, pathology and biophysics are vital to Biomedical science and these are introduced in the final year of the course. In the third year, the courses include more complex concepts of mechanisms of achieving regulated functioning of the biological systems, biophysical principles of biological systems, human genetics, genome organization, medical biotechnology and biochemistry and some of the recent excitement in biology and the application of bioinformatics in Biomedical science as part of Discipline specific elective (DSE) courses along with project work. One or two papers in the final year therefore will have a longer list of learning material to be drawn from different sources; however, the actual length of the material for reading/teaching will be maintained optimal. This will also introduce the students to resources for self-study.

The Generic Elective (GE) courses will be designed to give the essential exposure to the interdisciplinary nature of Biomedical sciences. For example, biological chemistry, bioethics and biosafety, biostatistics, immunology, biotechnology, pharmacology and toxicology are combined into one paper, bioinformatics, IPR, pathophysiology combining human physiology in the context of diseases, tools and model organism in biomedical research are part of GE courses.

Aims of the B.Sc. (Hons) Biomedical Science Programme

The overall aim(s) of the Bachelor's degree in Biomedical science are:

To help develop an inherent interest in the field of Biomedical science. The course aims to enhance understanding of key concepts, theories and principles that will help them to find answers to challenges being faced today in Biomedical science. The course will help the students develop a broad base understanding of various fields that the bachelor's degree opens up for them, so that they can take up their field of specialization in higher studies.

To help students to develop thinking and application skills to apply the knowledge thus gained in finding practical solutions to present day challenges.

To inculcate true scientific temperament in students, such that they apply their knowledge in interdisciplinary fields like Bioinformatics, Biophysics, and Data Science.

Structure of B.Sc.(Hons) Biomedical science

1.1. Credit Distribution

The B.Sc. (Hons) in Biomedical Science Programme is a three-year course divided into six- semesters. A student is required to complete 148 credits for the completion of course and the award of degree.

| Semester | Core Course (CC) (6 Credits/ Paper) | | | Generic Elective (GE) Course (6 Credits/ Paper) | | | Skill-Enhancement Elective Course (SEC) (4 Credits/ Paper) | | | Discipline Specific Elective (DSE) Course (6 Credits/ Paper) | | | Total credit/ Semest er |
|--------------|--|------------------|------------------|---|------------------|------------------|--|------------------|------------------|--|------------------|------------------|----------------------------------|
| | No. of Papers | Credits (L+P) | Total Credits | No. of Papers | Credits (L+P) | Total Credits | No. of Papers | Credits (L+P) | Total Credits | No. of Papers | Credits (L+P) | Total Credits | |
| I* | 2 | 8+4 | 12 | 1 | 4+2 | 6 | - | - | - | - | - | - | 22* |
| II* | 2 | 8+4 | 12 | 1 | 4+2 | 6 | - | - | - | - | - | - | 22* |
| III | 3 | 12+6 | 18 | 1 | 4+2 | 6 | 1 | 2+2 | 4 | - | - | - | 28 |
| IV | 3 | 12+6 | 18 | 1 | 4+2 | 6 | 1 | 2+2 | 4 | - | - | - | 28 |
| V | 2 | 8+4 | 12 | - | - | - | - | - | - | 2 | 8+4 | 12 | 24 |
| VI | 2 | 8+4 | 12 | - | - | - | - | - | - | 2 | 8+4 | 12 | 24 |
| Total | 14 | 56+28 | 84 | 4 | 16+8 | 24 | 2 | 4+4 | 8 | 4 | 16+8 | 24 | 148* |

***Students will have two papers of 4 credits each of Ability Enhancement Compulsory Course (AECC- English/ MIL and EVS) one in each semester.**

For Theory (L): 1Credit = 1hour lecture and there will be 4 lectures/ week.

For Practical (P): 1 Credit = 2 hours

1.2 Semester-wise Distribution of Courses

| SEMESTER I | SEMESTER II |
|---------------------------------------|---------------------------------------|
| Bioorganic Chemistry | Principles of Genetics |
| Cell and Radiation Biology | Human Physiology and Anatomy I |
| Ability Enhancement Compulsory Course | Ability Enhancement Compulsory Course |
| Generic Elective | Generic Elective |
| SEMESTER III | SEMESTER IV |
| Biochemistry | Immunobiology |
| Human Physiology and Anatomy II | Molecular Biology |
| Medical Microbiology | Medicinal Chemistry |
| Skill-Enhancement Elective Course | Skill-Enhancement Elective Course |
| Generic Elective | Generic Elective |
| SEMESTER V | SEMESTER VI |
| Biophysics | Human Pathology |
| Pharmacology | Toxicology |
| Discipline Specific Elective | Discipline Specific Elective |
| Discipline Specific Elective | Discipline Specific Elective |

C: Core Courses; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill-Enhancement Elective Courses; **DSE:** Discipline Specific Elective; **GE:** Generic Elective

Generic Electives (any one per semester in semesters 1-2)

1. Basics of Immunology
2. Biological Chemistry
3. Biosafety and Bioethics
4. Biostatistics
5. Bridging Information Technology and Biotechnology
6. Concepts in Biotechnology

Generic Electives (any one per semester in semesters 3-4)

1. Concepts in Medicinal Chemistry and Drug Development
2. Intellectual Property Rights (IPR) for Biologists
3. Pathological Basis of Diseases
4. Pharmacology and Toxicology
5. Tools and Model Organisms in Biomedical Research

AECC: Ability Enhancement Compulsory Course (anyone per semester in semesters 1-2)

1. English Communication
2. Environmental Studies

SEC: Skill-Enhancement Elective Courses (anyone per semester in semesters 3-4)

1. Methods in Epidemiological Data Analysis (EDA)
2. Medical Laboratory Diagnostics (MLD)
3. Techniques for Forensic Science
4. Tools in Modern Biology

DSE: Discipline Specific Elective (any two per semester in semesters 5-6)

1. Computational Biology and Drug Design
2. Genome Organization and Function
3. Human Genetics
4. Medical Biochemistry
5. Medical Biotechnology
6. Project Work (can be chosen only in semester 6)

***Practicals: (Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)**

SEMESTER I

| Paper Code | Name of the subject | Credit Units | Internal | External | Total |
|--------------------|---|--------------|--------------------|------------|-------|
| BMS 101 T | Bioorganic chemistry | 4 | 20 | 80 | 100 |
| BMS 102 T | Cell and Radiation Biology | 4 | 20 | 80 | 100 |
| BMS-G1 T | Basics of Immunology | 4 | 20 | 80 | 100 |
| BMS-G2 T | Biological Chemistry | | | | |
| BMS-G3 T | Biosafety and Bioethics | | | | |
| BMS-G4 T | Biostatistics | | | | |
| BMS-G5 T | Bridging Information Technology and Biotechnology | | | | |
| BMS-G6 T | Concepts in Biotechnology | | | | |
| *BMS-AECC 1 | English Communication | 4 | 100* | ----- | 100* |
| *BMS-AECC 2 | Environmental Studies | | | | |
| BMS 101 P | Bioorganic chemistry Practical | 2 | 20 | 30 | 50 |
| BMS 102 P | Cell and Radiation Biology Practical | 2 | 20 | 30 | 50 |
| BMS-G1 P | Basics of Immunology Practical | 2 | 20 | 30 | 50 |
| BMS-G2 P | Biological Chemistry Practical | | | | |
| BMS-G3 P | Biosafety and Bioethics Practical | | | | |
| BMS-G4 P | Biostatistics Practical | | | | |
| BMS-G5 P | Bridging Information Technology and Biotechnology Practical | | | | |
| BMS-G6 P | Concepts in Biotechnology Practical | | | | |
| | | 22 | TOTAL MARKS | 550 | |

*BMS-AECC 1/ BMS AECC 2 are Non-University Exams. Evaluation to be conducted by internal faculty/examiner.

SEMESTER II

| Paper Code | Name of the subject | Credit Units | Internal | External | Total |
|--------------------|---|--------------|--------------------|----------|------------|
| BMS 201 T | Principles of Genetics | 4 | 20 | 80 | 100 |
| BMS 202 T | Human Physiology and Anatomy I | 4 | 20 | 80 | 100 |
| BMS-G1 T | Basics of Immunology | 4 | 20 | 80 | 100 |
| BMS-G2 T | Biological Chemistry | | | | |
| BMS-G3 T | Biosafety and Bioethics | | | | |
| BMS-G4 T | Biostatistics | | | | |
| BMS-G5 T | Bridging Information Technology and Biotechnology | | | | |
| BMS-G6 T | Concepts in Biotechnology | | | | |
| *BMS-AECC 1 | English Communication | 4 | *100 | ---- | *100 |
| *BMS-AECC 2 | Environmental Studies | | | | |
| BMS 201 P | Principles of Genetics | 2 | 20 | 30 | 50 |
| BMS 202 P | Human Physiology and Anatomy I | 2 | 20 | 30 | 50 |
| BMS-G1 P | Basics of Immunology Practical | 2 | 20 | 30 | 50 |
| BMS-G2 P | Biological Chemistry Practical | | | | |
| BMS-G3 P | Biosafety and Bioethics Practical | | | | |
| BMS-G4 P | Biostatistics Practical | | | | |
| BMS-G5 P | Bridging Information Technology and Biotechnology Practical | | | | |
| BMS-G6 P | Concepts in Biotechnology Practical | | | | |
| | | 22 | TOTAL MARKS | | 550 |

*BMS-AECC 1/ BMS AECC 2 are Non-University Exams. Evaluation to be conducted by internal faculty /examiner.

B.Sc. (Hons) Biomedical science

Semester I

Bioorganic Chemistry

(Paper Code: BMS101 T)

Learning Objectives

Credits: 04

The Learning Objectives of this course are as follows:

Bioorganic Chemistry is a discipline that integrates organic chemistry and biochemistry. It aims at understanding the relevance of biological processes using the fundamental concepts of organic chemistry. This course includes basic principles of organic chemistry like concepts of stereochemistry and their importance in understanding various bio-molecular reactions along with introduction to biomolecules.

Course outcomes

The student at the end of the course will be able to understand:

CO 1: Identify, assess and analyze different types of stereoisomers and their properties in organic compounds and biomolecules.

CO 2: Explain the structures and function of biomolecules (carbohydrates, amino acids, lipids and nucleotide).

CO 3. To understand the mechanism of biologically significant name reaction and their role in biological systems.

COURSE CONTENT

UNIT – I Stereochemistry

(9 Hours)

Optical isomerism: Optical activity, specific rotation, enantiomerism, D and L designation, racemic modification, R and S sequence rules, diastereoisomers.

Conformational isomers: conformation of ethane and butane, interconversion of projection formula, cyclohexane (mono- and di-substituted), resolution, optical purity.

Geometrical isomerism: Definition, nomenclature– E and Z.

UNIT – II Introduction to Biomolecules I

(12 Hours)

Carbohydrates: Monosaccharides- cyclization of aldoses and ketoses, conformations, concept of mutarotation, anomers, epimers.

Disaccharides- structure, reducing and non-reducing sugars. Polysaccharides- Starch, glycogen and cellulose.

Lipids: Fatty acids, triacylglycerols, phospholipids, lipid bilayer formation, steroids (cholesterol)

UNIT – III Introduction to Biomolecules II (12 Hours)

Amino Acids:

Structure and classification of amino acids, ionization, chemistry of peptide bond, nonribosomal peptide bond formation, essential and non-essential amino acids, amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids, Definition of a peptide, peptide unit, peptide group, bond length, cis and transconformation, primary, secondary (alpha helix, beta sheet, beta turn, collagen helix), tertiary and quaternary structures (with examples).

Nucleotides:

Sugars and Bases, conformation of sugar phosphate backbone, hydrogen bonding and tautomerism in nucleic acid bases Effect of structure on reactivity of biomolecules.

UNIT – IV Biologically Significant Name Reactions (12 Hours)

Aldol (Glucogenesis), retro-aldol (Glycolysis), benzoin condensation (umpolung decarboxylation of pyruvate in the presence of TPP), Claisen condensation (synthesis of fatty acids), Michael addition (Dehydrases), Cannizzaro (Sugar metabolism), Bayer Villiger reaction (FAD dependent ketone synthesis), Pinacol-pinacolone rearrangement (1,2-carbon-carbon shift).

References

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2. Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-9781319114671
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4. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4
5. Morrison, R.N., Boyd, R.N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7th Edition,

6. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). ISBN 10:8131704815 ISBN 13:9788131704813
7. Eliel, L. (1975). 1st Edition. Stereochemistry of carbon compounds, New York, USA: Tata McGraw Hill. ISBN-13: 9780070992900
8. Finar, I.L. (2002), Organic Chemistry (Volume 1), 6th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). ISBN-13: 978-0582305601
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Bioorganic Chemistry
(Paper Code: BMS 101 P)

Practicals Credits: 02

1. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Mohlisch, Barfoed, Fehling/ Tollen/ Benedict tests
2. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Iodine test, Selvinoff, Osazone, Bial's tests
3. Qualitative tests for Amino acids and Proteins: Ninhydrin, Xanthoproteic, Million's, Lead Acetate, Biuret test.
4. Qualitative test for Fats
5. To determine the Iodine number of the given oil/fat.
6. To find pKa value of acetic acid
7. To study the titration curve of glycine
8. Absorption spectrum of Protein
9. Absorption spectrum of DNA
10. Estimation of a Reducing sugar in a given sample

Cell and Radiation Biology

(Paper Code: BMS-102 T)

Learning Objectives

Credits: 04

The Learning Objectives of this course are as follows:

Structure and functions of various cellular compartments and organelles

- Fundamentals of transport of biomolecules inside the cell and its cytoskeleton
- Cell growth, cell-division and cell-cycle control mechanisms.
- Cell to cell communication and participation of signal transduction pathways, in driving cell response mechanics

Course outcomes

The student at the end of the course will be able to understand:

CO 1: Students will learn about how the cell has evolved and the basic types of cells present.

CO 2: Students will acquire insights into the composition and structure of cell membrane by navigating through various proposed cell models. Students will also learn the functions in detail about the processes of transport across cell membranes.

CO 3: Students will learn about the structure and function of various cellular compartments and organelles along with the concept of protein sorting and distribution in unique ways.

CO 4: Students will understand the association between cells through unique types of communication and developing junctions for attachment between neighboring cells.

CO 5: Students will understand various cytoskeleton elements and their participation in maintaining cell shape and integrity. Students will gain knowledge about an overview of cell response to its environment, and involvement of cell- cell signalling mechanisms and to study signal transduction pathways.

COURSE CONTENT

UNIT – I The Cell (3 Hours)

Historical background, significant landmarks, cell theory, structure of prokaryotic and eukaryotic cells.

UNIT – II Cell Membrane and Membrane Transport

(6 Hours)

Functions, different models of membrane structure, types of membrane lipids, membrane proteins: types, methods to study membrane proteins (detergents, RBC ghosts), RBC membrane as a model, membrane carbohydrates, membrane asymmetry and fluidity, lipid rafts.

A. Transport of small molecules: Passive transport (simple diffusion and facilitated diffusion) and active transport and their types (P, V, F and ABC transporter) with example of Na⁺/K⁺ pump.

B. Transport of macromolecules: Endocytosis (pinocytosis, phagocytosis), exocytosis.

UNIT – III Cell Organelles

(15 Hours)

Structure and functions of various organelles:

- **Nucleus:** Different components, nuclear envelope- its structure, pore complex, nucleocytoplasmic, interaction (NLS and NES), nucleolus- structure and functions.
- **Endoplasmic reticulum:** RER- Biosynthesis and processing of proteins, co-translational and post-translational transport of proteins, signal hypothesis, protein sorting. SERdetoxification, biosynthesis of membrane, carbohydrate metabolism, steroid synthesis.
- **Golgi apparatus:** Golgi stack (cis, trans and medial cisternae), flow of proteins through Golgi body, glycosylation and protein sorting.
- **Lysosomes:** Development of different forms of lysosomes, role in cellular digestion, lysosomal storage diseases- Hurler syndrome, Hunter syndrome, Tay-Sachs disease and Inclusion cell disease (I-cell disease).
- **Peroxisomes:** Assembly, functions- H₂O₂ metabolism, oxidation of Fatty acids, glyoxysomes
- **Mitochondria:** Detailed structure, endosymbiotic theory, its genome and functions in brief
- **Chloroplast:** Detailed structure, its genome and functions in brief.

UNIT – IV Cell -Cell communication

(4 Hours)

Structures and functions of different types of anchoring junctions (desmosomes and hemidesmosomes), tight junctions, and communication junctions (gap junction and plasmodesmata).

UNIT – V Cytoskeletal Elements

(4 Hours)

Structure, assembly and functions of:

A. Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies).

B. Microfilaments: Globular and filamentous actin, general idea about myosin.

C. Intermediate filaments: Different classes.

Unit VI: Cell Signaling and Cell Cycle

(6 Hours)

Signaling molecules and their receptors (extracellular and intracellular), functions of extracellular receptors; Intracellular signal transduction pathways (cAMP, cGMP, steroid hormone response element). Different phases of cell cycle and their significance, mitosis and meiosis, checkpoints and regulation of cell cycle.

Unit-VII: Radiation Biology

(6 Hours)

Introduction to radiation biology: Introduction of radiations, basic concept of radioisotopes, types of radioactive decay (gamma and beta emitter), half-life.

Biological effects of radiation: Effects of Ionizing and non-ionizing radiation on cells, acute, delayed and late radiation effects (with particular reference to nervous system, gastrointestinal and hematopoietic syndrome).

Application in biomedicine: Use of radioisotopes in biology, autoradiography, radioisotopes in diagnosis (thyroid disorders, cancer) and therapy (radiotherapy).

Radiation bio safety: Precautions and safety measures in handling radioisotopes.

References

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Ltd; ISBN13 : 978-0716743668.

Cell and Radiation Biology

(Paper Code: BMS- 102 P)

Practicals

Credits: 02

1. Light microscopy: Principle, construction and types. Study of positive and negative staining using photomicrographs.
2. Fluorescence microscopy: principle and applications. Concept of GFP
3. Electron microscopy: Principle, construction and types. Study of positive and negative staining, freeze fracture, freeze etching, shadow casting, endocytosis, exocytosis and phagocytosis using electron micrographs
4. To explain mitosis and meiosis using permanent slides.
5. To measure cell size using a stage micrometer.
6. To cytochemically demonstrate presence of total and basic proteins in cheek cells or onion peel using mercuric bromophenol blue or fast green.
7. To cytochemically demonstrate presence of carbohydrates in cheek cells or onion peel using periodic acid Schiff's reagent.
8. To cytochemically demonstrate presence of DNA in cheek cells or onion peel using Feulgen reagent.
9. To study the effect of isotonic, hypotonic and hypertonic solutions on cell.

B.Sc. (Hons) Biomedical science

Semester II

Principles of Genetics

(Paper Code: BMS-201 T)

Learning Objectives

Credits: 04

The course intends to introduce students to Mendelian principles of inheritance, deviations from Mendelian inheritance and extra-nuclear inheritance, Introduction to pedigree analysis for autosomal and X-linked traits, Understanding of differences between prokaryotic and eukaryotic genome organization, transposons, and basic cytogenetics and Understanding of mechanisms of sex determination.

COURSE OUTCOMES:

The student at the end of the course will be able to understand:

CO 1: The flavour of genomics as a progression from Mendelian genetics will be introduced to the students. They will learn about classical experiments that led to discovery of the genetic material. They will also learn the structure of DNA.

CO 2: Students will be able to explain Mendelian laws of inheritance, deviations from monohybrid ratio (incomplete dominance, codominance, multiple alleles and lethal genes) and deviations from dihybrid ratio (gene-gene interactions, linkage). They must be able to distinguish sexlinked, sex-limited and sex-influenced traits. Students must also be able to interpret patterns of inheritance for autosomal and X-linked traits from pedigrees.

CO 3: Students would learn the concept of extra-nuclear inheritance. Students would learn the differences in genomes of prokaryotes and eukaryotes. They would also learn about transposable genetic elements with examples from prokaryotes and eukaryotes.

CO 4: The lectures will cover details of the structure of the chromosomes, the abnormalities that commonly occur at chromosomal level. Discussion of various types of mutations at the DNA level (deletion, addition, substitution), their consequence on gene structure/product and the diseases associated with these abnormalities.

COURSE CONTENT

Unit I: Overview of Changing Paradigms in Genetics

(05 Hours)

A brief overview of how genetic principles took shape, leading to the concept of a blueprint of life within the cell to the physical entity of DNA. Basic structure of DNA, salient features of the double helix, semi-conservative replication— Meselson and Stahl experiment.

Unit II: Concept of Genetic Inheritance**(15 Hours)**

Concept of alleles, haploid and diploid status, phenotype and genotype, Mendel's laws of inheritance, dominant and recessive inheritance, test, back and reciprocal crosses with two examples each. Chromosomal theory of inheritance. Concept of linkage and crossing over, cytological proof of crossing over, genetic mapping: two and three-point cross over. Distinguishing recombination and complementation. Allelic interactions- dominance relationships- complete, incomplete and co-dominance, gene-gene interactions. Sex linked, sex-limited and sex-influenced traits. Gathering family history, pedigree symbols and construction of pedigrees for autosomal and sex linked traits (dominant and recessive).

Unit III: Extra Nuclear Inheritance**(05 Hours)**

Criteria for extra nuclear inheritance, plastid inheritance in *Mirabilis jalapa*, kappa particles in *Paramecium*, maternal effect- snail shell coiling, cytoplasmic inheritance (mitochondria and chloroplast).

Unit IV: Genome Organization**(07 Hours)**

Organization of Genomes in prokaryotes and eukaryotes. Establishing the Central Dogma. Nucleosomes organization and assembly. Euchromatin, heterochromatin constitutive and facultative heterochromatin. Structure and significance of polytene and lampbrush chromosomes. Transposable genetic elements: Prokaryotic transposable elements- IS elements, Composite transposons; Eukaryotic transposable elements- Ac-Ds system in maize; Uses of transposons.

Unit V: Cytogenetics and Mutations**(08 Hours)**

Chromosome: Structure- centromere and telomere, types of chromosomes based on centromere. Karyotyping- banding pattern and nomenclature (G and Q banding). Structural abnormalities (Duplication, Insertion, Deletion, Translocation-Reciprocal and Non-Reciprocal) and associated syndromes. Numerical abnormalities (Aneuploidy and Euploidy) and associated syndromes. Spontaneous and induced mutations. Types of mutations: Point (Non-sense, miss-sense, silent, frameshift, insertion, deletion). Effects on the Gene products- loss of function and gain of function.

Unit VI: Introduction to Mechanisms of Sex Determination (05 Hours)

Chromosomal theory of sex determination, mechanisms of sex determination, environmental factors and sex determination in human and *Drosophila*. Barr bodies and dosage compensation.

References

1. Klug, W. S., Cummings, M., Spencer, C. A., Palladino, M. A., Darrell K. (2019). 12th Edition.
2. Concepts of genetics. San Francisco, NY:Pearson ISBN-13: 9780134604718.Snustad, D.P. and Simmons, M.J. (2019). 7th Asia Edition. Principles of genetics. New York, USA: John Wiley and Sons. ISBN-13: 9781119657552.
3. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). 8th edition Principles of genetics. USA. Wiley. ISBN-13: 978-8126510436

Principles of Genetics
(Paper Code: BMS-201 P)

Practical

Credits: 02

1. Observation of wild type and mutant phenotypes in *Drosophila*.
2. Preparation of culture media for *Drosophila* and study different stages of the life cycle of *Drosophila*.
3. Verification of Mendelian laws through *Drosophila*/ seeds – dominant, recessive and sexlinked.
4. Study of Barr bodies.
5. Karyotyping with the help of photographs (normal and abnormal karyotypes).
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of diploidy in onion root tip.
8. Study of polyploidy in onion root tip by colchicine treatment.
9. Study of polytene chromosomes.

Human Physiology and Anatomy -I

(Paper Code: BMS 202 T)

Learning Objectives

Credits: 04

The Learning Objectives of this course are as follows:

- The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic functioning of the human body and its interrelations with respect to heart, lung, kidney, gonads, endocrine glands and digestive system.
- It would give students exposure of physiological concepts needed as foundations for further studies in pharmacology, pathology and pathophysiology etc.
- The curricular objectives are focused primarily on normal body function. Accordingly, wherever possible clinical examples have been illustrated to the underlying physiological principles.

COURSE OUTCOMES:

The student at the end of the course will be able to understand:

CO 1: The usefulness of dividing the human body in different anatomical planes and sections, cavities, along with the role of feedback system in maintaining homeostasis. Functional anatomy of the epithelial and connective tissues while focusing on integumentary and skeletal system.

CO 2: Structure, function and regulation of components/different formed elements of blood and the mechanism of clotting. Students would be able to understand different blood groups, basis of their classification, their importance in blood transfusions and tissue grafting and basic concepts of blood and bleeding disorders.

CO 3: Student would be able to understand neurons their role and significance and how as a part of the brain they help in brain physiology. Students would learn organization of brain, with identification of structures and function of different brain regions. Identify different neural pathways and explain their significance.

CO 4: The five senses which help an individual to perceive the world would be studied in detail. Stimulus modality, sensory adaptation and the role of generator potential in the sensory physiology of touch, gustation, olfaction, hearing and vision. They would recognize and

explain the common disorders related to the senses.

COURSE CONTENT

UNIT – I Body organization and Integumentary system (6 Hours)

General Anatomy of the body. Introduction to various kinds of body planes, cavities and their membranes, Tissues level of organization (Types, origin, function & repair). Structure and functions of human skin.

UNIT – II Blood (6 Hours)

Composition and Function of Blood and its components (RBC, WBC, platelets and plasma). Hematopoiesis, Hemoglobin structure, function and abnormal hemoglobin. Basic concepts about Anemia and types. Blood Hemostasis (blood coagulation/ clotting, platelet function and role of endothelium).

UNIT – III Nerve physiology (6 Hours)

Structure, function and types of neuron, conduction of nerve impulse, resting membrane potential, action and graded potential. Synapse its types, Synaptic Transmission, Neurotransmitters and their receptors; types and function

UNIT – IV Nervous System I: Organization of nervous system (6 Hours)

Structure, function and organization of Central nervous system, Peripheral nervous system and Autonomic nervous system. Motor physiology: Reflexes, types and reflex arch

UNIT – V Nervous System II: Sensory Physiology (6 Hours)

Concept of receptors in the body and their types, structure, functional anatomy, regulation and common disorders of the following sensations: Vision, Hearing, Taste, Smell and other senses (Touch, Pain, Temp).

UNIT – VI Muscular system (9 Hours)

Functional anatomy of muscular system, types of muscles, neuromuscular junction structure property and transmission, General characteristics, molecular mechanism and properties of skeletal muscle excitation and contraction, energetics and characteristics of whole muscle contraction.

Unit- VII Skeletal System (6 Hours)

Cartilage: structure, types and function.

Bones: structure, function, location and types.

Joints: structure, function and types.

References

1. Guyton and Hall Textbook of Medical Physiology, 12th edition (2011), J. E. Hall; W B Saunders and Company, ISBN: 978-1-4160-4574-8 International Edition: 978-08089-2400-5
2. Human Physiology, 12th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN 978007-337811-4MHID 0-07-337811-9.
3. Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6.(e book),ISBN: 978-1-119-
4. Elements of Pharmacology, Dr. Ramesh K. Goyal, B. S. Shah Publication
5. Practical Anatomy and Physiology, Dr. Ramesh K. Goyal, Dr. N. M. Patel
6. Ross and Wilson, Anatomy and Physiology in health and Illness, Anne Waugh, Allison Grant.

Human Physiology and Anatomy - I
(Paper Code: BMS 202 P)

Practicals

Credits: 02

1. Estimation of haemoglobin (Sahli's method)
2. Determination of total erythrocyte count.
3. Determination of total leukocyte count.
4. Preparation of blood smears and identifying various WBC
5. To perform differential leukocyte count of blood.
6. To study a simple reflex arc
7. To study the sensation of taste, touch and smell.
8. To study different human organs and their sections through permanent histological slides T.S. of brain, spinal cord, skeletal fibres, cardiac muscles, skeletal muscles, cartilage joints and different tissues. (Minimum 8 slides covering the systems mentioned in theory.)

Generic Elective (GE) Courses

B.Sc. (Hons) Biomedical science

GE 1-2: Generic Electives (any one per semester in semesters 1-2) (Theory + Practical*)

BMS-G1: Basics of Immunology

BMS-G2: Biological Chemistry

BMS-G3: Biosafety and Bioethics

BMS-G4: Biostatistics

BMS-G5: Bridging Information Technology and Biotechnology

BMS-G6: Concepts in Biotechnology

(*Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

Basics of Immunology

(Paper Code: BMS-G1 T)

Learning Objectives

Credits: 04

A basic of immunology is a comprehensive study of the organization and functioning of the immune system with its network of cells and molecules. Understanding the biology of the immune system is, therefore, key to developing strategies towards prevention and cure to a number of disorders and diseases that result due to interference in the functioning and regulation of the immune system.

This paper covers the structure, organization, function and regulation of and by the immunesystem keeping the above aspects in mind.

COURSE OUTCOMES

The student at the end of the course will be able to understand:

CO 1:Students learn various aspects of human immune system.

CO 2:They will understand the functions of various types of cells and role played by them in immune response against pathogens.

CO 3:They will know the concept of antigen, antibody molecules and role of major histocompatibility complex and associated cells in the presentation of antigen.

CO 4:Various techniques associated with immunological reaction will enhance the understanding students about common laboratory instruments.

CO 5:Vaccine based immunotherapies and their designing will assist them to think about new path for combating with pathogens and working mechanism of immune system.

COURSE CONTENT

Unit-I: Overview

Historical background, general concepts of the immune system, innate and adaptive immunity; active and passive immunity; primary and secondary immune response.

Unit-II: Our Immune System

T and B lymphocyte, NK cells, monocytes and macrophages; neutrophils, eosinophils, basophils, mast cells and dendritic cells; thymus and bone marrow; lymph nodes, spleen.

General overview of the Complement System: Components of the complement activation (classical pathway); biological consequence of complement activation.

Unit-III: Immune Response

Antigens and haptens: Properties (foreignness, molecular size) and their importance in cell mediated and humoral immune response.

Humoral immune response: Concepts of B cell development in bone marrow, generation of plasma cells and memory B cells in lymphoid organs. Antibodies: Historical perspective of antibody structure; structure, function and properties of the antibodies; different classes and subclasses and biological activities of antibodies, hybridoma technology and monoclonal antibodies.

Cell mediated immune response: T cell maturation in thymus (in brief), thymic selection, self MHC restriction of T cells, T cell sub-types and their effector functions. Molecules involved in functioning of T cells-Trimolecular complex formation between APC and Naïve T cells, Properties and functions of Interferon (IFN- γ) and Interleukins (IL4).

Basic introduction to Major Histocompatibility Complex: Organization of MHC and inheritance in human

Unit-IV: Antigen-Antibody Interactions Based Immunological Techniques

Concept of affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, ELISA.

Unit-V: Vaccine

Concept and history of vaccines, contribution of Edward Jenner, components of vaccines (e.g. BCG vaccine), overview of National Immunization Course.

Unit-VI: Dysfunctions of Immune System

Types of hypersensitivity, overview of autoimmunity, Immunodeficiency disorders: Animal models of primary immunodeficiency (nude mouse and SCID mouse).

References

1. Delves, P.J. Martin, S.J. Burton, D.R. and Roitt, I. M. (2017). 13th Edition. Roitt's Essential Immunology. New Jersey, USA: Wiley-Blackwell Science. ISBN: 13: 978- 1118415771.
2. Hay, F.C. and Westwood, O.M.R. (2002). 4th Edition. Practical Immunology. New Jersey, USA: Blackwell Science. ISBN: 9780865429611.
3. Punt, J. Stranford, S. Jones, P. and Owen, J. (2019). 8th Edition. Kuby Immunology. New

York, USA: W.H. Freeman and Company. ISBN- 13: 978-1464189784.

4. Owen, J. A. Punt, J. Stranford, S. A. Jones, P. P and Kuby, J. (2013). 7th Edition Kuby Immunology. New York, USA: W.H. Freeman and Company. ISBN-13: 978-1429219198.
5. Willey, J. Sherwood, L and Woolverton, C.J. (2016). 10th Edition. Prescott's Microbiology. New York, USA: McGraw-Hill Education. ISBN-13: 978-1259281594.

Basics of Immunology
(Paper Code: BMS-G1 P)

Practicals

Credits:02

1. To perform immuno-diffusion by Ouchterlony method.
2. Immuno-diffusion by Mancini method
3. To perform ELISA experiment.
4. To perform Agglutination inhibition Assay
5. To perform sandwich dot ELISA.
6. To perform blood grouping (direct agglutination) or Widal test (indirect agglutination).

Biological Chemistry

(Paper Code: BMS-G2 T)

Learning Objectives

Credits: 04

Biological Chemistry integrates the fundamental principles of chemistry with biology. It aims to apply the tools of chemistry in understanding the molecular structure of biomolecules and the chemical reactions occurring in biological processes. It has been structured to understand the significance of acids and bases in the formation of the buffers and maintenance of pH in the cell. The course helps to understand the interaction of various organic and inorganic biomolecules to form ionic and covalent bonds. The inclusion of stereochemistry and molecular interactions explains the 3D structure and stability of biomolecules.

Course Outcomes

The student at the end of the course will be able to understand:

CO 1: To conceptualize ionization and effectively explain ionization of different molecules, ionic product. Explain pH, buffer and buffer action and titration curve of simple molecules.

CO 2: Application of Chemical Bonding and Molecular Structure in Biomolecules

CO 3: Role of the various electronic effect to explain the stability of various reaction intermediates, explain acidity and basicity of different molecules and its role in different biomolecule function

CO 4: To identify, classify and write various types of stereoisomers, chiral centers, configuration and projection formulae of different molecules

CO 5: To describe the mechanism for addition and substitution reaction and understand the mechanism of biologically significant name reactions.

COURSE CONTENT

Unit-I: Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases (concept of pK_a), pH scale and effect of pH on the structure of biomolecules. Common ion effect.

Buffer solutions and its action, Henderson-Hasselbach equation, buffering zone, buffer index.

Qualitative treatment of acid base titration curves (NaOH vs HCl, mono amino acid), isoelectric point, concept of pI and zwitter ion.

Unit-II: Application of Chemical Bonding and Molecular Structure in Biomolecules

Ionic Bonding: General characteristics of ionic bonding. Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds.

Covalent bonding: Shapes of some inorganic molecules and ions on the basis of VSEPR with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements. Hybridization (concept only).

Coordinate bonding: introduction, structure of biomolecules- Haemoglobin.

Unit-III: Fundamentals of Organic Chemistry

Concept of hybridization of carbon. Cleavage of a covalent bond: homolysis and heterolysis. Electronic effects and their applications (inductive, electromeric, hyperconjugation and resonance). Structure and stability of reactive intermediates (carbocations, carbanions and free radicals). Relative acid strength: carboxylic acids (aliphatic, aromatic and halo-substituted aliphatic). Relative basic strength of amines (aliphatic).

Intermolecular and intramolecular forces, Types of intermolecular forces and their characteristics-ion-dipole, dipole-dipole, dipole-induced dipole and dispersion forces.

Intermolecular and intramolecular hydrogen bonding. Effect of intermolecular and intramolecular forces on properties such as solubility, vapour pressure, melting and boiling points of organic compounds and effect of inter/intra-molecular forces on structure of different biomolecules-peptides and nucleotides.

Unit-IV: Stereochemistry

Conformations w.r.t. ethane, butane, angle strain, Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms).

Configuration: Geometrical- cis - trans nomenclature; CIP Rules and E/ Z Nomenclature (for up to two C=C systems), Threo and erythro.

Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds), R/ S (for up to 2 chiral carbon atoms).

D and L nomenclature, General Properties of Glucose and Fructose (open chain and cyclic

structure- Haworth projection), configuration and absolute configuration of Glucose and Fructose, Mutarotation, epimers, anomers (Glycosidic linkage, reducing and non-reducing sugars).

Unit-V: Reaction Mechanism and Name Reactions

Addition Reactions: Hydrohalogenation (Markovnikov's and Anti- Markovnikov's addition)

Nucleophilic substitution reactions: mechanism of SN1 and SN2 reactions, Walden inversion.

Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation,).

Biologically significant name reactions: Aldol (Glucogenesis), retro-aldol (Glycolysis),

Benzoin condensation (umpolung-decarboxylation of pyruvate in the presence of TPP),

Knoevenagel (Application in drug synthesis), Cannizzaro and Cross Cannizzaro (Sugar

metabolism), Bayer Villiger reaction (FAD dependent ketone synthesis), Pinacol-pinacolone

rearrangement (1,2-carbon carbon shift).

References

1. Eliel, L. (1975). 1st Edition. Stereochemistry of carbon compounds, New York, USA: Tata McGraw Hill. ISBN-13: 9780070992900.
2. Finar, I. L. (1996) 6th Edition (volume I and II). Organic chemistry. London, UK: ELBS, Longman Higher Education. ISBN-13: 978-0582305601.
3. Lee, J. D., (1999). 5th Edition. Concise inorganic chemistry, New Jersey, USA: Wiley-Blackwell. ISBN-13: 9780632052936.
4. Morrison, R. T. and Boyd R. N. (1992) 6th Edition. Organic chemistry. London, UK: Pearson Education. ISBN-13: 9780136436690.
5. Nelson, D. L. and Michael M. Cox (2008) 5th Edition. Lehninger principles of biochemistry. New Jersey, USA: Prentice Hall Publishers. ISBN-13:978-0321707338.

Biological Chemistry
(Paper Code: BMS-G2 T)

Practicals

Credits: 02

1. Preparation of solutions based on molarity, normality, percentage, dilutions etc.
2. Preparation of buffers.
3. Estimation of Mohr's salt/ oxalic acid by titrating with KMNO_4 .
4. Estimation of Cu (II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.
5. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution:
Mohlisch, Barfoed, Fehling/ Tollen/ Benedict, Selvinoff, Osazone, Bial's tests.
6. To determine the optical rotation of a biomolecule.
7. To find pKa value of given acetic acid/ amino acid.
8. Absorption spectrum of DNA/ Protein.
9. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titration using EDTA

Biosafety and Bioethics

(Paper Code: BMS-G3 T)

Learning Objectives

Credits: 04

Recent advances in the field of biotechnology have brought into focus several safety and ethical issues. The inventions in the field of genetic engineering and related fields of molecular biology not only affect us but also the plants, microflora, animals and the entire environment and the way we practice agriculture, medicine and food processing. An increase in our ability to change life forms in recent years has given rise to the new science of bioethics.

The present paper focuses on the biosafety and bioethical issues the modern society confronts. Topics such as biosafety levels, GM food debate, impact of biotechnology on biosafety, biotech products and ethical issues, governance of biosafety, environmentally responsible use of biotechnology, clinical ethics will be discussed in the curriculum.

COURSE OUTCOMES

The student at the end of the course will be able to understand:

CO 1: This will enable students to understand various hazardous biological substance they can come across while working in laboratory or day today life, and what are the steps to minimize the risk.

CO 2: The course should kindle the inquisitiveness in students about genetically modified and living modified organisms (GMO & LMO) and their impact on environment.

CO 3: This should give students idea of different regulation for handling biohazard and radioactive material.

CO 4: The students should be familiar with various aspects of bioethics followed in day to day life as well as while handling animals in laboratory.

CO 5: Student should understand their ethical and social, rights and responsibilities for medical care. They should also understand moral and ethical conflicts related to ICU care and HIV infection.

COURSE CONTENT

Unit-I: Introduction

Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals.

Unit-II: Biosafety Guidelines and Management

Government of India definition of genetically modified organisms (GMOs) and living modified organisms (LMOs), roles of institutional biosafety committee, review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMOs.

The GM-food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance.

Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.

Key to the environmentally responsible use of biotechnology and its ethical implications.

Unit-III: Handling and Transportation of GM, Infectious and Radioactive Materials

Risk analysis, risk assessment, risk management and communication, overview of national regulations and relevant international agreements including Cartagena Protocol.

Unit-IV: Codes, Covenants, Declarations and Guidelines

Reason to apply its principles to study cause of health problems and suggest appropriate intervention/ solution to problem. Definition, historic evolution, codes and guidelines, universal principles. Define the term "Bioethics" in relation to profession, society, and biomedicine, learn about gradation of moral and ethical norms from simpler to higher levels for initiating right actions to "first do no harm" and learn about prayers, oaths, covenants, declarations, guidelines and codes which have relevance to bioethics. Ethical use of animals in the laboratory.

Unit-V: Clinical Ethics

Describe the sanctity of human life and the need to preserve human life, explain about issues related to prenatal screening, clinical trials (Phase I/II/III/IV) studies. Vulnerability of women with respect to health care, examination and screening of women for disease, social issues like domestic violence and female genital mutilation and abortion.

Unit-VI: Critical Care Ethics

Medical error and medical negligence difference, remedies against medical negligence, protection and compensation related to it. History and need for ICU care, functioning and ethical principles of an ICU care, triage and futility, end of life care, ethical principles related to withholding treatment and withdrawing treatment (euthanasia), legal position regarding policies in ICU and handling of conflicts in the ICU. Basics of HIV infection, identify ethical issues in clinical practice of HIV medicine and its prevention, research ethics related to HIV.

References

1. Beauchamp, T.L and Childress, J.F. (2011). 6th edition. Principles of biomedical ethics. Oxford, UK: Oxford University Press.
2. Helga, K. and Peter, S. (2012). 2nd edition. A companion to bioethics. New Jersey, USA: John Wiley and Sons.
3. Hunt, E. F. and Colander, D. C. (2010). 14th edition. Social science: An introduction to the study of society. Boston, USA: Pearson/Allyn and Bacon.
4. Peter, A. S. and Viens, A. M. (2008). 1st edition. The Cambridge textbook of bioethics. Cambridge, UK: Cambridge University Press.
5. Sateesh, M.K. (2008). 1st edition. Bioethics and Biosafety. New Delhi, India: I K International Pvt Ltd.
6. Tristram, E.H. (1996). 2nd edition. Foundation of Bioethics. Oxford, UK: Oxford University Press.

Biosafety and Bioethics
(Paper Code: BMS-G3 P)

Practicals

Credits: 02

1. A case study based on genetic modified organism (Bt-Cotton).
2. A case study based on genetic modified organism (Bt-Brinjal).
3. A case study based on terminator seeds.
4. A case study based on clinical trials of vaccines with emphasis on ethical issues.
5. A case study on clinical trials of drugs in India with emphasis on ethical issues.
6. A case study on women health ethics.
7. A case study on medical errors and negligence.
8. A case study on critical care ethics.
9. A case study on ethical issues in clinical practice of AIDS.
10. A case study on handling and disposal of radioactive waste.

Biostatistics

(Paper code: BMS-G4 T)

Learning Objectives

Credits: 04

The objective of this course is to acknowledge, appreciate and effectively incorporate the basic statistical concepts indispensable for carrying out and understanding biological hypothesis, experimentation as well as validations.

The course is aimed to create awareness about the applications of statistics in biological sciences along with building confidence in students to logically test their experimental data with an appropriate test of significance. Use of open source software and web material is encouraged as the course intends to give wings to the students and not just the height for their soaring potentials.

COURSE OUTCOMES:

The student at the end of the course will be able to understand:

CO 1: Students will be able to recognise the importance of statistics in biological sciences, understand population and sample, sampling techniques; qualitative and quantitative variables, and differentiate discrete and continuous variables.

CO 2: This will help the student in recognizing the degree of uncertainty in making important decisions, learning joint probability, conditional probability.

CO 3: The student will be able to calculate the correlation between two variables and simple linear regression equation for a set of data

CO 4: The student will be able to learn the process of hypothesis testing, determine one or two tailed tests, understand level of significance, critical region and distinguish between Type I and Type II error.

COURSE CONTENT

Unit-I: Descriptive Statistics

Data in biology: Development in biostatistics, Samples and Populations, Techniques of sampling (random and stratified), Sampling and non-sampling errors, Variables in biology, Univariate and bivariate frequency distributions and their graphical representations.

Measures of central tendency: Arithmetic mean, mode, median and partition values. Measures of dispersion: Range, standard deviation, coefficient of variance and covariance. Measures of skewness: Pearson's coefficient of skewness. Kurtosis

Unit-II: Probability and Probability Distributions

Probability: Basic concepts, Addition and Multiplication rules of probability, Conditional probability, Bayes' theorem and its applications in biostatistics.

Random variables: Discrete and Continuous.

Mathematical Expectation and Variance: Definition and Properties

Probability Distributions: Binomial distribution, Poisson distribution and Normal distribution along with their properties and relationships

Unit-III: Correlation and Linear Regression

Correlation Analysis: Scatter diagrams, Pearson's and Spearman's coefficients of correlation, Coefficient of determination.

Regression Analysis: Method of least squares, Equations of lines of regression and their applications in biostatistics.

Unit-IV: Hypothesis Testing

Sampling distributions and standard error, Null and Alternate hypothesis, Basic concept and illustrations of type I and type II errors, Concept of confidence interval estimation.

Large sample tests for single mean and difference of means.

Student's t-distribution: test for single mean, difference of means and paired t-test. Chi-square distribution: tests for goodness of fit, independence of attributes and homogeneity. F-distribution, one-way and two-way analysis of variance (ANOVA).

Non-parametric analysis: Sign and run tests.

References

1. Daniel, W.W. and Cross, C.L. (2019). 11th Edition. Biostatistics: A foundation for analysis in the health sciences. New York, USA: John Wiley & Sons. ISBN-13: 978-1119588825.
2. Pagano M. and Gauvreau, K. (2000). 2nd Edition. Principles of biostatistics. California, USA: Duxbury Press. ISBN-13: 978-0534229023.
3. Glantz, S. (2011). 7th Edition. Primer of biostatistics. New York, USA: McGraw-Hill Medical. ISBN-13: 978-0071781503.
4. Gupta S.P (2018) Statistical methods. Delhi, India: Sultan Chand and Sons.

5. Triola M.M., Triola M.F., Roy J. (2019). Biostatistics for biological and health sciences. Harlow, UK: Pearson Education Ltd.
6. Zar, J.H. (2010). Biostatistical analysis. Harlow, UK: Pearson Education Limited.

Biostatistics
(Paper code: BMS-G4 P)

Practicals

Credits: 02

The experiments are designed for students to use spreadsheet/ R/ SPSS for doing biostatistics problem. All theoretical concepts would be covered in the practical using software which includes performing descriptive statistics, probability and probability distribution and inferential statistics.

Computer-based practical using any statistical software like 'R', MATLAB, SPSS, Spreadsheets, etc. to understand the following concepts:

1. Graphical data representation
2. Measures of central tendency and dispersion
3. Probability and probability distributions: Binomial, Poisson and Normal distribution
4. Correlation and linear regression analysis
5. Student's t- test
6. Chi-square test
7. ANOVA

Bridging Information Technology and Biotechnology

(Paper Code: BMS-G5 T)

Learning Objectives

Credits: 04

This course has been designed to reflect how information technology synergizes biotechnology. The course will focus on information retrieval from various databases, the basis of sequence data analysis, use of Hidden Markov Model to solve various sequence analysis problems, such as pairwise and multiple sequence alignments, gene annotation, phylogenetic analysis etc.

This course also covers in silico restriction site mapping and primer design, introduction to machine learning and applications to bioinformatics in biotechnology.

COURSE OUTCOMES

The student at the end of the course will be able to understand:

CO1: Appreciate the pivotal role of information technology in critically assessing the biological information.

CO2: Use one or several computer programs to extract and conduct comparative critical analyses of different types of biological and medicinal information from publicly available databases.

CO3: Learn the use of various tools for sequence alignment and phylogenetic analysis.

CO4: Learn biological interpretation of computationally and statistically derived results. They will also appreciate the application of computational biology at the whole genome level.

CO5: Learn the in silico tools used for restriction digestion, primer designing, PCR, cloning and expression.

CO6: Recognize the importance of mathematical modeling and computing, and the role of approximation and mathematical approaches in describing the biological processes.

COURSE CONTENT

Unit-I: Convergence of Biotechnology and Information Technology

Introduction to bioinformatics and its applications, Internet and bioinformatics.

Unit-II: Databases and Genome Browsers

Introduction to various databases and their classification (primary and secondary databases) e.g. NCBI, DDBJ, EMBL, ENSEMBL, UCSC and their use in laboratories: literature, sequence, structure, medical, enzymes and metabolic pathway databases.

Unit-III: Sequence Alignment and Phylogenetic Analysis

Local and global sequence alignments (Needleman-Wunsch and Smith-Waterman algorithms), pair-wise (BLAST and FASTA algorithms) and multiple sequence alignment (Clustal W) and its importance. Theory behind BLAST: How Hidden Markov Model (HMM) can be used to model a family of unaligned sequences or a common motif within a set of unaligned sequences and further be used for discrimination and multiple alignment. Basics and tools for phylogenetic analysis, Cladistics and its assumptions, Tree-building methods (Character and distance-based methods), Construction of phylogenetic trees (PHYLIP).

Unit-IV: Gene Ontology and Genome Analysis

The Ontologies: Cellular component, Biological process and Molecular function. Features of DNA sequence analysis, Gene prediction methods, SNP analysis (dbSNP), Sequence assembly and genome annotation.

Unit-V: Restriction Site Mapping and Primer Design

In silico restriction mapping, Cloning and expression, Identification of cDNA from databases, Design of primers for standard and real time PCR, e-PCR. PCR diagnostic design, Design strategy for over-expression of a therapeutic protein using specific examples to illustrate the strategy.

Unit-VI: Introduction to Machine Learning

Learning from data, how can we extract knowledge from data to take decisions and program the computer to be able to learn from examples and adapt systems dynamically to enable better user experience.

References

1. Baxevanis, A.D. and Ouellette, B.F.F. (2004). 3rd Edition. Bioinformatics: A practical guide to the analysis of genes and proteins. New Jersey, USA: John Wiley and Sons. ISBN- 13: 978-0471478782.
2. Brown, T.A. (2017). 4th Edition. Genomes 4. New York, USA: Garland Science. ISBN-13: 978-0815345084.
3. Mount, D.W. (2004). 2nd Edition. Bioinformatics: sequence and genome analysis. New York, USA: Cold Spring Harbour Laboratory Press. ISBN-13: 978-0879697129.
4. Kellehar, J.D., Namee, B.M. and D'Arcy, A. (2015). 1st Edition. Fundamentals of machine learning for predictive data analytics: algorithms, worked examples, and case studies. Boston, USA: The MIT Press. ISBN-13: 978-0262029445.
5. Leach, A.R. (2009). 2nd Edition. Molecular modeling: Principles and applications. Pearson India. ISBN 13: 9780582382107.

Bridging Information Technology and Biotechnology
(Paper Code: BMS-G5 P)

Practicals

Credits: 02

1. Retrieval of information from nucleotide databases.
2. Sequence alignment using BLAST.
3. Multiple sequence alignment using Clustal W.
4. Phylogenetic analysis using PHYLIP.
5. Gene Ontology.
6. Gene prediction and ORF finding.
7. In silico primer designing for standard and real time PCR and performing e-PCR.

Concepts in Biotechnology

(Paper Code: BMS-G6 T)

Learning Objectives

Credits: 04

To introduce importance of Biotechnology in allied fields. To enable students from diverse backgrounds to understand basic concepts in Gene Cloning and DNA Analysis. To provide them an insight into various molecular techniques commonly used in Biotechnology. To enable them to appreciate applications of Biotechnology in everyday life.

COURSE OUTCOMES

The student at the end of the course will be able to understand:

CO 1:Students shall learn basic biotechnology techniques and key concepts that are used in isolation and characterization of biomolecules (DNA and proteins).

CO 2:They will comprehend the importance of gene cloning in biotechnology and learn the intricacies of gene cloning using plasmids and bacteriophages as cloning vectors.

CO 3:Students shall learn the challenges (and troubleshooting) of heterologous expression and also learn about cDNA cloning and its significance.

CO 4:Students shall be able to understand the importance of construction of genomic libraries and their specialized screening methods to identify gene of interest.

CO 5:Through protein engineering, gene therapy, DNA profiling and biopharmaceutical production, students shall learn the importance of various applications of biotechnology.

CO 6:They shall gain an insight of safe and ethical practices required in medical biotechnology.

COURSE CONTENT

Unit-I: Techniques Used in Biotechnology

Brief history of biotechnology and its importance.

Isolation and purification of genomic and plasmid DNA, Agarose and polyacrylamide gel electrophoresis, Southern and Western hybridization (probes and labels used in the preparation of probes- radioactive, fluorescent, enzymatic and chemiluminescent).

Polymerase Chain Reaction (PCR): Principle, types of DNA polymerases, primer designing, types of PCR: hot start, multiplex, inverse, reverse transcription and touchdown PCR and

their applications.

Sequencing: Chemical (Maxam Gilbert) and Enzymatic (Sanger's dideoxy) method, automated DNA sequencing concept.

Unit-II: Process of Gene Cloning, Expression and Protein Purification

Restriction endonucleases: Restriction and modification systems, nomenclature and types of restriction enzymes (type I-IV), recognition of restriction sites, restriction mapping.

Joining of DNA molecules: sticky end and blunt end ligations, role of DNA ligase, reaction mechanism of ligation in viruses and bacteria, adaptors, linkers, homopolymer tailing.

Vectors: Plasmids (pUC vectors), Bacteriophage (lambda phage-derived replacement and insertion vectors), cosmids, in vitro packaging; expression vectors (one example each of prokaryotic and eukaryotic expression vectors); shuttle vectors.

Bacterial transformation, selection (antibiotic selection methods) and screening (blue/white) of transformants. Challenges in expression of eukaryotic proteins in prokaryotic hosts, factors affecting the expression, expression in eukaryotic cells, cDNA cloning.

Unit-III: Process and Challenges of Heterologous Gene Expression

Challenges in expression of eukaryotic proteins in prokaryotic hosts, factors affecting the expression, expression in eukaryotic cells, cDNA cloning.

Unit-IV: Genomic and cDNA Libraries

Construction of genomic and cDNA libraries, their screening by nucleic acid hybridization (Colony and Plaque hybridization) and immunochemical methods.

Unit-V: Applications of Biotechnology

Through protein engineering, gene therapy, DNA profiling and biopharmaceutical production, students shall learn the importance of various applications of biotechnology.

Unit-VI: Biosafety and Ethical Issues

Safe handling and disposal of GMOs and toxic reagents. Concerns about gene editing, gene therapy and impact of GMOs on the environment.

References

1. Bernard, R. G. Jack, J. P. and Cheryl, I. P. (2009). 4th Edition. Molecular biotechnology: principles and applications of recombinant DNA. USA: ASM press, ISBN-13:9781555814984.
2. Brown, T. A. (2016). 7th Edition. Gene cloning and DNA analysis: An introduction. New York, USA: John Wiley and Sons, ISBN- 978-1-119-07256-0.
3. Cantor, C. R. and Smith, C. L. (1999). 1st Edition. Genomics: The science and technology behind the human genome project. New York, USA: John Wiley and Sons. ISBN-13:978- 0471599081.
4. Kornberg, A. (2005). 2nd Edition. DNA Replication. California, USA: University Science Books, ISBN -13:978- 0716720034.

Concepts in Biotechnology
(Paper Code: BMS-G6 P)

Practicals

Credits: 02

1. To prepare general media and reagents.
2. To perform genomic DNA isolation.
3. To perform plasmid DNA isolation.
4. To perform agarose gel electrophoresis.
5. To amplify DNA using PCR.
6. To perform restriction digestion of plasmid DNA
7. To analyze DNA sequence from autoradiogram/ electrophoretogram.

English Communication
(Paper Code: BMS-AECC 1)

Learning Objectives

Credits: 04

This course's goal is to introduce students to communication theory, fundamentals, and tools while also helping them acquire critical communication skills that should be present in all of their interactions—personal, social, and professional.

COURSE OUTCOMES

At the end of the course, students will be able to:

CO1: Develop the skills of the professional undergraduate students for proper self-expression, social communication, spoken English, correct pronunciation, voice modulation and business etiquettes.

CO2: Improve their personality, communication skills and enhance their self-confidence.

COURSE CONTENT

Unit –I: Introduction to Communication

Basic forms of communication; Process of communication; Principles of effective communication, 7Cs; Types of Communication; Barriers of communication.

Unit-II: Fundamental of Grammar and their Usage

Improve command over spoken and written communication with emphasis on nouns, verbs, tenses and adjectives; Correcting sentence errors, punctuation; Building vocabulary to communicate effectively; common errors in writing.

Unit: III Business Letter Writing

Types and layouts of letter Writing: Persuasive Letters, Request Letters, Sales Letters, Complaints and Adjustments; Interview Letters, Promotion. Letters, Resignation Letters, News Letters, Circulars, Agenda, Notice, Office Memorandums, Office Orders, Press Release.

Unit -IV Business Etiquettes and Public Speaking

Business manners; Body language gestures, Email; Etiquettes on internet; Etiquettes on the

Telephone; Group Meetings.

Unit –V: Reading and Listening Skills

Close Reading, Comprehension, Summary writing, Paraphrasing, Analysis and Interpretation; Self-Awareness, Active Listening.

Unit –VI: Audience to Communication

Intrapersonal, Interpersonal, Group and Mass Communication; Devising feedbacks in communication; Interviews – Types, Do's and Dont's in an Interview.

References

1. Boove, C.L., Thill, J.V., and Chaturvedi, M., (2009) Business Communication Today, Pearson Education.
2. Murphy and Hildebrandt, (2008) Effective Business Communication, McGraw Hill Education.
3. Krizan, A. C. Buddy, and Merrier, Patricia (2008) Effective Business Communication, 7th Edition, Cengage Learning.
4. Lesikar, (2009), Business Communication: Making Connections in a Digital World, McGraw Hill Education.
5. Fluency in English - Part II, Oxford University Press, 2016.
6. Language, Literature and Creativity, Orient Blackswan, 2013.

Environmental Studies

(Paper Code: BMS-AECC 2)

Learning Objectives

Credits: 04

The course examines health issues, scientific understanding of causes, and possible future approaches to control the major environmental health problems in industrialized and developing countries. It includes how the body reacts to environmental pollutants; physical, chemical, and biological agents of environmental contamination; vectors for dissemination (air, water, soil); solid and hazardous waste; susceptible populations; biomarkers and risk analysis; the scientific basis for policy decisions; and emerging global environmental health problems.

COURSE OUTCOMES

At the end of the course, students will be able to:

CO 1: Gain in-depth knowledge on natural processes and resources that sustain life and govern economy.

CO 2: Understand the consequences of human actions on the web of life, global economy, and quality of human life.

CO 3: Develop critical thinking for shaping strategies (scientific, social, economic, administrative, and legal) for environmental protection, conservation of biodiversity, environmental equity, and sustainable development.

CO 4: Acquire values and attitudes towards understanding complex environmental-economic-social challenges, and active participation in solving current environmental problems and preventing the future ones.

COURSE CONTENTS

Unit I: The Multidisciplinary Nature of Environmental Studies

Natural Resources Renewable and non-renewable resources: Natural resources and associated problems a) Forest resources; b) Water resources; c) Mineral resources; d) Food resources; e) Energy resources; f) Land resources. Role of an individual in conservation of natural resources.

Unit II: Ecosystems

Concept of an ecosystem, Structure (Biotic and Abiotic factors) and function of an ecosystem. Dynamics of Ecosystem: Food Chain, Food web and Ecological Pyramids. Salient features of Forest, Grassland, Desert and Aquatic ecosystem.

Unit III: Environmental Pollution and Health

Environmental Pollution: Definition, Causes, Effects of air, water, soil, noise, thermal and nuclear pollution.

Control and preventive measures of air, water, soil noise, thermal and nuclear.

Unit IV: Global Environmental Problems

Global Warming and Climate Change, Photochemical Smog, Ozone Layer Depletion, Acid Rain.

References

1. Divan, S. and Rosencranz, A. (2002). Environmental Law and Policy in India: Cases, Material & Statutes, 2nd Edition. Oxford University Press, India. Chapter 2 (Pages: 23-39); Chapter 3 (Pages: 41-86).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). Environment, 9th Edition. Wiley Publishing, USA. Chapter 19 (Pages: 370-376); Chapter 20 (Pages: 385-399).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi. Chapter 23 (Pages: 555-598); Chapter 30 (Pages: 801-807)
4. McCully, P. (1996). Rivers no more: the environmental effects of dams, In: Silenced Rivers: The Ecology and Politics of Large Dams, Zed Books, New York, USA. Page. 29-64.