**Syllabus**
**for**
**M. Sc. Biochemistry**

**To be effective from academic session 2022-2023**

**Central University of Rajasthan**

**NH-8, Bandarsindri, Kishangarh-305817**

**Dist. Ajmer**

**Objective of the Programme:** The M.Sc. Biochemistry program is designed to impart theoretical and experimental knowledge about living organisms' biomolecules and biochemical processes. The program extends its aims to provide the biochemistry based skills to students for identifying scientific issues, developing hypotheses based on literature, designing and conducting experiments, and utilizing experimental results for sustainable human betterment.

**Program outcomes:** At the completion of this course, the students will be able to:

1. Understand the structure of biomolecules and their dynamic roles in cellular, physiological, and metabolic activities.
2. Gain insight into cellular and genomic organization and their physiological intricacies.
3. Reveal the underlying mechanisms of various cellular processes and their dysregulation at genomic, transcriptomic, proteomic, and metabolomics levels.
4. Employ modern biochemical, molecular\, cellular, microbial, and bioinformatic methods in addressing various biochemical phenomena, conducting biochemical diagnostic tests, and designing therapeutics.
5. Enhance scientific knowledge and skills in specific biological domains to meet the current academic and industrial (pharmaceutical and agricultural) demands.
6. Acquire experience in developing scientific hypotheses, conducting experiments, analyzing data and communicating research findings at national and international levels.

**Employability:** Students will either get PG diploma (1 year) or Master's degree (2 years) on completion of the course**.** Subsequently they can work in the biochemical, agricultural, healthcare and education sectors. Further, the degree holders can also opt for research carrier in research institutes or universities in India or abroad by qualifying entrance tests for research fellowships. Students may also have opportunities for teaching profession in different Indian colleges and universities by qualifying National/State level Eligibility Tests.

# Course Structure

**SEMESTER I**

| Course Code | Title of the Course | Course | Nature of Course | Credits |
|---|---|---|---|---|
| BCH 401 | Biomolecules and Metabolism | Core | Theory | 03 |
| BCH 402 | Immunology | Core | Theory | 03 |
| BCH 403 | Cell Biology & Cell Signaling | Core | Theory | 03 |
| BCH 404 | Genetics | Core | Theory | 03 |
| BCH 405 | Microbiology | Core | Theory | 03 |
| BCH XXX | Discipline Specific Elective (DSE) - I* | Elective | Theory | 03 |
| BCH 406 | Methods in Biochemistry and Microbiology | Core | Practical | 03 |
| BCH 407 | Methods in Cell biology and Immunology | Core | Practical | 03 |
| **Credits** | | | | **24** |

**SEMESTER II**

| Course Code | Title of the Course | Course | Nature of Course | Credits |
|---|---|---|---|---|
| BCH 408 | Clinical Biochemistry# | Core | Theory | 03 |
| BCH 409 | Molecular Biology | Core | Theory | 03 |
| BCH 410 | Enzymology | Core | Theory | 02 |
| BCH XXX | Discipline Specific Elective (DSE) - II* | Elective | Theory | 03 |
| BCH XXX | Non discipline Specific Elective (NDSE) - I* | Elective | Theory | 03 |
| BCH 411 | Techniques in Molecular Biology and Enzymology | Core | Practical | 03 |
| BCH 412 | Techniques in Clinical Biochemistry | Core | Practical | 03 |
| BCH 413 | Dissertation I | SEC | Project | 02 |
| BCH 414 | Internship | AEC | Internship | 02 |
| **Credits** | | | | **24** |

**SEMESTER III**

| Course Code | Title of the Course | Course | Nature of Course | Credits |
|---|---|---|---|---|
| BCH 501 | Biophysics and Bioinformatics | Core | Theory | 03 |
| BCH 502 | Analytical Biochemistry# | Core | Theory | 03 |
| BCH 503 | Human Physiology | Core | Theory | 03 |
| BCH 504 | Plant Physiology and Biochemistry | Core | Theory | 03 |
| BCH XXX | Discipline Specific Elective (DSE) - III* | Elective | Theory | 03 |
| BCH XXX | Non discipline Specific Elective (NDSE) - II* | Elective | Theory | 03 |
| BCH 505 | Methods in Human Physiology and Computational Biology | Core | Practical | 03 |
| BCH 506 | Methods in Analytical Biochemistry and Plant Tissue culture | Core | Practical | 03 |
| **Credits** | | | | **24** |

**SEMESTER IV**

| Course Code | Title of the Course | Course | Nature of Course | Credits |
|---|---|---|---|---|
| BCH 507 | Discipline Specific Elective (DSE) - IV* | Elective | Theory | 03 |
| BCH 508 | Research Paper Presentation | AEC | Presentation | 02 |
| BCH 509 | Dissertation presentation | SEC | Presentation | 03 |
| BCH 510 | Dissertation II (Major Project) | SEC/AEC | Project | 16 |
| **Credits** | | | | **24** |
| **Total Credits of (Semester I, II, III & IV)** | | | | **96** |

*Students have to select the discipline specific elective from the courses given in Annexure I or from other departments. ** Students have to select the elective from the other departments of the Central University of Rajasthan. SEC: Skill Enhancement Course, AEC: Ability Enhancement Course, # Core as well as SEC

# Annexure I: Discipline Specific Elective (DSE)

| Sr. No | Course Code | Title of Course | Credits |
|---|---|---|---|
| 1 | BCH 431 | Agricultural Biotechnology | 3 |
| 2 | BCH 432 | Antimicrobial Resistance | 3 |
| 3 | BCH 433 | Cancer Cell Biology | 3 |
| 4 | BCH 434 | Developmental Biology | 3 |
| 5 | BCH 435 | Ecology & Molecular Evolution | 3 |
| 6 | BCH 436 | Host-Pathogen Interaction | 3 |
| 7 | BCH 437 | Infection Biology | 3 |
| 8 | BCH 438 | Molecular Endocrinology | 3 |
| 9 | BCH 439 | Molecular Medicine | 3 |
| 10 | BCH 440 | Protein Engineering | 3 |
| 11 | BCH 531 | Nanobioscience | 3 |
| 12 | BCH 532 | Computer Aided Drug Design | 3 |
| 13 | BCH 533 | Cell culture and Animals in Research | 3 |
| 14 | BCH 534 | Plant Cell Technology | 3 |
| 15 | BCH 535 | Cell Death Mechanisms | 3 |
| 16 | BCH 536 | Enzymes of Extremophilic bacteria | 3 |
| 17 | BCH 537 | Small RNA in Health and Disease | 3 |
| 18 | BCH 538 | Parasitology | 3 |
| 19 | BCH 539 | Applied and Environmental Microbiology | 3 |
| 20 | BCH 540 | Epigenetics & Stem cell biology | 3 |
| 21 | BCH 541 | Plant Functional Genomics | 3 |
| 22 | BCH 542 | Plant Genetic Engineering & Genome Editing | 3 |
| 23 | BCH 543 | Plant Stress Biology | 3 |
| 24 | BCH 544 | Virology and Vaccinology | 3 |
| 26 | BCH 545 | Bacterial Infectious Diseases and Therapeutics | 3 |
| 27 | BCH 546 | SWAYAM, NPETL and MOOC courses | 3 |

**Mapping of course outcomes with Program Outcomes**

| Course code | Course title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|
| BCH 401 | Biochemistry and Metabolism | 3 | - | 2 | - | - | 2 |
| BCH 402 | Immunology | - | - | 2 | - | 3 | - |
| BCH 403 | Cell Biology & Cell Signaling | 1 | 3 | 2 | 2 | - | - |
| BCH 404 | Genetics | - | 3 | 3 | - | - | - |
| BCH 405 | Microbiology | - | 1 | 3 | - | - | - |
| BCH 406 | Methods in Biochemistry and Microbiology | 3 | 3 | 2 | - | - | - |
| BCH 407 | Methods in Cell and Molecular Biology | 3 | 3 | - | 3 | 2 | 2 |
| BCH 408 | Clinical Biochemistry | - | - | 3 | 3 | - | - |
| BCH 409 | Molecular Biology | 3 | 3 | 2 | - | - | - |
| BCH 410 | Enzyme Technology | 1 | - | 2 | - | 3 | 3 |
| BCH 411 | Methods in Immunology and Enzyme Technology | - | - | 1 | 2 | 3 | 3 |
| BCH 412 | Methods in Clinical Biochemistry | - | - | 1 | - | 3 | 3 |
| BCH 413 | Internship | - | - | - | 3 | 3 | 3 |
| BCH 414 | Dissertation I | - | - | - | 3 | 3 | 3 |
| BCH 501 | Biophysics and Bioinformatics | 2 | - | - | 3 | 3 | 3 |
| BCH 502 | Analytical Biochemistry | - | - | - | 2 | 3 | 3 |
| BCH 503 | Human Physiology | 1 | 3 | 2 | - | 1 | 1 |
| BCH 504 | Plant Physiology and Biochemistry | 3 | 3 | 2 | - | - | - |
| BCH 505 | Methods in Human Physiology and Computational Biology | - | 2 | - | 2 | 3 | 3 |
| BCH 506 | Methods in Analytical Biochemistry and Plant Tissue culture | - | - | - | 2 | 3 | 3 |
| BCH 508 | Research Paper Presentation | - | 2 | - | - | 3 | 3 |
| BCH 509 | Dissertation presentation | - | - | - | - | 3 | 3 |
| BCH 510 | Dissertation II (Major Project) | - | - | 2 | 2 | 3 | 3 |
| BCH 431 | Agricultural Biotechnology | - | 1 | - |  | 2 | 3 |
| BCH 432 | Antimicrobial Resistance | - | - | 1 | - | 3 | 1 |
| BCH 433 | Cancer Cell Biology | - | 3 | 1 | - | - | 2 |
| BCH 434 | Developmental Biology | - | - | 2 | 2 | - | - |
| BCH 435 | Ecology & Molecular Evolution | - | 3 | - | - | 2 | - |
| BCH 436 | Host-Pathogen Interaction | - | - | 2 | - | 3 | - |
| BCH 437 | Infection Biology | - | - | 2 | - | 3 | - |
| BCH 438 | Molecular Endocrinology | - | - | 3 | - | 1 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| BCH 439 | Molecular Medicine | - | 3 | 2 | - | 1 | - |
| BCH 440 | Protein Engineering | 1 | - | - | - | 3 | - |
| BCH 531 | Nanobioscience | - | - | - | 1 | 1 | 3 |
| BCH 532 | Computer Aided Drug Design | - | - | - | 1 | 1 | 3 |
| BCH 533 | Animals and animal cells in Research Technology | - | 1 | - | 2 | 1 | 3 |
| BCH 534 | Plant Cell Technology | - | - | - | 1 | 1 | 3 |
| BCH 535 | Cell Death Mechanisms | - | 3 | 2 | - | 1 | - |
| BCH 536 | Extremophilic bacteria and their enzymes | - | 3 | - | - | 1 | - |
| BCH 537 | Small RNA in Health and Disease | - | 1 | - | - | 3 | - |
| BCH 538 | Protozoan Parasitology | - | 1 | 2 | - | 3 | - |
| BCH 539 | Applied and Environmental Microbiology | - | - | - | 1 | 2 | 3 |
| BCH 540 | Epigenetics & Stem cell biology | 1 | 2 | 1 | - | 3 | - |
| BCH 541 | Plant Functional Genomics | - | - | 1 | 2 | 3 | - |
| BCH 542 | Plant Genetic Engineering & Genome Editing | - | - | 1 | 2 | 3 | - |
| BCH 543 | Plant Stress Biology | - | 3 | 1 | - | 2 | - |
| BCH 544 | Virology and Vaccinology | - | - | 2 | 1 | 3 | - |
| BCH 545 | Bacterial Infectious Diseases and their Therapeutics | - | - | 3 | - | 1 | - |

**BCH-401 Biomolecules and Metabolism Credit-3**

**Course Objectives:**

The course is aimed to

- Provide insights into the fundamentals of structures and interactions within various biomolecules that assist in cellular functioning and organization.
- Communicate and discuss the theoretical and practical knowledge of various biochemical processes.
- Impart knowledge about various metabolic disorders and associated diseases

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Know about the constituents of living matter and its significance in biological functions.
2. Comprehend the energy production and bioenergetics principles
3. Interpret molecular structure and interactions within proteins, nucleic acids, carbohydrates and lipids.
4. Explain organization and molecular mechanisms of various biomolecules within living cell.
5. Understand the metabolism of amino acids, carbohydrate, lipids and nucleic acids.
6. Infer the significance of vitamins and co-factors in biological system

| Course Name Biochemistry and Metabolism | Course Code BCH 401 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Structure of monosaccharides, oligosaccharides and polysaccharides, glycoproteins, glycolipids, proteoglycans, mutarotation, annomerisation, epimerization, stability of polysaccharides. Glycolytic pathway; regulation of the hexokinase, phosphofructokinases, Kreb's cycle; amphibolic nature of TCA cycle, oxidative phosphorylation, ATP production and bioenergetics glyoxylate cycle, glycogen breakdown, glycogen synthesis, regulation of glycogen metabolism, gluconeogenesis and its regulation, pentose phosphate pathways, metabolism of Fructose and Galactose. | | | | | | |
| Unit 2 | | | 15 h | | | |

| |
|---|
| Structure and properties of fatty acids, storage and membrane lipids, phospholipids and cholesterol, Composition and synthesis of lipoproteins and their transport in the body, oxidation of fatty acids (beta & alpha), oxidation of long chain fatty acids, Synthesis of lipids, elongation of fatty acids, desaturation of fatty acids, regulation of fatty acid synthesis, cholesterol metabolism, regulation of cholesterol metabolism.<br>Structure, composition and properties of nucleic acids, De-Novo synthesis of purine and pyrimidine nucleotides and its regulation. Synthesis of nucleoside di- and triphosphates, deoxynucleotides and TMP and degradation of purine and pyrimidine nucleotides, salvage pathways of nucleotides synthesis. |

| Unit 3 | 15 h |
|---|---|
| Structure and properties of amino acids, Structure of protein (Primary, Secondary, Tertiary and Quaternary), essential and non-essential amino acids, general reactions of amino acid metabolism, urea cycle, synthesis of various molecules via amino acid metabolism intermediates, non-standard Amino Acids.<br>Structure and properties of vitamins, co-enzymes, biochemical action of vitamin and water-soluble vitamins, Biosynthesis of vitamins, role of vitamins in the metabolism. | |

**Reference Books:**


- Voet D., Voet J.G, Biochemistry 5th Edition., John Wiley and Sons
- Nelson, D. C. andCox, M.M., Lehninger Principles of Biochemistry, 11th Edition,W. H. Freeman,
- Berg J.M., Tymoczko J.L. and Stryer L., Biochemistry. New edition, W.H. Freeman and Co. New York


**BCH-402 Immunology Credit 3**

**Course Objectives:**

The course is aimed to

- Introduce the cellular and molecular basis of immune system.
- Develop the understanding of human body protection system
- Provide knowledge about humoral and cellular immune molecules and their significance in the protection from human infectious diseases.

**Course outcomes:**

After the completion of this course, the students will be able to:

1. Acquire the knowledge of the structure and function of the major organ systems, including the molecular, biochemical and cellular mechanisms for maintaining homeostasis.

2. Develop the knowledge about the pathogenesis of diseases, interventions for effective treatment, and mechanisms of health maintenance to prevent disease.
3. Conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens.
4. Determine what immune-modulatory strategies can be used to enhance immune responses
5. Learn the mechanism to suppress unwanted immune responses such as those required in hypersensitivity reactions, transplantations or autoimmune diseases.
6. Explore strategies to improve existing vaccines and how to approach these.

<table>
<tr><td rowspan="2">Course Name:<br>Immunology</td><td rowspan="2">Course Code<br>BCH 409</td><td>Type of Course:</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Credits<br>3</td></tr>
<tr><td>Core</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td colspan="4">Unit 1</td><td colspan="3">15 h</td></tr>
<tr><td colspan="7">Introduction to Immune system: Basic concept of immune system, cells and organs of immune system, lymphoid cells (B- lymphocytes, T- lymphocytes and Null cells), mononuclear cells (phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cell. Structure and functions of primary and secondary lymphoid organs. Innate Immunity: TLR receptors and sensing of PAMPs. Opsonization, Fc Receptors, prostaglandins and leukotrienes. Antigen, super antigens, immunogens, adjuvents, antigen processing, antibody structure and function, classification of immunoglobulins, concept of variability, cross reactivity, isotypes, allotypes and idiotypic markers, class switching, receptor and soluble form of immunoglobulins.</td></tr>
<tr><td colspan="5">Unit 2</td><td colspan="2">15 h</td></tr>
<tr><td colspan="7">B and T cell Immunology- B and T cell development, differentiation, maturation, clonal anergy, humoral immune response, B cell differentiation, antibody engineering, BCR and pre-BCR, Receptor editing, complement system, classical and alternative pathways, concept of histocompatibility, structure and function of class I and class II MHC molecules, structure of HLA complexes. T cell receptors, Antigen presentation cells, APC-T cell interaction, T cell differentiation in thymus, Th1, Th2, Th17, Treg cells and cytokines, chemokines, cytotoxic T cells, natural killer cells, dendritic cells.</td></tr>
<tr><td colspan="5">Unit 3</td><td colspan="2">15 h</td></tr>
<tr><td colspan="7">Antigen dependent cell cytotoxicity, cytotoxicity reactions, CD8+ T cell cytotoxicity, autoimmunity, acquired immunodeficiency, hypersensitivity reactions, grafting and transplantation immunology, host-pathogen interaction, immunotherapy, T cell immunotherapy & B cell immunotherapy. Vaccines, different types of vaccines and its significance, monoclonal and polyclonal antibody production, hybridoma technology. Recent trends in immunology research and techniques.</td></tr>
</table>

**Books recommended:**

1. Kindt, T. J.,Osborne, B. A. and Goldsby, R. A. Kuby Immunology, 6th Edition, W. H. Freeman, 2006.

2. Abbas, A. K., Lichtman, A. H. and Pillai, S., Cellular and Molecular Immunology, 6th Edition, Saunders, 2007.
3. Roitt's, Essential Immunology. Ivan M Roitt& Peter J. Delves. 10th edition. Blackwell Publishing.

**BCH-403 Cell Biology & Cell Signaling Credit 3**

**Course Objectives:**

The course is aimed to

- Illustrate cell properties, cellular and molecular organization, sub-cellular organelles, and cytoskeleton structure
- Impart knowledge about extracellular matrix, cell adhesion molecules and their role in diverse cellular functions
- Introduce the aspects about cell cycle, cell division, cell death mechanisms and cell signaling pathways

**Course Outcomes (CO):**

After the completion of this course, the students will be able to

1. Know the cellular organization and function of various intra cellular organelles
2. Understand the differences among diverse kinds of cells originating from bacteria, plant and animals
3. Comprehend fundamental understanding of protein sorting and cell signalling.
4. Learn the basics of cell to cell communication and its relevance in biological response
5. Understand the renewal and regeneration of differentiated cells, stem cells and cancer cells
6. Elucidate the molecular mechanisms of cell cycle and cell death.

| Course Name: Cell Biology & Cell Signaling | Course Code: BCH 403 | Type of Course: Core | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Cellular organization: Membrane models, chemical composition of membrane, membrane proteins, movement of small and large molecules across the cell membrane, osmosis, diffusion, endocytosis, phagocytosis, artificial liposomes and its application; Sub-cellular organelles: Structure and functions of intracellular organelles such as nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, plastids, peroxisomes; Cytoskeleton: Structure, organization and function of microtubules and microfilaments, role of myosin, kinesin and dynein, cell movements. | | | | | | |
| Unit 2 | | | 15 h | | | |

| | |
|---|---|
| Extracellular matrix and cell adhesion molecules: Extracellular matrix molecules, cell adhesion molecules, integrin, cadherin and immunoglobin superfamily proteins.; Protein targeting: Synthesis, secretion and transport of protein to various cell compartments:<br>Signal Transduction: Post translational modifications, Receptors and ligands, cellular communication, signalling through membrane receptors like GPCR, receptor tyrosine and serine/threonine kinase, and nuclear receptor; PI3K/Akt, MAPkinase, cytokine signalling like JAK-STAT, TCR mediated signalling, TGF beta and BMP signaling | |
| Unit 3 | 15 h |
| Cell cycle and Stem cells: cell cycle and cell division, cellular differentiation and stem cells, and epigenetics and induced pluripotent stem cells. Cell deaths: Apoptosis, necrosis and autophagy; Cancer: oncogenes, tumor suppressor genes, cancer cell division, virus-induced cancer, interaction of cancer cells with normal cells, embryonic signature in cancer cells. Research ethics on animal cell research. Recent trends in cell biology research and techniques. | |

**Reference Books:**


- G.M. Cooper. 2013. The Cell - A Molecular Approach, Sunderland (MA), Sinauer Associates, Inc. USA.
- Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
- Lodish, H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., and Scott M.P. Molecular Cell Biology, 7th Edition, Freeman, W. H. and Co., 2013.
- Alberts B., Walter P., Johnson A., Lewis J., Morgan D., and Raff. M., RobertsK., Walter P. Molecular Biology of the Cell, 6th Edition, Garland Publishing Inc., 2014.


**BCH-404 Genetics Credit 3**

**Objectives:**

The course is aimed to

- Introduce the aspects of inheritance and its regulation
- Provide knowledge about the genetic control of various characteristics of living organisms.
- Illustrate the cause and consequences of different human genetic disorders and its molecular diagnosis.

**Course Outcomes (CO):**

After the completion of this course, the students will be able to

1. Understand the fundamental principle of genetics.
2. Learn about the exceptions of mendelian genetics and transposable elements
3. Discern the phenotypic consequences of different genetic interactions
4. Know the various mechanisms of sex determination and genetic mapping

5. Gain the knowledge of various molecular mechanisms involved in human genetic disorders and diseases
6. Interpret hereditary diseases caused by genetic defects

| Course Name: Genetics and Genetic Disorders | Course Code-404 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |

| Unit 1 | 15 h |
|---|---|
| Introduction to Genetics, Mendelian Genetics, Extension of Mendelian Genetics: Incomplete dominance Codominance, Concept of alleles, Multiple alleles, Lethal alleles, Allelic and non-allelic interactions, Organization of nuclear and organelle genomes, C-value paradox, Repetitive DNA-satellite DNAs and interspersed repeated DNA, Chromosome organization, Giant chromosomes: Polytene and lamp brush chromosomes, Genome dynamicity, Transposable elements, LINES, SINES, Alu family, Extra chromosomal Inheritance / cytoplasmic Inheritance, including kappa articles in Paramecium, Shell coiling in snail. Bacterial Genetics: Transformation, Transduction, Conjugation: F factor-mediated, Hfr and Sexduction | |

| Unit 2 | 15 h |
|---|---|
| Point Mutations, Molecular basis of point mutation, Mutagenic agent: Chemical and radiation, Evaluation of mutagens, Chromosome theory of Sex determination: XX- XY, XX-XO, ZZ-ZW, Environment induced sex determination, Dosage compensation, Linkage, Linkage group, Complete linkage, and incomplete linkage, Crossing over, Mapping eukaryote chromosomes by recombination, Genetics control of the development of Drosophila: early development; origin of anterior-posterior and dorso-ventral polarity, the role of maternal genes, zygotic genes-segmentation genes and homeotic selector genes. Recent trends in genetics research and techniques. | |

| Unit 3 | 15 h |
|---|---|
| Human genetics, Normal human karyotype, Genetic disorders, Genetic disorders due to DNA mutations, Chromosomal disorder: changes in chromosome number, changes in chromosome structure, Genetic disorder related to mitochondrial genome, Multifactorial genetic disorders, Sex-linked genetic disorder in human, Pedigree analysis for the inheritance pattern of genetic diseases, Genetic counseling, Population Genetics, , Gene pool, Hardy-Weinberg principle and its application in studying the inheritance of genetic disorders, Diagnostics for genetic diseases. | |

**Reference Books:**

1. An Introduction to Genetic Analysis, Anthony JF Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart. New York: W. H. Freeman;

2. Genetics: A Conceptual Approach by Benjamin A Pierce (W.H. Freeman & Co. Ltd
3. Concepts of Genetics by William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Benjamin-Cummings Publishing Company
4. Genetic Analysis: An Integrated Approach by Mark Frederick Sanders, John L. Bowman
5. Theory and Problems of Genetics (Schaum's Outline Series) by William Stansfield McGraw-Hill Book Company

**BCH 405** **Microbiology** **Credit 3**

**Course Objectives:**

The course is aimed to

- Understand the origin and evolution of microbes and their benefits
- Illustrate the methodologies for microbes' identification and importance of microbes for developing therapeutics.
- Introduce structure and classification of various viruses and their life cycle

**Course Outcomes (CO):**

After the completion of this course, the students will be able to

1. Identify and classify different members of microbial world
2. Understand the origin and evolution of microorganisms and major microbial habitats
3. Recognize the relationship between microorganisms and diseases
4. Gain theoretical understanding of clinical samples, their examination and interpretation
5. Learn the basics of microbial growth and physiology
6. Understand host pathogen interaction and its association with diseases.

| Course Name: Microbiology | Course Code: BCH 405 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Origin and evolution of microbes and their benefits; Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese. Archaea, Classification and bacterial and archaea systematics, Classification of bacteria according to Bergey's manual, 16S rRNA, genomic similarity - content of guanine (G)+ cytosine (C) (%GC), metagenomics and human microbiome, Microbiome hotspots Microbiome based therapy, Microbes Growth and growth curve, Effect of environmental on bacterial growth, Eubacteria: cell structure, cell membrane and cell wall, cell wall staining, Gram and acid-fast staining, nutrition, isolation and cultivation, Antibiotic and enzyme isolation from microbes, Phage therapy for microbial disease | | | | | | |

| Unit 2 | 15 h |
|---|---|
| General characteristics of various groups of prokaryotes: bacteria including, Rickettsiae, Chlamydiae, Spirochaetes and Actinobacteria, Cyanobacteria and Mycoplasmas. General principles of diagnostic microbiology; Collection, transport and processing of clinical samples; Cultural, biochemical, serological and molecular methods for microbial typing; Physical, biochemical and microscopic examination of clinical samples (Blood, urine, stool etc.). Endemic, epidemic, pandemic and sporadic diseases; Concepts of mortality/ morbidity rates, incidence and prevalence; Communicable and non-communicable diseases | |
| Unit 3 | 15 h |
| Virology- Structure of animal viruses and plant viruses; satellite viruses; viroids; prions; diseases caused by animal viruses and plant viruses, genome organization of animal viruses; genome organization of DNA and RNA plant viruses, bacteriophages, lytic and lysogenic cycles, cultivation of viruses, diagnosis viruses, Protozoa: Classification, morphology, reproduction, modes of nutrition, modes of transmission, life cycle, cultivation of protozoa. Structure and significance: *Leishmania*, *Entamoeba*, *Plasmodium*. Biosafety and good practices in research. | |

**Reference Books:**


- Lansing M Prescott, Donald A Klein, John P Harley, Microbiology, Mc Graw Hill.
- Michael J Pelczar, Microbiology, Tata McGraw, India.
- Kathleen Park Talaro, Foundations in Microbiology, McGraw Hill.
- Christiaan Hoek, David Mann,Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E, Adelberg EA. 23rd edition. Lange Publication. 2004.
- Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2nd edition. American Society for Microbiology Press. 2005.
- Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society for Microbiology Press, Washington, DC USA. 2002


**BCH 406 Methods in Biochemistry and Microbiology Credit 3**

**Course Objectives-**

The course is aimed to

- Demonstrate the preparation of various buffers and estimation of biomolecules
- Explain about preparation and sterilization of microbiological media and microbial quantification methods

**Course Outcomes (CO):**

After the completion of this course, the students will be able to

1. Learn different Buffer preparations and practical applications of Henderson-Hasselbach equation.
2. Quantitatively Analysis different biomolecules
3. Isolate, enumerate, identify and characterize microorganisms from various samples
4. Learn different procedures of nucleic acid isolations.

<table>
<tr><td rowspan="2">Course Name:<br>Methods in Biochemistry and Microbiology</td><td rowspan="2">Course Code:<br>BCH 406</td><td>Type of Course:</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Credits<br>3</td></tr>
<tr><td>Core</td><td>0</td><td>0</td><td>6</td></tr>
<tr><td colspan="4">Unit 1</td><td colspan="3">45 h</td></tr>
<tr><td colspan="7">• To prepare different Buffer system (e.g Acetic-Na Acetate) and validate the Henderson-Hasselbach equation.<br>• Qualitative and Quantitative Analysis of Carbohydrates, proteins, Vitamin C.<br>• Separation of amino acids and sugars by TLC.<br>• Extraction of proteins, RNA and DNA from cultured cells.</td></tr>
<tr><td colspan="4">Unit 2</td><td colspan="3">45 h</td></tr>
<tr><td colspan="7">• Methods of sterilization, preparation of Media: Nutrient broth, Nutrient agar, plates, slants, soft agar<br>• Pure culture technique: Streak plate, spread plate and pour plate methods.<br>• Microbial Growth Kinetics<br>• Plasmid and DNA isolation</td></tr>
</table>

**BCH 407 Methods in Cell Biology and Immunology Credit 3**

**Course Objectives:**

The course is aimed to

- Demonstrate microscopic examination of various animal cells using cell counting and staining techniques, and Isolation and separation of nucleic acids and proteins from animal cells
- Provide hands-on experience to basic immunological techniques for determination of microorganisms in biological fluids and other samples

**Course Outcomes (CO):**

After the completion of this course, the students will be able to

1. Visualise morphology of various cell types and their growth
2. Determine the impact of various factors on cellular proliferation and viability.

3. Determine and quantify presence/absence of antigens and antibodies in biological samples.
4. Understand the interaction between antigen and antibody and its importance in the diagnosis

| Course Name: Methods in Cell and Molecular Biology | Course Code: BCH 407 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 0 | 0 | 6 | |
| Unit 1 | | | 45 h | | | |
| • Microscopic visualization of various animal cells,<br>• H&E and Giemsa staining<br>• Cell passaging and cell counting<br>• Cell viability assay | | | | | | |
| Unit 2 | | | 45 h | | | |
| • Radial and double immunodiffusion<br>• Rocket immunoelectrophoresis<br>• ELISA- Sandwitch and direct<br>• PBMC/lymphocytes isolation | | | | | | |

**BCH 408 Clinical Biochemistry Credit 3**

## Course Objectives:

The course is aimed to

- Understand basic concepts of biochemical investigation of different biofluids and tissues
- Comprehend and correlate the pathophysiological significance of clinical biochemistry analysis
- Gain fundamental and clinical knowledge of various human diseases along with diagnostic measurement of disease biomarkers.

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Acquire knowledge about chemical composition of various body fluids.
2. Understand the clinical basis of human diseases.
3. Know the fundamental deviation in biochemistry between metabolisms (carbohydrate, amino acid, nucleic acid and fats) of healthy and diseased person.
4. Learn quality control methods for clinical biochemistry lab

5. Acquire the basic knowledge about the diagnostic and prognostic tests for different diseases.
6. Design small projects for their summer or other training.

| Course Name: Clinical Biochemistry | Course Code: BCH 408 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |

| Unit 1 | 15 h |
|---|---|
| Quality control, accuracy, precision, specificity, sensitivity and limitation of errors allowable in the laboratory; Chemistry, composition & functions of blood, CSF, and synovial fluid; Urine formation, excretion and urine analysis; collection of bloods, anti-coagulants, preservatives of blood; Composition, chemistry & functions of specialized tissues like i.e. bone, brain, adipose tissue, etc. Clinical investigation of sugar levels in blood and urine; factors influencing blood glucose level; carbohydrate tolerance tests, glycogen storage diseases; Biosynthesis of bile acids, bile pigments and steroid hormones, plasma lipoproteins, Disorders associated with lipid metabolism and its therapeutic intervention, ketone bodies and ketosis | |
| Unit 2 | 15 h |
| Hemoglobin, Met-Hb, embryonic-Hb, heme metabolism associated diseases, sickle cell anemia, thalasemia, malnutrition, measurement of fuel values of foods, measurement and calculation of BMR, Metabolic disorders of amino acid metabolism and urea cycle, phenylketonuria, alkaptonuria, albinism, Lesch-Nyhan syndrome, disorders of nucleic acids metabolism. Biochemical mechanism of blood clotting and hemorrhagic disorders, disseminated intravascular coagulation, acquired prothrombin complex disorders. Biochemistry of vitamins and micronutrients, biochemical basis of diseases with their deficiency | |
| Unit 3 | 15 h |
| Electrolytes, reabsorption of electrolytes, acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, regulation of sodium and water balance, renin-angiotensin system, clinical investigation of sodium, potassium, chloride; Pathophysiology of different diseases like diabetes, Jaundice, Fatty liver, atherosclerosis, and osteoporosis; Functional test of liver, kidney, thyroid, gastrointestinal and pancreas, biochemical diagnosis of diseases by enzymatic assays; Clinical tissue analysis, biopsy, liquid biopsy, circulating RNA and DNA as molecular diagnosis of different diseases. Recent trends in clinical biochemistry research and techniques. Research ethics for human subjects and animal research. | |

**Reference Books:**


- Harpers Illustrated Biochemistry 30th Edition, McGraw-Hill Education, 2015
- Clinical Biochemistry and Metabolic Medicine Eighth Edition by Martin Andrew Crook, CRC Press, 2012
- Textbook of Biochemistry for Medical Students, 7th edition, by D M Vasudevan, Sreekumari S, KannanVaidyanathan, 2010, Jaypee.
- Clinical chemistry: Techniques, Principles, Correlations, 6th Edition, by Bishop, Fody and Schoeff, 2012, Lippincott Williams & Wilkins

**BCH-409 Molecular Biology Credit-3**

**Course Objectives:**

The course is aimed to

- Provide basic knowledge to students about Genome organization
- Illustrate the concept of central dogma of molecular biology; DNA replication, transcription and translation.
- Elucidate the various post transcriptional processing and its role in gene expression and regulation.

**Course Outcomes (CO):**

After completion of the course, students will be able to

1. Understand the basic knowledge about genome organization in various life forms.
2. Learn the processes of DNA replication, repair and recombination mechanism.
3. Comprehend the mechanisms of transcription, RNA processing and post transcriptional modifications
4. Acquire mechanistic knowledge about translational process in prokaryotes and eukaryotes.
5. Know the regulatory mechanisms of gene expression and function
6. Discern the fundamental knowledge of protein folding and transport

| Course Name<br>Molecular Biology | Course Code<br>BCH 402 | Type of Course:<br>Core | L<br>3 | T<br>0 | P<br>0 | Credits 3 |
|---|---|---|---|---|---|---|
| Unit 1 | | | 15 h | | | |
| Genome organization: Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics(Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting. | | | | | | |
| Unit 2 | | | 15 h | | | |
| DNA Replication, Repair and recombination: DNA Replication overview, Enzymes of replication; Details mechanism of prokaryotic and eukaryotic replication; DNA damage and repair; Recombination: Homologous and non-homologous; Site specific recombination; transposable elements and retrotransposon;<br>Transcription: Mechanism of Prokaryotic and Eukaryotic Transcription; Operon concept-lac, trp, ara, his, and gal operons; Attenuation; Transcriptional Regulation-Positive and negative; Termination-Rho-dependent and independent; Anti-termination; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eucaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP | | | | | | |

| |
|---|
| associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing. |

| Unit 3 | 15 h |
|---|---|
| Post Transcriptional Modifications: Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Mechanism of Splicing; Alternative slicing; RNA editing; Nuclear export of mRNA; mRNA stability; Ribozyme.<br>Translation & Transport: Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Genetic code in mitochondria; Degeneracy of codons; Termination codons; structure of tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation. Research ethics on working with recombinant DNA technology. Recent trends in molecular biology research and techniques. | |

**Reference Books:**


- Benjamin Lewin, Gene IX, 12th Edition, Jones and Barlett Publishers, 2017.
- J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 7th Edition, Benjamin Cummings Publishing Company Inc, 2017.
- Alberts et al; Molecular Biology of the Cell, New edition, Garland, .


**BCH 410 Enzymology Credit 2**

Course Objectives:

The course is aimed to

- Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms
- Describe the mechanisms of enzyme kinetics and activity through positive and negative feedback
- Illustrate the basic and advanced developments in the field of enzymology and enzyme technology

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Understand the basic principle of enzyme function in the biological systems.
2. Derive logical conclusions about enzymatic reactions
3. Learn the biochemical calculation for enzyme kinetics that will help them in hands-on training in the industry.
4. Compare methods for production, purification, characterization and immobilization of enzymes
5. Know the interaction of various inhibitors and medicines at biochemical level.
6. Understand the development of artificial enzymes which are current need of the industry.

<table>
<tr><td rowspan="2">Course Name:<br>Enzyme Technology</td><td rowspan="2">Course Code<br>BCH 410</td><td>Type of Course:</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Credits<br>2</td></tr>
<tr><td>Core</td><td>2</td><td>0</td><td>0</td></tr>
<tr><td colspan="4">Unit 1</td><td colspan="3">10 h</td></tr>
<tr><td colspan="7">Enzyme definition and characteristics; activation energy; active site and its mapping; nomenclature and classification of enzyme; cofactor and coenzyme; type of enzymatic catalysis; acid-base, nucleophilic-electrophilic covalent catalysis, kinetics of single substrate reaction, rapid equilibrium and steady-state approach, enzyme kinetics parameters (Km, Vmax, Kcat, Kcat/Km), determination of kinetics parameters using Lineweaver-Burk, Eddie-Hofstee plot, Scatchard plot; mechanisms of action of chymotrypsin, lysozyme; beta-lactamase, synthetic artificial enzymes, Ribozymes and its applications.</td></tr>
<tr><td colspan="5">Unit 2</td><td colspan="2">10 h</td></tr>
<tr><td colspan="7">Enzyme Inhibition; mechanism and kinetics of competitive, non-competitive and un-competitive inhibition; model of enzyme inhibitions; kinetics of bi-substrate reaction, ping-pong reaction; multi-substrate reaction; therorell chance displacement. Allosteric enzymes; symmetrical and sequential model; Isozymes and their significances; Hill's coefficients; Cooperativity, positive and negative; Hemoglobin as a model for cooperativity; Enzyme regulation and feedback control, covalent modification.</td></tr>
<tr><td colspan="5">Unit 3</td><td colspan="2">10 h</td></tr>
<tr><td colspan="7">Thermostable and cryostable enzymes; Protein engineering strategies to improve enzyme stability; CRISPR-Cas system, engineered chimeric antibody, catalytic antibodies (abzymes); Enzymes in bacterial resistance; Engineering of therapeutics against diseases associated enzymes; Strategies for the discovery of improved and novel enzymes for industrial applications; Enzyme immobilization techniques; Industrial important enzyme; enzyme replacement therapy. Recent trends in enzymology research and techniques.</td></tr>
</table>

**Reference Books:**

- Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer,

Publisher; Horwood Publishing Limited 2nd Edition. (2007)

- Enzymes: A Practical Introduction To Structure, Mechanism And Data Analysis by Robert A. Copeland, publisher: Wiley (2012)
- Introduction to Enzyme and Coenzyme Chemistry, 3rd Edition 2012 by T.D.H. Bugg, publisher Wiley-Blackwell
- Lehninger Principles of Biochemistry, Fourth Edition, David L. Nelson and Michael M. Cox. W. H. Freeman; 6th edition (2013).

**BCH 411 Techniques in Molecular Biology and Enzyme Technology Credit 3**

**Course Objectives:**

The course is aimed to

- Acquire knowledge about enzyme characterization and utilization in research and industry
- Provide knowledge about nucleic acids and protein isolation and PCR based cloning.

**Course Outcomes (CO):**

After completion of this course, the students will be able to:

1. Learn the calculation of kinetics parameter of the enzymes that will help them in hands-on training in the industry.
2. Know the interaction of various inhibitors and medicine at biochemical level.
3. Acquire practical knowledge in isolation of cellular proteins, DNA and RNA
4. Gain hands-on training in PCR and gene cloning.

| Course Name: Methods in Enzyme Technology | Course Code BCH 411 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 0 | 0 | 6 | |
| Unit 1 | | | 45 h | | | |
| • Isolation of cellular proteins, DNA and RNA and run on SDS-PAGE and agarose gels<br>• Isolation and purification of plasmid DNA.<br>• Primer designing and PCR amplification<br>• Restriction digestion and Cloning of PCR product | | | | | | |
| Unit 2 | | | 45 h | | | |

- Effect of substrate concentration on enzyme kinetics of beta galactosidase or beta-lactamase
- Determination of Kinetic Parameters for beta galactosidase or beta-lactamase
- Determination of optimum pH for enzymatic activity of beta-lactamase or beta galactosidase
- Determination of optimum temperature for enzymatic activity of beta-lactamase or beta galactosidase.

**BCH 412 Techniques in Clinical Biochemistry Credit 3**

**Course Objectives:**

The course is aimed to

- Provide students hands-on training on analysis of clinical samples for diagnosing different diseases.
- Enable students to correlate the biochemical analysis with disease symptoms and disease progression

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Learn various techniques used in clinical sample analysis
2. Correlate biological parameters with healthy and disease conditions.
3. Practical knowledge about the diagnostic and prognostic parameter associated different diseases.
4. Gain for designing a clinical based project proposal.

| Course Name: *Methods in Clinical Biochemistry* | Course Code: BCH 412 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 0 | 0 | 6 | |
| Unit 1 | | | 45h | | | |
| • Blood cell counting<br>• Blood plasma and serum isolation<br>• Determination of blood sugar, urea.<br>• Determination of blood cholesterol, triglycerides. | | | | | | |
| Unit 2 | | | 45 h | | | |

- Determination of blood uric acid, albumin, creatinine.
- Determination of blood SGPT, SGOT.
- Determination of blood SOD, Catalase and alkaline phosphatase activity
- Determination of blood Ca2+, Na+ and K+
- Paper chromatography – Separation of amino acids and carbohydrates in a mixture

**BCH 413** **Dissertation-I** **Credit 2**

**Course Objective**:

The course is aimed to

Provide knowledge about scientific writing skill, graphical and tabular presentation of data and analyzing the research outcome

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

- Learn about research aptitude and presentation skill of executed research project

**BCH 414** **Internship** **Credit 2**

**Course Objectives:**

The course is aimed to

- Expose students to real work environment and at the same time, to provide knowledge through hands on observation.
- Provide training to relate theoretical knowledge with its application in the industry.

**Course Outcome (CO):**

After the completion of this course, the students will be able to:

1. Execute the skills in the application of theory to practical work situations.
2. Apply skills and techniques directly applicable to their careers.
3. Work in real work environment experience, gain knowledge in writing report in technical works/projects.

**BCH 501 Biophysics and Bioinformatics Credit 3**

**Course Objectives:**

The course is aimed to

- Discuss the structure and function of proteins and nucleic acids
- Give insight of membrane structure, composition and transport
- Impart knowledge of basics of biophysics and bioinformatics, especially related with biological system and therapeutics.

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Understand the basics of structure, properties, and dynamics of biomolecules such as Protein, DNA and lipids.
2. Understand the molecular basis of various diseases associated with misfolding or incorrect conformation of the biomolecules.
3. Get insights into structure, composition and transport mechanism in Membrane
4. Know about different databases used for DNA, protein etc.
5. Learn the concept of phylogenetic relationship amongst the different species and biomolecules.
6. Design the suitable therapeutics using in-silico approach.

| Course Name: Biophysics and Bioinformatics | Course Code: 501 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Conformations of peptide and proteins, alpha and Pi helix, Turns (beta, alpha, gamma etc.), Ramachandran plot, protein folds and motifs, domains and domain swapping, protein symmetry, molecular chaperons, Structure of fibrous proteins, unnatural amino acids and peptides, peptidomimetics, intrinsically disorder proteins, Protein stability and denaturation, effect of osmolytes on biomolecules stability, protein folding- rules, pathways, and kinetics, folding of RNaseA, Levinthal Paradox, Chevron plot, Φ-value analysis, m-value analysis, protein-protein interactions, Receptor agonists and antagonists. biogenetics of amyloidogenesis, stability of extreme proteins (thermophile and cryophile) | | | | | | |
| Unit 2 | | | 15 h | | | |

| | |
|---|---|
| Torsion angles of nucleotide, sugar conformation, DNA motifs, DNA repeats and their significance chemical structure and properties of purine, pyrimidine, nucleoside, nucleotide and their derivative, structure and properties of different type of DNA and RNA, triple-helix DNA, quadraplex DNA, higher orders of DNA structure. Effect of pH, humidity, metal & salt on the conformation of DNA, protein-nucleic acid interactions. Effect of membrane composition on the Tm of membrane, trans-membrane helices, hydropathy plot and prediction of membrane spanning domains, membrane asymmetry, membrane fluidity, detergents and membrane solubilization, functional reconstitution of artificial membranes, Membrane potentials, Nernst equation, trans-membrane potential, Zeta, Stern, Donnan's equilibrium, mechanism of membrane transport | |
| Unit 3 | 15 h |
| Databases, multiple sequence alignment, phylogenetic clustering and analysis, protein modelling, molecular docking, identification of drug targets, In-silico drug designing, Combinatorial library, molecular mechanics; molecular dynamics simulation and force fields, ADMET analysis, Chimeric vaccine design and development, Design of hybrid antibiotics; Quantitative Structure Activity Relationship (QSAR), 3D pharmacophore, Pharmacokinetics, pharmacogenomics, chemoinformatics and chemogenomics. | |

Reference Books:


- Thomas E. Creighton, Proteins: Structure and Molecular Properties, W H Freeman & Co, 2016.
- Carl-IvarBrändén, John Tooze, Introduction to Protein Structure , Garland Pub., 2nd Edition.2012.
- Jack Kyte , Structure in Protein Chemistry , Garland Science, 2007.
- David Whitford, Proteins-Structure and function, Wiley, 2005.
- A. Kessel and Nir Ben-Tal, Introduction to Proteins-Structure, function and motion, CRC press, Taylor and Francis, 2011.
- Georg E. Schulz, R. HeinerSchirmer, Principles of protein structure, Springer, 1998.


**BCH 502 Analytical Biochemistry Credit 3**

**Course Objectives:**

The course is aimed to:

- Discuss about various spectroscopic techniques
- Communicate the centrifugation and chromatographic techniques
- Give insights on various Electrophoretic and radioactive based techniques

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Understand the underlying principles of diverse modern and classical spectroscopic techniques that are very useful in research.
2. Perform these techniques once given chance for hands-on training.
3. Know the applications and significances of techniques in biochemistry, molecular and structural biology research etc.
4. Appreciate the history and development of these techniques over a span of several decades.
5. Learn the basics of microscopic, spectroscopic, separation and labelling techniques.
6. Know the instrumentation layout and inside components of various instrument used for life science research

| Course Name: Analytical Biochemistry | Course Code: BCH 502 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Colorimetry and Spectrometry: Beer Lambert's law, Transmittance, Absorbance, Optical density; Types of Spectroscopy: UV & Visible - Principle, instrumentation & application. Fluorescence spectroscopy, FRET, Luminescence, Circular Dichroism, Infra-Red spectroscopy, Raman spectroscopy, Nuclear Magnetic Resonance, X-ray diffraction and Mass spectrometry. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Centrifugation Techniques: Theory - Clinical, High speed and Ultracentrifuge - analytical and preparative; Centrifuge rotors: vertical, fixed angle, swinging bucket; Subcellular fractionation by differential centrifugation.<br>Chromatographic Techniques: Partition- Adsorption-Ion Exchange- Gel filtration and Affinity chromatography; Principles of Gas Liquid chromatography and High Performance Liquid Chromatography. SDS-PAGE, AGE, PFGE, Capillary electrophoresis, Southern blotting, Northern blotting, Western blotting, South-western blotting, | | | | | | |
| Unit 3 | | | 15 h | | | |
| Electrophoretic Techniques: Principle and applications of Paper, Starch, Agarose, Polyacrylamide, Cellulose Acetate and Immunoelectrophoresis; Southern, Northern, Western Blots; Concepts and application of PCR. Radioactive techniques: Types of radiation- Units if radioactivity- Radioisotopes, Half-life- - Pulse labeling technique, Autoradiography. Introduction to Intellectual Property Right and patents. | | | | | | |

**Reference Books:**


- Christian, G. D., Analytical Chemistry, John Wiley & Sons (Asia) Pvt. Ltd.,7 th Edition 2013.
- Wilson, K. and Walker, J., Principles and Techniques of Practical Biochemistry and Molecular Biology, 7th Edition, Cambridge Univ. Press, 2010.

- David Freifelder, Physical Biochemistry, 2nd edition, John Wiley and Sons 2005.


**BCH 503 Human Physiology Credit 3**

**Course Objectives:**

The course is aimed to:

- Illustrate how human body works and fundamental mechanisms underlying normal function of cells, tissues, organs, and organ systems in humans.
- Discuss the homeostatic and physiological mechanisms of human body, structure, function and coordination of different organ systems.
- Apply knowledge of functional mechanisms and their regulation to explain the pathophysiology underlying common diseases.

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Understand The anatomy and physiology, various levels of organizations, basic homeostatic mechanism and classify the peripheral nervous system, nerves and morphology and physiology of special senses.
2. Know the importance of the endocrine system, hormonal action, function of various body fluids like blood and lymph, their significance, and related disorders.
3. Comprehend the anatomy, physiology and parameters related to CVS and related disorders.
4. Learn haemopoetic and lymphatic system homeostatic and its altered physiology.
5. Know the physiology of muscle contraction and anatomy and physiology of respiratory system and its disorders.
6. Learn the physiology of digestive, nervous, urinary and reproductive systems and their disorders.

| Course Name: Human Physiology | Course Code BCH 503 | Type of Course: Core | L 3 | T 0 | P 0 | Credits 3 |
|---|---|---|---|---|---|---|
| Unit 1 | | | | | | 15 h |
| Introduction to Physiology, Functional Organization of the Human Body and Control through homeostasis, Chemical Composition of the Body, Membrane Potentials and Action Potentials, Excitable Tissue (Nerve & Muscle), Organization of the Nervous System (CNS & PNS), functional areas of Brain, Basic Functions of Synapses, and Neurotransmitters, Sensory Systems: Special senses (vision, sense of hearing, taste and smell) Neuronal Circuits for Processing Information , Autonomic and Somatic Nervous Systems, Contraction of Skeletal | | | | | | |

| | |
|---|---|
| Muscle. | |
| Unit 2 | 15 h |
| The Endocrine System (all hormones and its functions), The Cardiovascular System: The Heart, Cardiovascular Physiology: Blood Vessels and Hemodynamics, Blood, Microcirculation and Lymphatic System, Regulation of circulation, The Respiratory System, Respiratory Physiology, Pulmonary Ventilation, Pulmonary Circulation, Pulmonary Edema, Pleural Fluid, Principles of Gas Exchange; Diffusion of Oxygen and Carbon Dioxide Through the Respiratory Membrane, Transport of Oxygen and Carbon Dioxide in Blood and Tissue Fluids, Regulation of Respiration. | |
| Unit 3 | 15 h |
| The Urinary System: Functional Anatomy and Urine Formation by the Kidneys, Glomerular Filtration, Renal Blood Flow, and Their Control, Renal Tubular Reabsorption and Secretion, Urine Concentration and Dilution; Regulation of Extracellular Fluid Osmolarity and Sodium Concentration Fluid, Electrolyte, and Acid–Base Homeostasis, Gastrointestinal physiology, Metabolic Adaptations, Energy Balance, and Temperature Regulation, The Reproductive Systems. | |

**Reference Books:**


- A text book of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia.
- Introduction to Physiology by Davidson H and Segal M. B. Academic Press.
- Review of Medical Physiology-William F.Ganong
- Physiological basis of Medical Practice, John.B.West.
- Vander‟s Human Physiology-The mechanism of Body function, Widmaier, Raff, strang.
- Netter's Clinical Anatomy atlas.


**BCH 504 Plant physiology and Biochemistry Credit 3**

**Course Objectives:**

The course is aimed to:

- Educate about the mechanism and physiology of life processes in plants.
- Discuss the plant nutrient uptake and translocation, photosynthesis, respiration and nitrogen metabolism.
- Illustrate the biochemistry and specific knowledge of compounds and biochemical pathways that occur in plants.

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Know about the structure of plant cell, and apply specific biochemical functions to all compartments of the plant cell.
2. Learn the structure, function and biosynthetic pathways of essential biochemical molecules including their key chemical and physical properties.
3. Understand how light energy is captured and used to provide chemical forms of energy to power the functions of cells and whole plants.
4. Know the importance of $CO_2$ fixation and carbohydrate metabolism.
5. Comprehend the central metabolism for the growth, its plant-specific components, and their functional significance at multiple levels.
6. Learn the variety of secondary compounds and metabolism in plants and their use in human health.

| Course Name: Plant physiology and Biochemistry | Course Code: BCH 504 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Absorption of water and Ascent of sap: diffusion and osmosis, Plant cell Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal movement, transpiration, photoperiodism and biological clocks, plant movement; Photosynthesis: Photoreceptorsphytochromes, Photosynthetic apparatus, pigments of photosynthesis, Calvin cycle (C3 plants), Hatch slack (C4 plants) & CAM pathways of carbon reduction and its regulation, Structure, function and regulation of RUBISCO, Crassulacean acid metabolism in plants; Photorespiration: photorespiration pathway and significance, cyanide Resistance, Photoinhibition | | | | | | |
| Unit 2 | | | 15 h | | | |
| Phytohormones: Biosynthesis, transport, physiological effects, mode of action and signal transduction of auxins, gibberlic acid, abscisic acid, ethylene and cytokinins; Nitrogen metabolism: Nitrogen fixation, nitrogenise complex, biochemistry and genetics of nitrogen fixation and ammonium assimilation, structure of 'NIF' genes and its regulation, nitrate reductase and nitrite reductase, regulation of nitrate and sulphate assimilation. Secondary plant metabolites: Nature, distribution, biosynthesis and function of plant metabolites, biosynthesis of nicotine. Biochemistry of plant toxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins, role of secondary metabolites in chemical defense. | | | | | | |
| Unit 3 | | | 15 h | | | |

Plant stress physiology: Plant responses to abiotic and biotic stresses, salinity, water, heat, chilling, heavy metals and their impact on plant growth and metabolism, mechanisms of resistance to biotic stress and abiotic stress, antioxidative defence mechanism; Plant defence: Genetic basis of plant-pathogen interactions, antio R-Avr gene interactions and isolation of R genes, hypersensitive response (HR), systemic acquired resistance (SAR) and induced systemic resistance (ISR). Recent trends in Plant physiology and Biochemistry research and techniques.

**Reference Books:**


- Introduction of Plant Biochemistry, by Goodwin T. W. and E.I. Mercer, Pergamon Press,
- Oxford, 2nd Edition. 2005.
- Plant Physiology, 6th Edition, by Lincoln Taiz and Eduardo Zeiger, Amazon press, 2015.
- Buchanan BB, Gruissem W & Jones RL. 2015. Biochemistry and Molecular Biology of
- Plants. 2nd Ed. John Wiley.
- Dey PM &Harborne JB. 2013. Plant Biochemistry. Academic Press.
- Heldt HS. 1997. Plant Biochemistry and Molecular Biology. Oxford Univ.Press.


**BCH 505 Methods in Human Physiology and computational Biology Credit 3**

**Course Objectives:**

The course is aimed to:

- Give the students hands on practice of different bioinformatics tools and to find sequences, analysis of protein and nucleic acid sequences by various software packages
- Train the students for measuring different parameters of the human physiology.

**Course Outcomes (CO):**

After the completion of this course, the students will be able to:

1. Identify various tissues and organs of different systems of human body.
2. Perform the haematological test like blood cell count, haemoglobin estimation, bleeding/clotting time, etc.
3. Know about the interface, resources, various tools to study most important bioinformatics databases;
4. Learn multiple sequence alignment, its principle and execution of pairwise sequence alignment.

| Course Name: Methods in Human Physiology and computational Biology | Course Code: BCH 505 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 0 | 0 | 6 | |
| Unit 1 | | | 45 h | | | |

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| • Measurement of Blood Pressure by auscultatory method using sphygmomanometer.<br>• Estimation of Hemoglobin by sahli's method using haemoglobinometer.<br>• Enumeration of WBC and RBC using hemocytometer.<br>• Measurement of Erythrocyte sedimentation by westergren method. |
| Unit 2 — 45 h |
| • NCBI and Uniprot web resources.<br>• Multiple sequence alignment using ClustalW<br>• Use of various primer designing and restriction site prediction tools<br>• Homology modelling of proteins |

**BCH 506 Method in Analytical Biochemistry and Plant Tissue Culture Credit 3**

**Course Objectives:**

The course is aimed to:

- The course will provide knowledge of the analytical instrument.
- The course aims at the concept, scope, instrumentation, basic requirements, and applied aspects of plant tissue culture technique.

**Course Outcome (CO):**

After the completion of this course, the students will be able to:

1. Perform the Quantitative estimation of biomolecules.
2. Get hands on experience of basic chromatographic and electrophoretic techniques.
3. Achieve a valuable understanding of plant tissue culture techniques
4. Learn transformation approach in plant biotechnology

| Course Name: Method in Analytical Biochemistry and Plant Tissue Culture | Course Code: BCH 506 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core | 0 | 0 | 6 | |
| Unit 1 | | | 45h | | | |
| • Preparation of standard curve of protein and determination of unknown concentration using Absorption spectroscopic technique and Bradford reagent<br>• Determination of reducing sugar concentration using dinitro-salycilic acid reagent<br>• Isolation of casein from milk<br>• Separation of amino acids by paper chromatography | | | | | | |
| Unit 2 | | | 45h | | | |

- Preparation of M.S. media
- Preparation of callus
- Plasmid transformation in *Agrobacterium tumefaciens* strain
- Isolation of plant genomic DNA by modified CTAB method and gel electrophoresis

**BCH 508 Research paper presentation Credit 2**

**Course Objectives**:

The course is aimed to:

- get students acquaint with reading and understand of published scientific research papers.

**Course Outcomes (CO):**

After the completion of this course, the students will be able to

- get knowledge about how to understand any research paper and presentation skill

**BCH-509 Dissertation presentation Credit 3**

**Course Objectives:**

The course is aimed to

- provide the experience in communicating and defending dissertation findings.

**Course Outcomes (CO):**

After completion of this course, Student will be able to

- acquire the skills for presenting their research work.

**BCH-510 Dissertation II (Major Project) Credit 16**

**Course Objectives:**

The course is aimed to

- train for designing and executing the research project.

**Course Outcomes (CO):** After completion of this course, Student will be able to

- develop research hypothesis and carry out objective based experiments, data analysis and prepare the research manuscript for publication.

## The detailed course content of Discipline Specific Elective (Annexure 1)

**BCH-431 Agricultural Biotechnology Credit 3**

**Course Objectives:**

The course is aimed to

- Provide a basic knowledge about genetic engineering and the foundations of modern biotechnology
- Elucidate the principles that form the basis for recombinant DNA technology.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Understand and explain the concept of genetic engineering, including the techniques, applications, and limitations.
2. Demonstrate the ability to design recombinant molecules and apply information extracted from various sources, including journal articles, technical bulletins, product manuals, and drug information sheets, to solve problems.
3. Design an experiment with step-by-step instructions to address a research problem

| Course Name: | Course Code: | Type of Course: | L | T | P | Credits |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Agricultural Biotechnology | BCH 431 | DSE | 3 | 0 | 0 | 3 |
| Unit 1 | | | 15 h | | | |
| Food and Agriculture-Food and agriculture; Scenarios of rise in population and food production at National and International levels; Indian farming; Major crop plants; Achievements and limitations of conventional plant breeding science. Molecular Mapping and Marker-assisted Breeding-Marker-assisted plant breeding; Relative advantages/ disadvantages in conventional plant breeding and molecular breeding; Molecular polymorphism, Construction of genetic and physical map; Marker Assisted Selection (MAS) for genes of agronomic importance. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Agrobacterium biology; Ti plasmid-based transformation; crown gall and hairy root disease, Ti and Ri plasmids, T-DNA genes, borders, overdrive, chromosomal and Ti plasmid virulence genes and their functions, vir gene induction, mechanism of T-DNA transfer; Tipasmid vectors, vir helper plasmid, super virulence and monocot transformation, binary vector; Floral dip transformation; Promoters and polyA signals; Protein targeting signals; Plant selectable markers; Reporter genes; Positive selection; Selectable marker elimination; Transgene silencing; Strategies to avoid transgene silencing. | | | | | | |
| Unit 3 | | | 15 h | | | |
| Genetic engineering of crops; Commercial status of transgenic plants; Herbicide resistance, glyphosate, sulfonyl urea, phosphinothricin, atrazine; Pest resistance, Bt toxin, synthetic Bt toxin; Protease inhibitor; GNA and other lectins; α-amylase inhibitor; nematode resistance; Genetic engineering for male sterility Barnase-Barstar; Delay of fruit ripening; polygalacturanase, ACC synthase, ACC oxidase; Improved seed storage proteins; Improving and altering the composition of starch and plant oils; Golden rice for βcarotene accumulation; Production of antibodies and pharmaceuticals in plants; Recent trends in agricultural biotechnology research and techniques. | | | | | | |

**Suggested Readings**:


- Altman, A. Hasegawa, P. M. (2011) Plant Biotechnology and Agriculture: Prospects for the 21st Century. Academic Press, USA.
- Gurib-Fakim, A. (2014) Novel Plant Bioresources: Applications in Food, Medicine and Cosmetics. Wiley Blackwell, USA.
- Kirakosyan, A. (2016) Recent Advances in Plant Biotechnology. Springer, USA.

- Stewart, C. N. (Jr.) (2016) Plant Biotechnology and Genetics: Principles, Techniques, and Applications. Wiley, USA.


**BCH-432** **Antimicrobial Resistance** **Credit 3**

**Course Objectives:**

The course is aimed to

- develop the concepts of the molecular basis of antimicrobial molecules.
- understand the mechanism of the emergence of antimicrobial resistance, and therapeutics developments.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Explain key concepts of the molecular mechanism of antimicrobial molecules.
2. Understand the emergence of global antibiotic resistance in different pathogens.
3. Learn to develop novel therapeutics for the antimicrobial-resistant pathogens

| Course Name: Antimicrobial Resistance | Course Code: BCH 432 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Antibiotics; Classification of antibiotics; Natural antibiotics; Synthetic and semi-synthetic antibiotics; Mechanism of antibiotics action (inhibition of cell walls synthesis, protein synthesis, nucleic acids synthesis, metabolic reactions); Pre-antibiotics era; Bactericidal and bacteriostatic antibiotics; Molecular targets of antimicrobial like metabolic pathways, signal transduction pathways, post-translations and epigenetic modifications; Antifungal molecules, Antibiofilm molecules, Disinfectants in hospital acquired infections; Phage therapy for bacterial pathogen; Lysin therapy. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Antibiotic resistance mechanisms; Modification of antibiotic targets, Influx channel; Efflux pumps; Beta-lactamases; Alteration in antibiotics; Intrinsic and acquired resistance; Superbugs; Antibiotics use and resistance; Resistance of existing classes targeting cell wall, ribosome, nucleic acid synthesis (replication and transcription); Role of mobile genetic elements and genetic mutation in resistance; Transmission of mutations by vertical gene transfer, Role of | | | | | | |

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|---|
| horizontal gene transfer in resistance; Role of evolution and natural selection in resistance; Spread of antibiotic resistance, Factor leading to overuse and misuse of antibiotics; global antibiotic surveillance; Case study of antibiotics resistance in *Acinetobacter, Staphylococcus, Salmonella* and *Mycobacterium;* WHO reports on antibiotics resistance; Resistance mechanism against antifungal agents. |

| Unit 3 | 15 h |
|---|---|
| Experimentally evolving antibiotics susceptibility and resistance; Production of natural, synthetic and semi-synthetic antibiotics; Methods & barriers of development of new antibiotic and their approval; Repurposing and modification of current antibiotics for better efficacy; Chimeric antibiotics; Enhancement of efficacy of current antibiotics (Nano-capsulation, chemical modification), Case study of discovery of antibiotics from novel sources (soil, nasal etc) and extreme environments; Nanomedicine and nano-herbal formulation for drug resistant pathogens; Databases for antibiotic resistance and virulence, Use of artificial intelligence in antimicrobial resistance. Recent trends in antimicrobial resistance research and techniques. | |

**Books recommended:**

- Prescott's Microbiology: Willey & Sherwood.
- Brock Biology of Microorganism: Madigan &Martinko
- Microbiology; an introduction: Tortora & Funke
- David Freifelder, Physical Biochemistry, 2nd edition, John Wiley and Sons 2005.

**BCH-433 Cancer Cell Biology Credit 3**

**Course Objectives:**

The course is aimed to

- Explain the fundamental molecular and biochemical basis of cancer diseases.
- Elucidate the mode of action of different anticancer therapeutics.

**Course outcomes (CO):**

After completion of the course students will be able to

1. Learn the basic genetic, molecular, and biochemical principles of cancer diseases, which certainly lead to developing their research projects
2. Acquire knowledge about biochemistry and biology of cancer incidence, development, progression, and cancer metastasis.
3. Gain a concept about both merit and short comings of therapy used in cancer treatment.

| Course Name: Cancer Cell Biology | Course Code: BCH 433 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Introduction to Cancer Biology: Definition and classification; evolution of cancer cells; cellular oncogenes; oncogene, viral-oncogene, tumorigenicity, tumor suppressor genes; p53, Rb and PTEN, micro RNAs and regulation of cancer growth; tumor suppressor microRNAs and oncomiRs. Cancer metastasis, migration & invasion, metastasis steps, epithelial to mesenchymal transition, angiogenesis; hypoxia and crosstalk between autophagy and apoptosis in mammalian cells. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Microenvironment of Tumor cells: Stroma interaction, adipose stromal cells, cancer associated fibroblast, tumor associated macrophages, mesenchymal stem cells, impact of tumor-stroma interaction on tumor development, tumor immunology; interferons, T cells, cancer stem cells; origin, isolation and culture of cancer stem cells, animal models of cancer study; xenograft and metastasis models. | | | | | | |
| Unit 3 | | | 15 h | | | |
| Cancer growth and metastasis: Growth factor, receptors and cancer; *in vitro* testing of stemness property of cancer stem cells; detection and monitoring of metastasis process in animal models; osteoblastic & osteolytic metastasis, Success and failure of chemotherapy, targeted specific therapy, monoclonal antibody for cancer treatment, micro-RNA mediated cancer treatment and targeted drug delivery, drug resistance, molecular diagnosis and stem cell therapy. Recent trends in cancer research and therapy. | | | | | | |

**Books recommended:**

- The Biology of Cancer, 2nd Edition, Robert A Weingberg, ISBN-10: 0815342209, ISBN-13: 978-0815342205
- Cancer Biology, 4th Edition, Raymond W Ruddon, ISBN-10: 0195175441 | ISBN-13: 978-0195175448

**BCH 434** **Developmental Biology** **Credit 3**

**Course Objectives:**

The course is aimed to

- To familiarize the concepts of developmental biology and evolutionary principles.
- To explain the cell specification mechanism and early developments of different model organisms like *C.elegans*, Drosophila, amphibian, fish, and mouse development.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Understand the stages of animal development.
2. Describe the autonomous and conditional specification works in coordination in determining the axis and fate maps of the organism.
3. Know different types of metamorphosis and mechanisms and associated anatomical and physiological changes.

<table>
<tr><td rowspan="2">Course Name: Developmental Biology</td><td rowspan="2">Course Code: BCH 434</td><td>Type of Course</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Credits 3</td></tr>
<tr><td>DSE</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td colspan="4">Unit 1</td><td colspan="3">15 h</td></tr>
<tr><td colspan="7">Basic concept of development: Historical view of developmental biology, Basic features of development in animals, gametogenesis, typesof eggs, fertilization, cleavage, blastula and gastrulation, evolutionary developmental biology, principles of Karl Ernst von Baer, generation of multicellular embryo, formation of germ layers, patterning of vertebrate body plan, Fate maps and cell lineages, Cell specification: Autonomous and conditional specification, Differential gene expression: Histone , DNA, RNA and Translation level of regulation, Juxtacrine and paracrine signaling in morphogenesis, Developmental signals,</td></tr>
<tr><td colspan="4">Unit 2</td><td colspan="3">15 h</td></tr>
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| | |
|---|---|
| Sex determination in mammals and Drosophila: Primary and secondary sex determination, ovary and testis pathway, Mammalian gametogenesis. Extra cellular membranes of egg. Fertilization: factors critical in external fertilization and activation, fertilization in mammals. Early development in Snails and *C.elegans*cleavage and axis formation, early developmental aspects of Drosophilla, Segmentation genes, Homeotic selector genes, early development in Sea Urchins and Tunicates, early development in Amphibians and fish, Molecular mechanisms of amphibian axis formation, | |
| Unit 3 | 15 h |
| Developmental aspects of Birds and mammals, Organogenesis, Post embryonic development: Metamorphosis in Amphibian, insects and pluteus larva, Regeneration in Hydra, Flatworms, Salamanders and mammals, Aging and senescence, Teratogenesis, Geneticerrors of human development, in-vitro fertilization, environmental assaults on human development, design of future medicines like gene therapy, therapeutic cloning and regeneration therapy. Recent trends in developmental biology research and techniques. | |

**Books recommended**:

- Developmental Biology by Scott F. Gilbert and Michael J.F. Barresi Sinauer Associates, Inc, MA, USA, 11th Edition.
- An introduction to embryology, B I Balinsky 5th Edition.
- Developmental Biology by Werner A. Müller.
- CaenorhabditisElegans: Molecular Genetics and Development, second edition, By Joel H. Rothman Academic Press, 2011.
- A. Nagy, M. Gertsenstein, K Vintersten, R. Behringer. 2003. Manipulating the mouse embryo: a laboratory manual, Cold spring Harbor Press, New York, USA.

**BCH-435 Ecology and Molecular Evolution Credit 3**

**Course Objectives:**

The course is aimed to

- Provide different concepts of ecology which drive the plant and the interrelation between different life forms.

- Illustrate about the molecular evolution of a living organism, various theories of evolution.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Know the characteristics of the population and its dynamics.
2. Understand that energy flow and recycling of matter are driving forces of the ecosystem to function as one unit.
3. Gain the knowledge about the pollution and its adverse effects on the biodiversity of this planet.

| Course Name: Ecology and Molecular Evolution | Course Code: BCH 435 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Abiotic environment and biotic environment, concept of habitat and niche, population characteristics, population growth curves, population regulation, metapopulation, age structures. species interactions, tropic interactions, interspecific competition, mutualism, commensalism, competition and predation. Nature of communities, community structure and attributes; levels of species diversity and its measurement; edges and ecotones, ecological succession. Dynamics of ecosystems, energy flow, nutrient cycles, trophic levels, and biomes. Major terrestrial biomes, biogeographical zones of India. Environmental pollution, global change, biodiversity and principles of conservation. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Origin of biomolecules, abiotic synthesis of organic polymers, origin of cells, evolution of prokaryotes and eukaryotes, evolution of anaerobic and aerobic metabolism, origins of unicellular and multi cellular organisms. Concepts of neutral evolution, molecular divergence and molecular clocks, selection and genetic drift on the molecular level, molecular tools in phylogeny, classification and identification, cladistics and phonetics, mutational processes, evolution of mutation rates, protein and nucleotide sequence analysis; origin of new genes and proteins, polymorphism, SNPs, gene duplication and divergence. | | | | | | |
| Unit 3 | | | 15 h | | | |

Introduction to evolution, origin of earth, origins of early evolutionary thought, Darwin's evidence of evolution, variation, struggle for existence, natural selection, migration, genetic drift and adaptation radiation, concepts of speciation, allopatric and sympatric, convergent evolution, co evolution and sexual selection, Hardy-Weinberg equilibrium, mutation and gene flow. Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale.Recent trends in ecology and molecular evolution research and techniques.

**Books Recommended:**

- Evolution: What the fossils say and why it matters, by Donald Prothero.
- On the Origin of Species, by Charles Darwin.
- The Blind Watchmaker, by Richard Dawkins.
- The Selfish Gene, by Richard Dawkins.
- Evolution and the myth of creationism, by Tim M.Berra.
- Evolution: The Human Story, by Dr. Alice Roberts
- Concepts of Ecology, by Kormondy Edward J.

**BCH 436 Host-Pathogen Interaction Credit 3**

**Course Objectives:**

The course is aimed to

- Enlighten the concept of interaction of different pathogens with their host.
- Provide a concept for designing of therapeutics targeted to lethal pathogens.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Gain the knowledge about the basic concept of interaction of different pathogens with their corresponding hosts.
2. Understand different strategies of pathogen to overcome host immune system.
3. Learn to design novel therapeutics for pathogens targeting to the host pathogen. Interaction.

| Course Name | Course Code | Type of Course: | L | T | P | Credits |
|---|---|---|---|---|---|---|
| Host-Pathogen Interaction | 436 | DSE | 3 | 0 | 0 | 3 |

| Unit 1 | 15 h |
|---|---|
| Molecular basis of bacterial pathogenesis, bacterial persistence, extracellular and intracellular pathogens, virulence factors, adhesins, pathogenicity island, protein and DNA secreting systems in pathogenicity and disease, role of biofilm and quorum-sensing in virulence and disease, sensors of extracellular colonization by bacteria, bacteriophage-bacterial interaction; phage tolerance and resistance; holin-endolysin system in bacteriophage; disrupting bacterial communication and quorum sensing; Evolution of CRISPR-Cas system in bacteria | |
| Unit 2 | 15 h |
| Course Content<br>Model systems to understand pathogenic mechanisms, modulation of host signaling system in response to infection, mechanisms of immune tolerance and alteration of host cell behaviour by pathogens; bacterial escape to autophagy and xenophagy; Role of host-pathogen interaction in human diseases caused by bacteria and virus; Bacterial competition and evolution in similar habitat; Hospital acquired infections and ESKAPE pathogens. | |
| Unit 3 | 15 h |
| Course Content<br>Human microbiome and distribution in the human body; interaction of human microbiodata with the pathogenic bacteria; molecular basis of plant microbe interactions, plant immunity to pathogen; Animal model to study host-pathogen interaction; development of therapeutics (in-silico, nano-herbal) targeting to host-pathogen interaction, methods used to study host-pathogen interactions; Diagnosis of bacterial and viral infection; Role of CRISPR-Cas system in investigating host-pathogen interaction. Recent trends in host-pathogen interaction research and techniques. Recent trends in host-pathogen interaction research and techniques. | |

Reference Books:


- Prescott's Microbiology: Willey & Sherwood. 2008.
- Brock Biology of Microorganism: Madigan & Martinko
- Microbiology; an introduction: Tortora & Funke. 11th Edition. 2016.
- David Freifelder, Physical Biochemistry, 2nd edition, John Wiley and Sons 2005.


**BCH-437 Infection Biology Credit 3**

**Course Objectives:**

The course is aimed to

- Explain various agents causing infectious diseases in animals and humans and disease-causing mechanism.
- Propose measures for the prevention and cure of infectious diseases.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Classify different agents causing infectious diseases and understand the mode of infection, biology, and life cycle of different infectious agents.
2. Have a detailed understanding of the epidemiology and preventive methods of different infectious diseases
3. Learn an overview of the current challenges such as drug resistance and immune evasion for treating infectious diseases

| Course Name: Infection Biology | Course Code: BCH 437 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Viral infection: Development of HIV virus, HIV infection to humans, Structure of HIV virus, mechanism of HIV infection, role of T cells in infection development, development of therapy against HIV, anti-retroviral therapy, HAART, economic loss by HIV at national & international level. Hepatitis virus, types of hepatitis infection, viral outbreaks such as Ebolla, H1N1, and Zika virus, SARS-COV-2. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Bacterial infection: Development of tuberculosis infection, diagnosis of tuberculosis, epidemiology and geography of tuberculosis, treatment of tuberculosis, identification of drug targets, vaccine development for tuberculosis, mechanism of antituberculosis drug action, development of resistant, multidrug-resistant, economic loss by tuberculosis at the national and international level, HIV-tuberculosis co-infection. | | | | | | |
| Unit 3 | | | 15 h | | | |

Parasite infection: Parasitic infectious diseases, leishmaniasis, epidemiology and geography of leishmaniasis, vector and transmission of leishmaniasis, host-pathogen interaction, diagnosis and treatment for leishmaniasis, genetics of leishmaniasis, mechanism of drug resistance and drug susceptibility for promastigotes and amastigotes, history of malaria, life cycle of *Plasmodium*, factors affecting transmission of parasite, vectors and epidemics, parasite metabolisms, secondary endosymbiosis, drug resistant parasites, identification of drug targets, amoebiasis. Recent trends in infection biology research and techniques.

**Books recommended:**

- Irwin W. Sherman, Malaria Parasite Biology, Pathogenesis, andProtection, American Society for Microbiology. 1998.
- WHO technical series-949; Control of the leishmaniasis (ISBN 978 92 4 120949 6).
- Virology: Principles and Applications John Carter, Venetia Saunders.

**BCH-438 Molecular Endocrinology Credit 3**

**Course Objectives:**

The course is aimed to

- Provide knowledge about hormone synthesis, action, and regulation.
- Offer knowledge about hormone receptors, signal transduction pathways, and signaling related to various diseases.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Know the endocrine system with molecular concepts and the body's homeostasis.
2. Understand the hormone receptors and signaling of autocrine and paracrine signaling.
3. Understand diseases associated with abnormal hormonal regulation.

| Course Name: Molecular Endocrinology | Course Code: BCH 438 | Type of Course | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |

| Unit 1 | 15 h |
|---|---|
| Introduction to hormones, Definition and classification. Mechanism of action of hormones and its regulation. Hypothalamic and pituitary hormones- Diabetes insipidus and Hypo and Hyper pituitarism. Pancreatic hormones-synthesis, regulation, transport, and biological actions mechanism of Glucagons, somatostatin and insulin. Introduction and biological action of gastrointestinal hormones. Thyroid hormones –transport, metabolic fate and biological actions. Hormonal regulation of calcium and phosphate metabolism. Secrection and biological actions of PTH, Calcitonin. Adrenal cortical hormones. Adrenal medullary hormones. Gonadal hormones: Regulation, transport and biological actions of androgens. Regulation, metabolism and biological effects of osterogen and progesterone - menstrual cycle- Pregnancy. | |
| Unit 2 | 15 h |
| Receptors and signaling pathways: cell surface receptors. G Protein coupled receptors, regulatory GTPases, heterotrimeric G proteins and effector molecules of G Proteins. Signaling molecules cAMP, cGMP. Ca2+, DAG and NO as signaling molecules, ryanodine and other Ca2+ receptors, phosphoregulation of inositol and the calcium channel activation. Ser/Thr-specific protein kinases and phosphatases. Receptor tyrosine kinases, Role of phosphotyrosine in SH2 domain binding. Signal transmission via Ras proteins and MAP kinase pathways. Signaling by nuclear receptors: nuclear functions for hormones/metabolites - orphan receptors; cytoplasmic functions and crosstalk with signaling molecules, signaling pathway of the steroid hormone receptors. Cytokine receptors- structure and activation of cytokine receptors, Jak-Stat path way, Janus kinases, Stat proteins. | |
| Unit 3 | 15 h |
| Signal transduction: Hormone-receptor interactions, biochemistry of receptor activation. Signal transduction through cytoplasmic and nuclear receptors.Endocrine, paracrine and autocrine signaling. Sensory Transduction: Nerve cells, synapses, ion channels, neurotransmitters, neurotransmitter receptors and impulse transmission. Rod and cone cells in the retina, biochemical changes in the visual cycle, photochemical reaction and regulation of rhodopsin. Odor receptors. Chemistry of muscle contraction- actin and myosin filaments, theories involved in muscle contraction, mechanism of muscle contraction, energy sources for muscle contraction. Recent trends in molecular endocrinology research and techniques. | |

**Suggested readings:**

- Molecular Endocrinology: Genetic Analysis of Hormones and Their Receptors. by Gill Rumsby and Sheelagh M. Farrow (springer)
- Biochemistry of signal transduction and regulation. by Gerhard Krauss (Wiley)
- Signal Transduction: Principles, Pathways, and Processes Hardcover (2014) by Lewis Cantley
- Hormone Receptors (Advances in Experimental Medicine and Biology) Paperback (2014) by David Klachko
- Introduction to Endocrinology Paperback – 2009 by Negi and Chandra S

**BCH-439 Molecular medicine Credit 3**

**Course objectives:**

The course is aimed to

- Elucidate the changes in cellular processes and pathophysiology of infectious diseases and metabolic disorders.
- Explain different approaches for developing advanced diagnosis and treatment methods.

**Course outcomes (CO):**

After completion of the course students will be able to

1. Acquire a broad and comprehensive understanding of the molecular mechanism of diseases and how parasites' different cellular processes can be manipulated to develop therapeutics.

2. Identify modern diagnostic technology concepts and new concepts to meet the demand for new diagnostic methods.

3. Pick up scientific thinking and exploration needed for future medicines.

| Course Name: Molecular medicine | Course Code: BCH 439 | Type of Course | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |

| |
|---|
| Molecular basis of fungal, protozoan, bacterial and viral interactions with the human host that leads to infection and diseases, Role of virulence factors, Pathogenicity Island, Bacterial toxins; endotoxins and exotoxins, The mode of action of antimicrobial drugs and the mechanism of antimicrobial resistance, Identification and validation of new molecular targets for better microbial therapeutics, advanced methods of microbial diagnostics. |
| Unit 2 \| 15 h |
| Receptors and signaling pathways: cell surface receptors. G Protein coupled receptors, regulatory GTPases, heterotrimeric G proteins and effector molecules of G Proteins. Signaling molecules cAMP, cGMP. Ca2+, DAG and NO as signaling molecules, ryanodine and other Ca2+ receptors, phosphoregulation of inositol and the calcium channel activation. Ser/Thr-specific protein kinases and phosphatases. Receptor tyrosine kinases, Role of phosphotyrosine in SH2 domain binding. Signal transmission via Ras proteins and MAP kinase pathways. Signaling by nuclear receptors: nuclear functions for hormones/metabolites - orphan receptors; cytoplasmic functions and crosstalk with signaling molecules, signaling pathway of the steroid hormone receptors. Cytokine receptors- structure and activation of cytokine receptors, Jak-Stat path way, Janus kinases, Stat proteins. |
| Unit 3 \| 15 h |
| Therapeutics drugs and classes, Peptide therapeutics, monoclonal antibodies, the pharmacodynamics of different classes of drugs, Mechanisms of toxicity, therapeutic index, mechanisms of detoxification, Medicinal plant products or secondary metabolites, Stem Cells in therapy, Gene therapy, personalized medicine, Challenges in therapeutics and vaccine development. Recent trends in molecular medicine research and techniques. |

**Books recommended:**


- Virology: Principles and Applications John Carter, Venetia Saunders,
- Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka.
- Microbiology, Michael J Pelczar, Tata McGraw, India.
- Introduction to Molecular Medicine, Ross Dennis W., Springer-Verlag New York Inc
- Molecular Medicine, R.J. Trent, Academic Press
- Molecular Medicine: An Introduction, Jens Kurreck, Cy Aaron Stein, Wiley-Blackwell

**BCH-440 Protein Engineering Credit 3**

**Course Objectives**:

The course is aimed to

- To introduce methods and strategies commonly used in protein engineering.
- To provide knowledge about various processes of protein modeling.

**Course Outcomes (CO)**:

After completion of the course students will be able to

1. to understand and explain the differences between rational design and directed evolution.
2. learn about miscellaneous topics such as searches in bioinformatics databases, isolation, expression, and purification of novel proteins.
3. give an overview of several biophysical techniques used for the analysis of secondary, tertiary, and quaternary structures, as well as of screening methods used for the selection of novel protein variants with improved properties.

| Course Name: Protein Engineering | Course Code: BCH 440 | Type of Course: DSE | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | Core/Practical/Elective | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Protein structural families Introduction; Basic structural principles: amino acids and their conformational accessibilities, Ramachandran Plot; Motifs of protein structures and their packing; Schematic and topology diagrams; Families of protein structures: alpha, alpha/beta,beta, small etc, Protein folding and assembly, Protein folding pathways in prokaryotes and eukaryotes; Single and multiple folding pathways; Protein folding of single domain and multi-domain proteins; Inclusion bodies and recovery of active proteins; Osmolyte assisted protein folding; Structure of chaperones and role of chaperones in protein folding | | | | | | |
| Unit 2 | | | 15 h | | | |

| | |
|---|---|
| Protein engineering Strategies for protein engineering; Random and sitedirected mutagenesis; Various PCR based strategies; Role of low-fidelity enzymes in protein engineering; Gene shuffling and Directed evolution of proteins; Protein backbone changes; Antibody engineering; All topics will deal with case studies. | |
| Unit 3 | 15 h |
| Prediction and design of protein structures, Similar structure and function of homologous proteins; Role of multiple alignment; Homology and ab-initio method for protein structure prediction; Phage display systems; Yeast surface display system, structure based drug design and case studies, Rational protein design. All topics will deal with case studies.Recent trends in Protein Engineering research and techniques.Recent trends in protein engineeringresearch and techniques. | |

**Books recommended:**

- Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
- Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
- Protein engineering handbook. Edited by Stefan Lutz - Uwe Bornscheuer. Weinheim: Wiley-VCH, 2009. xli, 409-9. ISBN 9783527318506.
- Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.

**BCH-531 Nano bioscience Credit 3**

**Course Objectives:**

The course is aimed to

- Enlighten the specific knowledge of basic sciences in the fundamentals of Nanomaterials and
- Discuss their application in agriculture and the medical field.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Understand the application of nanomaterials in biology and acquire knowledge about the DNA, proteins, amino acids, drug delivery, biomedicine, etc.

2. Gain knowledge in the basics of nanotechnology in biosciences.
3. Learn the international/national visibilities of nano-science developments and their relevance in multi-functionalities.

| Course Name: Nanobioscience | Course Code: BCH 531 | Type of Course | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Definition of Nanomaterials, recent advances in nanomaterials.Nanoscale Science and Technology-Implications for chemistry, physics and biology. Classifications of nanomaterials-Zeolites, mesoporous materials, nanomembranes - Carbon nanotubes and graphene - Core shell and hybrid nanocomposites.Quantum Dots. Theory of advanced drug delivery: Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Top down and bottom up approaches: Chemical approaches: Sol gel processing-Solvothermal, hydrothermal, precipitation, Spray pyrolysis, Electro spraying and spin coating routes, Self-assembly, Vapour phase deposition, self-assembled monolayers (SAMs).Preparation and Characterization of Bionanomaterials- Dendrimers, Gene transfection.pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA.Magnetic nanoparticles, liposomes, niosomes, exsosomes and solid lipid nanoparticles (SLNs). Natural polymers assisted for the synthesis of the nanomaterials. Synthesis of nanoparticles usingPlants bacteria and Fungi. | | | | | | |
| Unit 3 | | | 15 h | | | |
| Physiochemical characterization of Nanomaterials:Basicprinciplesof UV Visible spectroscopy, Electron Spin Resonance, NMR Spectroscopy, FTIR, Zeta potential, Dynamic light scattering (DLS),Differential Scanning Calorimetry (DSC), Scanning Electron Microscopy(SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Thermogravimetric Analysis, X-RayDiffraction.Nanotechnology in gene therapy.Nanoprobes-Nanoimmunoassay and nano-immunosensors- Immunodiagnostics for cancer and other non-communicable diseases.Diagnosis by in vivo imaging- detection of tumors, cancer and genetic defects.Nanobot medical devices. Nano-bioconjugates and their significance. Nanoscaffolds. Multifunctional Inorganic and organic nanoparticles and their biomedical | | | | | | |

applications.Nanotoxicology- Societal and Ethical Implications-Environmental Regulation.

Recent trends in nanobioscience research and techniques.

**Books recommended**:


- K.W. Kolasinski, ―Surface Science: Foundations of Catalysis and Nanoscience‖, Wiley, 2002.
- Nanotechnology in Biology and Medicine: Methods, Devices and Application by Tuan Vo-Dinh .CRC press, 2007.
- G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties &Applications ,Imperial College Press, 2004.
- A. S. Edelstein and R. C. Cammarata, ―Nanomaterials: Synthesis, Properties and Applications‖, Institute of Physics Pub., 1998.
- G.A. Ozin and A.C. Arsenault, ―Nanochemistry : A chemical approach to nanomaterials‖, Royal Society of Chemistry, 2005. 8. Physical Chemistry – Atkins Peter, Paula Julio.


BCH 532 **Computer Assisted Drug Design** **Credit 3**

**Course Objectives:**

The course is aimed to

- Illustrate a comprehensive and in-depth overview of the approaches and procedures used in computer-assisted drug design (CADD)
- Impart the knowledge of the application of CADD in modern-day drug discovery

**Course Outcomes (CO):**

After completion of the course students will be able to

1. gain an in-depth understanding of the current methods and techniques used in CADD.
2. select the best approach (in terms of applicability, accuracy, and economy) for a particular issue, such as lead optimization, structure-based design, or research into ligand-receptor interaction.
3. carry out the calculations, comprehend and interpret the results, and bring them in a publication-ready format.

| Course Name: | Course Code: | Type of Course: Elective | L | T | P | Credits |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Computer Assisted Drug Design | BCH 532 | DSE | 3 | 0 | 0 | 3 |

| | |
|---|---|
| Unit 1 | 15 h |
| Introduction to drug designing, Drug discovery pipeline, Conventional drug design approaches vs. modern drug design approaches, Computer-aided drug design (CADD) approach in the drug development pipeline, Role of CADD at each stage of R&D, lead discovery, different small compound databases and libraries, Quantitative Structure-Activity Relationships (QSAR), Homology modeling and generation of 3D-structure of protein, Lead Discovery, Molecular docking, Types, and related software, High throughput virtual screening (HTVS), Absorption, distribution, metabolism and excretion (ADME) and toxicity analysis, Molecular mechanics with generalized Born and surface area solvation (MM/GBSA) analysis, Machine learning, Artificial intelligence, Chemoinformatics, Advantages, achievements, limitations and future challenges of CADD, In silico clinical trails | |
| Unit 2 | 15 h |
| Peptide-based drug designing, Advantages of peptides over small molecule drugs, Peptide docking, Different peptide libraries, Peptide docking software, HTVS of peptides, Physicochemical properties, Biochemical and structural properties, Prediction and analysis of antigenicity, allergenicity, and toxicity, Peptide-based immunotherapeutics, Challenges and scopes of in silico peptide-based drug discoveries | |
| Unit 3 | 15 h |
| Introduction to Molecular Dynamic Simulations, Related tools, Introduction to GROMACS – Setup, run MD Simulation of a Protein and analyze the results, Force Fields- MM3, AMBER, GROMOS, ECEPP/3 force fields, Energy Minimisation, Energy conservation, Root Mean Square Deviation (RMSD), Root Mean Square Fluctuation (RMSF), Radius of gyration (Rg), Solvent-accessible surface area (SASA), Hydrogen-bond graphs, Trajectories, and their analyses – Graphical representations of trajectories of geometrical parameters | |

**Reference Books:**


- Computer Aided Drug Design (CADD): From Ligand-Based Methods to Structure-Based Approaches, Mithun Rudrapal and Chukwuebuka Egbuna, ISBN: 9780323906081
- Computational and structural approaches to drug discovery, Robert M StroudandJanet.F Moore, RCS Publishers
- Principles of Drug Design by Smith and Williams, CRC Press, Taylor & Francis
- Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press, Taylor&Francis group.

**BCH 533 Cell Culture and Animals in Research Credit 3**

**Course Objectives:**

The course is aimed to

- Provide students to acquire a basic knowledge about the uses of various animal models in research technology.
- Study efficacy and toxicity of drugs in pre-clinical models prior to clinical trial.
- Allow students to gain very important insights into the functioning of the mammalian cells.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Acquire a basic knowledge of analysing of PKPD and toxicity of a drug candidate in animal models.
2. Learn the principles of many basic and advanced techniques which certainly lead to develop their research projects.
3. Be familiar practically in cell culture based study and they will certainly get a privilege for their higher study or company job since no one laboratory can be functioned properly without cell culture based study.

| Course Name: Animals and Animal Cells in Research Technology | Course Code: BCH 533 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| **Animal Care and Management of Laboratory Animals**: Rat, Mouse, Rabbit, Guinea pig, Hamster. Animal House – Necessities Design and maintenance; Breeding cycles and Nutritional requirements. Animal models for study of cancer, diabetes, obesity, aging, and neurological diseases. Toxicity and PKPD of drugs in pre-clinical models. Animal ethics and associated laws and issues. | | | | | | |
| Unit 2 | | | 15 h | | | |
| **Animal Cell Culture and Cell Characteristics:** Introduction to animal cell culture, Culture media and culture procedure; aseptic culture techniques; Development and maintenance of cell lines; Monolayer adherent culture and suspension cell culture; Culture media and growth conditions; Role of CO2, serum and supplements; Tissue disaggregation and primary culture; Measurement of viability and cytotoxicity | | | | | | |
| Unit 3 | | | 15 h | | | |

**Scale-up, animal Organ Culture and applications:** Cell synchronization; Cell cloning and micromanipulation; Cell transformation; Scaling-up of cell cultures; Micro-carrier attached growth; Cell culture in continuous, perfusion and hollow fibre reactor; Organ and histotypic cultures; Three dimensional culture; Tissue Engineering. Hybridoma technology; Cell culture based vaccines; Stem cell therapy; Transgenic animals: Gene editing

**Reference Books:**


- Freshney R.I., "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications", Wiley-Blackwell, 2010.
- Pörtner R., "Animal Cell Biotechnology: Methods and Protocols", Humana Press, 2007.
- Castilho L., Moraes A., Augusto E. and Butler M., "Animal Cell technology: From Biopharmaceuticals to Gene Therapy", Taylor & Francis, 2008.


**BCH 534 Plant Cell Technology Credit 3**

**Course Objectives:**

The course is aimed to

- To provide students to acquire a basic knowledge about tissue culture transformation
- To allow students to gain very important insights into the functioning of the plant cells.

**Course Outcomes (CO):**

After completion of the course students will be able to

1. Understand the basic of plant tissue culture
2. Describe the application of genetic engineering
3. Understand the basic properties of plant cell and with apply their basic knowledge in the fields plant biotechnology

| Course Name: Plant Cell Technology | Course Code: BCH 534 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Basic principles of plant tissue callus culture, meristem culture, organ culture, Totipotency of cells, differentiation and dedifferentiation. Preparation of Murashige and Skoog's (MS medium), phytohormones, medium for micro-propagation/clonal propagation of ornamental and horticulturally important plants. Callus subculture maintenance, growth measurements, morphogenesis in callus culture – organogenesis, somatic embryogenesis | | | | | | |
| Unit 2 | | | 15 h | | | |

| |
|---|
| Restriction Endonucleases, Cloning Vectors, (Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning, Construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by complementation technique, colony hybridization, Methods of gene transfer, Selection of transgenic |
| Unit 3 — 15 h |
| Applications of Plant Genetic Engineering – crop improvement, herbicide resistance, insect resistance, virus resistance. Tolerance of environmental extremes in crops - drought, cold, salinity, flooding, heavy metal, Plant as Bioreactors, Genetically engineered food, manufacture of pharmaceutical products in plants using modified plant viruses, Biofuels and Bioplastics from genetically engineered plant. |

**Reference Books:**


1. Pullaiah. T. and M.V.Subba Rao. 2009. Plant Tissue culture. Scientific Publishers, New Delhi.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.


**BCH 535 Cell Death Mechanisms Credit 3**

**Course Objectives:**

The course is aimed to

- Explain the conserved, molecular machinery that eliminates cells through different types of cell death mechanisms
- Discuss how cells are eliminated from our body during development and throughout adult life

**Course Outcome (CO):**

After completion of the course students will be able to

1. Differentiate between different types of cell death mechanisms
2. Evaluate and correlate the importance of cell death mechanism in pathophysiology
3. Comprehend the induction or inhibition of cell death pathways in various diseases

| Course Name: Cell Death Mechanisms | Course Code: BCH 535 | Type of Course | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| **Mechanism of Apoptosis and Necrosis:** Modes of cell death in physiological situations, Programmed cell death, Intrinsic and extrinsic pathways of apoptosis, modes of cell death in pathological conditions, necrosis, Mitochondria in cell death regulation. Oxidative metabolism, | | | | | | |

mitochondrial membrane permeabilisation and potential Bcl-2 family proteins, their structure and complex role in regulation and dynamics of mitochondrial function. Proapoptotic proteins released from mitochondria - cytochrome c, Smac/DIABLO, Omi/Htra, AIF etc., their role and signifinance. P53 protein as an important regulator of intrinsic apoptotic pathway, assocoiation with cell cycle regulation and DNA damage cell death pathways aberration in various diseases like cancer and autoimmune diseases.

| Unit 2 | 15 h |
|---|---|

**Mechanism of Autophagy:** Fundamental aspects of cellular autophagy and metabolism and how these pathways are regulated in physiological and pathological conditions Autophagy initiation, elongation and maturation, autophagy pathway regulation, macroautophagy and chaperone mediated autophagy, selective autophagy, mitophagy, xenophagy, autophagy and inflammation. Cellular and molecular mechanisms of different autophagic pathways, genetic and pharmacological modulation of autophagy, the role of autophagy in cancers; metabolic pathways, cancer cell metabolism, metabolic control of autophagy, current methods to assay autophagy and metabolism.

| Unit 3 | 15 h |
|---|---|

**Other types of cell death pathways:** Mechanism of entosis, anoikis, ferroptosis, lysosome-dependent cell death, Characterisation and comparison of individual cell death forms, definitions, description, classification, molecular mechanisms, interactions and significance in health/disease. Atypical cell death modalities, their signaling pathways, regulation, significance. Methods for cell death detection – modern methods of cell and molecular biology and biochemistry. Principles of selected apoptosis detection methods, advantages, limitations, criteria for selection, applications. Data interpretation. Methods for detection of other cell death forms, principles, and individual examples. Examples of individual diseases (neurodegenerative, immunological, allergic, inflammatory, cardiovascular, viral etc.) related to deregulated cell death, and the consequences. New therapeutic possibilities of regulation.

**Reference Books:**

- Cell Death: Apoptosis and Other Means to an End, Second Edition, Douglas R. Green, St. Jude Children's Research Hospital, ISBN 978-1-621822-14-1
- Cell Survival and Cell Death, Second Edition, Book Series: A Cold Spring Harbor Perspectives in Biology Collection, Kim Newton, Genentech; James M. Murphy, Walter and Eliza Hall, CSHL, ISBN 978-1-621823-55-1
- Cell Death -Autophagy, Apoptosis and Necrosis; Tobias Ntuli, Intechopen, 2015 ISBN 978-953-51-2236-4
- Molecular biology of the Cell, 6th edition, 18 November 2014, Bruce Alberts, Alexander D. Johnson etal, ISBN: 978-0-393-88484-5


**BCH 536 Enzymes of Extremophilic bacteria Credit 3**

**Course Objectives:**

The course is aimed to

- Explain techniques to explore the bacterial diversity in any habitat.
- Have an understanding about the extremophilic habitats and the bacteria living in such habitats and industrial application of ectremophilic bacteria and their enzymes.

**Course Outcomes (CO):**

After the completion of this course, students will be able to

1. Understand various methods of estimating bacteria diversity and the strategies of extromophilic bacteria to cope with the extreme environment.
2. Learn different types of extremophilic bacteria like thermophiles, psuchrophiles, Halophiles, Alkaliphiles etc.
3. Know various Industrial applications of such bacteria and their enzymes.

| Course Name Extremophilic bacteria and their enzymes | Course Code BCH 536 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Microbial Diversity in extreme environment. Peculiar features of Archaea compared to bacteria. Identification of microbes in extreme environment. Thermophiles-classes, extremely thermophilic archaebacteria, thermozymes, psychrophilespsychrophilic archael extremozymes, Molecular adaptation of extremophiles. Protein stability in extremophilic microbes. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Halophiles-osmoregulation, cellular adaptation, structural adaptation, molecular adaptation.Xerophiles. Radiation resistant bacteria-Deinococcus radiodurans, Barophiles/Peizophiles: mechanism in barophily, alpha proteobacteria, Cryophiles, Psychrophiles: (cold shock proteins and regulation), Polaromonas, Pseudomonas , heat shock proteins, rho factors and regulation, Aquifex, Tepidomonas, Rhodothermus. | | | | | | |

| Unit 3 | 15 h |
|---|---|
| Biotechnological applications of archaea, Industrially important enzymes from extremophic organism, their industrial importance, hydlolases, Bioelectronics from lipids of archaea. Space microbiology-introduction. Panspermia-definition,mechanisms proposed. Microbiological research in space environment. | |

**Reference Books:**


- Colwd , D.(1999) Microbial Diversity. Academic Press.
- Kushner,D.J(2007)MIcrobial Life in Extreme Environments,.Academic Press.
- Da Costa,M.S., Duarte,J.C & Williams,R.A.D(1989) Microbiology of Extreme Environments and its potential for Biotechnology. Elsiever Applied Science, London.
- Heinrich,M.R (1976)Extreme Environment: Mechanism of Microbial Adaptation. Academic Press.


**BCH 537 Small RNA in Health and disease Credit 3**

**Course Objectives:**

The course is aimed to

- To provide students with the basic knowledge of the functions of different small RNAs.
- To make them understand the importance of non-coding RNA in cellular homeostasis, prevention of diseases and crop improvement.

**Course Outcomes (CO):**

After the completion of this course, students will be able to

1. Learn the functions of different non-coding RNAs and their relevance in physiology
2. Acquire knowledge about siRNA vector design, siRNA delivery and genome editing
3. Know about role of non-coding RNAs in different diseases including cancer, cardiovascular disease and neurodegeneration

| Course Name: Small RNA in Health and disease | Course Code: BCH 537 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |

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|---|
| Discovery of RNA interference (RNAi): PTGS, RNAi and related phenomena. Detection of small RNAs. Mechanism of RNAi: Different components of RNAi pathway and their evolutionary conservation and role in gene silencing, RNAi-like pathway in bacteria, Molecular basis of RNAi /siRNA /miRNA mediated gene silencing. RNAi in defense and the regulation of chromatin structure and gene expression; RNAi suppressors. Computational tools for miRNA discovery, siRNA and miRNA design. Large-scale genetic analysis using RNAi: Genome-wide RNAi screens in C. elegans, and other systems, High-throughput small RNA profiling, RNAi microarrays. |

| Unit 2 | 15 h |
|---|---|
| Non-coding RNAs. Categories of non-coding RNAs: dsRNAs, siRNAs, shRNAs, piRNAs and miRNAs, Long non-coding RNA, XIST, lincRNA. miRNAs and siRNAs: Pathways, expression and functions of microRNAs, High-throughput analysis of miRNA gene expression; siRNA vectors, siRNA delivery in vitro and in vivo; RNA informatics RNA biology including RNA silencing, RNA-guided transcriptional regulation, CRISPR/Cas immunity and genome editing, telomerase biogenesis, riboswitches, exosome and editosome. Nonsense Mediated RNA Decay. RNA Editing. Alternative Splicing. RNA Secondary Structure. Bacterial ncRNAs and Riboswitches. | |

| Unit 3 | 15 h |
|---|---|
| OncomiRs and Tumor Suppressor miRNAs. Expression of dsRNA in animals and plants, and its applications: RNAi vectors and generation of transgenic animals and plants, Analysis of expression of dsRNA and gene silencing. Circulating non-coding RNA in extra-cellular vesicles. Role of Long-non coding RNA in cancer, cardiovascular disease. Neurodegenerative disease. The use of RNAi in the prevention of diseases in animal models and crop improvement; RNAi therapy; Future prospects of RNAi in biology, medicine and agriculture. Breakthroughs of RNA biology in medicine and biotechnology.Recent trends in small RNA in health and disease research and techniques. | |

**Reference Books:**


- The RNA World TEds. TGesteland et al. CSHL Press
- RNA Interference Technology: From Basic Science to Drug Development. Eds. Fire et al. Cambridge University Press
- RNAi: A Guide to Gene Silencing. Ed. Gregory J.Hannon CSHL Press
- RNA Silencing: Methods and Protocols Ed. Gordon G. Carmichael CSHL Press
- RNA Interference in Practice Ed. Ute Schepers, Wiley-VCH GmbH & Co. KGaA.
- Genes IX. Lewin B Jones and Barlet

**BCH-538 Parasitology Credit 3**

**Course objectives:**

The course is aimed to

- Provide an understanding of protozoan parasites, their mode of transmission, and the epidemiological aspects of protozoan diseases.
- Discuss about parasite biology, clinical presentation, treatment, and prevention of protozoan infections.

**Course outcomes (CO):**

After the completion of this course students will be able to

1. Describe the common protozoan infections and their epidemiological characteristics
2. Learn the biochemical and cellular mechanisms of protozoan parasites and the change of cellular processes of humans infected with parasites
3. Know the molecular and immunological methods used for the diagnosis of protozoan infections and different drugs/vaccines used for the treatment of protozoan infections

| Course Name: Protozoan parasitology | Course Code: BCH 538 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| **Protozoan parasites, Taxonomic overview, Biodiversity,** Modes of Transmission, Specific Morphological and Physiological Adaptations of parasites, Flexible Strategies of Reproduction, Parasite–Host Coevolution, Malaria as an Example of Coevolution, Host defense system for parasites, Immune Evasion, Virulence factors | | | | | | |
| Unit 2 | | | 15 h | | | |
| The cell structure of *Leishmania*, Life cycle, Types of leishmaniasis, Indian scenario of leishmaniasis, Epidemiology and geography of leishmaniasis, Vector and transmission of leishmaniasis, Host-pathogen interaction, Diagnosis and treatment for visceral and cutaneous leishmaniasis, Mechanism of drug resistance and drug susceptibility for promastigotes and amastigotes.The cellular structure of *Plasmodium*, the life cycle of *Plasmodium*, Malaria | | | | | | |

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| pathology, factors affecting Transmission of the parasite, Vectors, and epidemics, host-parasite interactions, asymptomatic malaria, host-vector interactions, parasite metabolisms, secondary endosymbiosis, Drug-resistant parasites, identification of new drug targets |

| Unit 3 | 15 h |
|---|---|
| The cellular structure of *Entamoeba histolytica*, Life cycle, Mode of transmission, Pathophysiology, Epidemics, Host-parasite interactions, Parasite metabolisms, Mode of actions of drugs, Drug-resistant parasites, Diagnostic tools, Preventive measures<br>The cellular structure of *Trypanosoma brucei* and *Trypanosoma cruzi*, Life cycle, Trypanosomasis, Mode of transmission, Epidemics, Host-parasite interactions, Parasite metabolisms, Mode of action of drugs, Drug-resistant parasites, Diagnostic tools, and Preventive measures. Recent trends in protozoan parasitology research and techniques. | |

**Books recommended:**

- Parasitic Protozoa, Series Editors: Julius Kreier Hardcover ISBN: 9780124260146,eBook ISBN: 9780323139182,Imprint: Academic Press
- Protozoa and Human Disease, Mark F Wiser, Garland Science, ISBN 9780815365006
- Protozoan Parasitism: From Omics to Prevention and Control | Book, Edited by: Luis Miguel de PablosTorró and Jacob-Lorenzo Morales, Publisher: Caister Academic Press,ISBN: 978-1-910190-83-8
- Parasitic Protozoa: v. 3 (Parasitic Protozoa S.) by Julius P. Kreier (Editor), Publisher: Academic Press Inc,ISBN-10: 0124260136,ISBN-13: 978-

**BCH 539 Applied and Environmental Microbiology Credit 3**

**Course Objectives:**

The course is aimed to

- Demonstrate the use of microorganisms and their industrial applications.
- Explain the composition of industrial waste water and xenobiotics, and their treatment using microorganisms.

**Course Outcomes (CO):**

After the completion of this course students will be able to

1. Get equipped with a theoretical understanding of industrial microbiology.
2. Gain knowledge about the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.
3. Learn various aspects of environmental microbiology and microbial ecology and to become familiar with current research in environmental microbiology.

| Course Name: Applied and Environmental Microbiology | Course Code: BCH 539 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |

| Unit 1 | 15 h |
|---|---|

Scope and historical development; Sources of industrially important microbes, strain development, Fermentation process and recovery; Downstream processing of microbial products: Filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane processes, drying (lyophilization and spray drying), and crystallization. Types of fermentation systems; Bioreactor designs and operations. Industrially important enzymes, Hydrolytic enzymes from natural microbes, Isolation and application of Extremophilic microbes like thermophilic, halophilic, acidophilic organisms and their enzymes for application in industries and agriculture.

| Unit 2 | 15 h |
|---|---|

Microbiology of Waste-water: Occurrence and distribution of microbes in water, Concepts of C-BOD, NBOD and COD, General characteristics of industrial wastewater, Disinfection of drinking water with anti-microbial agents. Primary treatment of waste water, Methods of anaerobic treatment of sludge. Bioaccumulation of heavy metal ions from industrial effluents, Determination of LD50, Effect of heavy metals, pesticides on the microbial population in air, water and soil. Water borne risk to human health. Microbial Toxicology and Degradation of Xenobiotics: General chemistry of pollutants viz., particulate matter, poly-aromatic hydrocarbons, organosulfur, organophosphorous, organohalides, organonitrogen, organometallic compounds. Ames test to determine the genotoxicity of toxicants, Microbial tolerance and resistance against heavy metals, antibiotics and pesticides, Concepts of xenobiotics, Bio-transformation and biodegradation of xenobiotics like organophosphates and organohalides compounds, plastic, paints. Topics will deal with case studies.

| Unit 3 | 15 h |
|---|---|

Molecular Microbial Ecology: Nucleic acid extraction from environmental samples, prokaryotic systematics: PCR and sequence analysis of amplified 16s rRNA genes, DNA Fingerprinting of microbial communities, molecular typing of environmental isolates, RT-PCR and mRNA expression analysis of functional genes, Quantitative real-time PCR, stable isotope probing, applications of nucleic acid hybridization in microbial ecology, Fluorescence in situ hybridisation for the detection of prokaryotes. Lessons from the genomes: microbial ecology and genomics, Metagenomic libraries from uncultured microorganisms, PCR primers for functional gene analysis, Molecular detection of fungal communities in soil, Environmental assessment: bioreporter systems, Bioinformatics and web resources for the microbial ecologist. Recent trends in applied and environmental microbiology research and techniques.

**Reference Books:**


- Cruger W and Cruger A. (2004). Biotechnology - A Textbook of Industrial Microbiology. Panima.
- Kun LY. (2006). Microbial Biotechnology. World Scientific.
- Baker, K.H. And Herson D.S. (1994). Bioremediation. MacGraw Hill Inc. N.Y.
- EcEldowney, S. Hardman D.J. and Waite S. (1993). Pollution: Ecology and Biotreatment, Longman Scientific Technical.
- Christon J. Hurst (2001). A Manual of Environmental Microbiology. 2nd Edition. ASM Publications.
- Processes in microbial ecology, David L Kirchman, Oxford ; New York : Oxford University Press, 2012.


**BCH 540 Epigenetics and stem cell biology Credit 3**

**Course Objectives:**

The course is aimed to

- Illuminate fundamental understanding of epigenetics and stem cells
- Provide a concept about the regulation of physiological and path-physiological functions of cells/tissue/organs.

**Course Outcomes (CO):**

After the completion of this course students will be able to

1. Learn the basic role of epigenetics in controlling cellular and physiological functions.

2. Know the fundamental role of stem cell in the development and regeneration of tissues and its application in therapy and tissue engineering.
3. Gain the concept of how environmental and biological factors regulate the physiological functions by modulating epigenetic changes in the cellular system.

| Course Name: Epigenetics and stem cell biology | Course Code: BCH 540 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Epigenetics: Introduction to epigenetics and physiological functions, Epigenetic control of the transcription process, DNA packaging and chromatin architecture, histone modification machinery and DNA methylation; Enzymes Involved in DNA Methylation, epigenetic control of cell-specific gene expression; epigenetic control of the mitotic cell cycle; epigenetic control of cellular differentiation. Epigenetics and cancer, abnormal patterns of DNA methylation in cancer | | | | | | |
| Unit 2 | | | 15 h | | | |
| Stem cell biology: Introduction to stem cell in health and disease, and regenerating organs, Bone Marrow-Derived Stem Cells, Hematopoietic Stem and Progenitor Cells in Clinical Use, Embryonic Stem Cells, Regulation of Self-Renewal and Pluripotency of stem Cells, Induced Pluripotent Stem Cells, Adult stem cells like liver, pancreas etc, Mesenchymal Stem Cells, cancer stem cell, Drug-Resistant Cancer Cells and Side-Population Cells, Elimination of Cancer Stem Cells, Stem Cells in Tissue Engineering. | | | | | | |
| Unit 3 | | | 15 h | | | |
| Epigenetic and stem cell: Epigenetic control on stem cell, from cellular totipotency to pluripotency, maintenance of pluripotency in embryonic stem cells, Nuclear Cloning and Epigenetic Reprogramming, differentiation of embryonic stem cells, Non-coding RNAs and epigenetics and stem cell; Stem cell isolation, stem cell based therapy, Tools to Analyze DNA Methylation, Global DNA Methylation Analysis, Ethics of Human Stem Cell Research, Recent trends in epigenetics and stem cell research. Recent trends in epigenetics & stem cell biology research and techniques. | | | | | | |

**Reference Books:**


- Epigenetics by Lyle Armstrong, Garland Science, Taylor and Francis
- T. Dittmar, K.S. Zanker (eds.), Stem Cell Biology in Health and Disease, Springer
- Essentials of Stem Cell Biology, Robert Lanza, John Gearhart,Brigid Hogan, et al, Editors, Elsevier


**BCH 541** **Plant Functional Genomics** **Credit 3**

**Course Objectives:**

The course is aimed to

- Introduce the knowledge about complete genome information of species.
- Elucidate The comparative genomics will predict the function of unknown gene.

**Course Outcomes (CO):**

After the completion of this course students will be able to

1. Learn plant functional genomics will give exposure to cutting edge biology to students.
2. Gain knowledge about Structural, Comparative and Functional genomics of plants gives genome wide high throughput data information and its function.
3. Understand Proteomics, Metabolomics and System biology details global and targeted approaches, gene expression networks etc to answer the biological question.

| Course Name: Plant Functional Genomics | Course Code: BCH 541 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Introduction to Genomics: Sequencing techniques, Sequencing generations, Sequencing of Complex Genomes, Studies on model plant genomes, Annotation of genomes and predictions of genes, Comparative Genomics, Transcriptomics, Small RNA world, metagenomcis | | | | | | |
| Unit 2 | | | 15 h | | | |
| Introduction to Proteomics, Extraction and purification of proteins from biological samples, SDSPAGE, 2D- Gel Electrophoresis & DIGE, NMR and LC-MS/MS Spectroscopy for protein/peptide characterization, Gel based and gel free proteomics, Functional Proteomics, Organellar Proteomics | | | | | | |
| Unit 3 | | | 15 h | | | |
| Metabolomics, Isolation and characterization of metabolites for Global and targeted metabolome, Introduction to systems Biology, system biology tools and modelling of biological pathways, Gene expression/Co- expression networks. Recent trends in Plant Functional Genomics research and techniques | | | | | | |

**Reference Books:**


- Plant Genomics: Methods and Protocols, Editors: DJ Somers, P.Langridge, JP Gustafson
- Functional Plant Genomics- J F Morot-Gaudry, P Lea, J F Briat
- The Proteomics Protocols Handbook, by John M. Walker (Editor), Humana Press, 2005.
- Introduction to Genomics, 2 editions. by Arthur M. Lesk, Oxford University Press,
- Plant Systems Biology, D A Belostotsky, Springer,2009


**BCH 542 Plant Genetic Engineering & Genome Editing Credit 3**

**Course Objectives:**

The course is aimed to

- Introduce the knowledge about plant genetic modification by different approaches
- Discuss various biosafety regulations.

**Course Outcomes (CO):**

After the completion of this course students will be able to

1. Undersatnd Recombinant DNA technology and Genetic engineering principles.
2. Learn pros and cons of Genetically modified (GM) technology and crop biotechnology.
3. Gain a concepts of genome editing in plants application and regulations.

| Course Name: Plant Genetic Engineering & Genome Editing | Course Code: BCH 542 | Type of Course | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Introduction to Genes and Genomes, Molecular scissors, Recombinant DNA technology, Molecular Cloning, cDNA and genomic Libraries, DNA sequencing. | | | | | | |
| Unit 2 | | | 15 h | | | |
| Genetic Transformation in Plants, Physical DNA delivery and Agrobacterium mediated transformation, Overexpression and antisense/RNAi technologies, Transgenic Plants, screening, Gene Integration, Molecular and Physiological characterization of transgenics, GM Plants, controversies, Regulations, Biosafety guidelines for GM Plants, Gene expression, Application of Genetic Engineering | | | | | | |
| Unit 3 | | | 15 h | | | |
| Introduction to Genome Editing, Tools, TALENS, ZFN, CRISPR- CAS, Genome edited Plants, Regulations and Future of Genome Editing in Crop Biotechnology. Recent trends in plant genetic engineering & genome editing research and techniques. | | | | | | |

**Reference Books:**


- Techniques for Engineering Genes; Curell BR et al;2004
- Recombinant DNA and Biotechnology; 2nd Ed ; Kreuzer H and Massey A ;ASM;2006
- Plant Genetic Engineering- J H Dodds,2012
- Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery- K. Appasani,2018
- Molecular Cloning; 3rd Ed; Sambrook & Russel : Cold Spring Harbour Laboratory press, NY ; 2001


**BCH543 Plant Stress Biology Credit 3**

**Course Objectives:**

The course is aimed to

- To introduce the knowledge about plant stress
- To illustrate regulation under environmental stress.

**Course Outcomes (CO):**

After the completion of this course students will be able to

1. Gather knowledge of biotic, abiotic stress and nutritional deficiency stress
2. Understand the defense mechanism in response to various stress
3. Gain knowledge about miscellaneous transcriptional regulation, signaling, redox metabolism, programmed cell death and systemic acquired response in response to stress.

<table>
<tr><td rowspan="2">Course Name:<br>Plant Stress Biology</td><td rowspan="2">Course Code:<br>BCH 543</td><td>Type of Course:</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Credits<br>3</td></tr>
<tr><td>DSE</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td colspan="4">Unit 1</td><td colspan="3">15 h</td></tr>
<tr><td colspan="7">Abiotic Stress: Plant response to abiotic stress; drought and salt stress, osmotic adjustment and its role, acid soil stress, metal stress, waterlogging, light, cold and heat stress, stress-inducible proteins and genes. The role of plant growth regulators in stress tolerance mechanisms and nutrient deficiency stress and disorders in plants</td></tr>
<tr><td colspan="5">Unit 2</td><td colspan="2">15 h</td></tr>
<tr><td colspan="7">Biotic Stress: Plant pathology; its scope and relationships to other sciences, concept of plant diseases, pathogenicity, pathogen penetration and entry, colonization in the host, factors affecting infection. Enzymes in plant diseases; cell wall degrading enzyme, toxins in relation to plant diseases, defense mechanism. Genetics of plant-pathogen interaction; effect of environment on diseases development, epidemiology, forms of epidemics and conditions governing some of the important crop diseases.</td></tr>
<tr><td colspan="5">Unit 3</td><td colspan="2">15 h</td></tr>
<tr><td colspan="7">Plant Stress Molecular Biology: Stress sensors; signal transduction, MAPK pathway, CDPK, and other pathways. Transcriptional regulation of stress tolerance, MYB, WRKY, NAC, bZIP and other factors. Stress responsive gene expression and phenotypic responses; Hyper sensitive response (HR), systemic acquired response, ROS generation, programmed cell death.Recent trends in Plant stress biology research and techniques.</td></tr>
</table>

**Reference Books:**


- Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry & Molecular Biology of Plants. American Society of Plant Physiologists, USA.
- Dey, P. M. and Harborne, J. B., New Edition, Plant Biochemistry. Academic Press, USA.
- Metzler, D. E. (2007) Biochemistry. Academic Press, USA.

- Nelson D. L. and Cox, M. M. (2008) Principles of Biochemistry. W H Freeman & Co., USA.
- Stryer L., Berg, J. M. and Tymoczko, J. L. (2006) Biochemistry. W.H. Freeman & Co., USA


**BCH 544** **Virology and Vaccinology** **Credit 3**

**Course Objectives:**

The course is aimed to

- Elucidate the basic and advance concepts of viral infections, outbreak of viral diseases, spread of infection to become epidemic and pandemic etc.

**Course Outcome (CO):**

After the completion of this course students will be able to

1. Understand the history and recent infections developed by the virus to the human beings.
2. Identify the relationship between a virus and human disease and its mechanism.
3. Explain how virus and microorganisms interact with host cells and the way in which diseases arise
4.

| Course Name: Virology and Vaccinology | Course Code: BCH 544 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |
| Virus classifications, types of viruses, virus infection mechanism to animal cells, Development of HIV virus, HIV infection to humans, Structure of HIV virus, mechanism of HIV infection, role of T cells in infection development, development of therapy against HIV, anti-retroviral therapy, HAART, economic loss by HIV at national & international level. HIV-tuberculosis co-infection, Hepatitis virus, types of hepatitis infection, viral outbreaks such as Ebolla, H1N1, and Zika virus, emerging viral infections | | | | | | |
| Unit 2 | | | 15 h | | | |
| Historical background of vaccination, Life expectancy and vaccine, vaccine preventable infectious diseases, Evolution of human infectious diseases and vaccine, Mechanism behind vaccine immunity, mucosal immune responses to vaccines**,** Vaccines and immunological memory**,** antigens and antigenicity, Omics & databases of vaccine, Vaccine Engineering, Epitope and paratope mapping, IEDB, screening of epitope and paratope and identification of potential epitope for vaccine designing, BCL, CTL and HTL epitopes, MHC and HLA, selection of HLA/MHC for vaccine, population coverage analysis, Adjuvants, types and adjuvanticity, mechanism of adjuvant, antibody and monoclonal antibody, antibody engineering application for monoclonal antibody affinity and its mutations. | | | | | | |

| Unit 3 | 15 h |
|---|---|
| Integrated networking of vaccine response, Infection, immunity and vaccine, vaccine clinical trial, phase-I, phase-II, phase-III and phase-IV**,** Defining sample size, How to design, recruit volunteers for, and analyse the results of selected phase trials**,** vaccine manufacturing, vaccine administration, neoantigens, HIV vaccine, malaria vaccine, tuberculosis vaccine, cancer and vaccines, monoclonal antibody immunotherapy, development of new viruses (eg. Ebola, corona etc.) and role of vaccines in society, Impact of vaccines and immunization in the control of new and emerging infectious diseases, venoms and toxoid in vaccination. Recent trends in virology and vaccinology research and techniques. | |

**Reference Books:**


- System Vaccinology: The History, the Translational Challenges and the Future; by Vijay Kumar Prajapati, Elsevier, ISBN: 9780323859417
- Vaccinology: Principles and Practice, by W. John W. Morrow, Nadeem A. Sheikh, Clint S. Schmidt, D. Huw Davies
- Introduction To Molecular Vaccinology by GIESE M, SPRINGER


**BCH 545 Bacterial Infectious Diseases and Therapeutics Credit 3**

**Course Objectives:**

The course is aimed to

- Explain the concept of emergence of antimicrobial resistance and
- Describe therapeutics developments in ESKAPE Pathogen.

**Course Outcomes (CO):**

After the completion of this course students will be able to

1. Understand about ESKAPE pathogens.
2. Learn the emergence of global antibiotic resistance in ESKAPE pathogens.
3. Gain a knowledge about development of novel therapeutics ESKAPE pathogens.

| Course Name Bacterial Infectious Diseases and their Therapeutics | Course Code BCH 546 | Type of Course: | L | T | P | Credits 3 |
|---|---|---|---|---|---|---|
| | | DSE | 3 | 0 | 0 | |
| Unit 1 | | | 15 h | | | |

| | |
|---|---|
| Molecular basis of bacterial pathogenesis and virulence, bacterial biofilm, bacterial persistence, bacterial secreting systems, cell wall biosynthesis, hospital acquired infections and ESKAPE pathogens, biology and distribution of infection caused by *A. baumannii, P. aeruginosa, S. aureus, K. pneumoniae* | |
| Unit 2 | 15 h |
| Interaction of host and microbes process of recognition and entry in host cells by different pathogens, human microbiome and their symbiotic relation, alteration of host cell behaviour and signaling by pathogens, Sensors of bacterial colonization, mechanisms of immune tolerance and alteration of host cell behavior by pathogens, mechanism of bacterial co-infection like tuberculosis with HIV etc. | |
| Unit 3 | 15 h |
| In-silico approach to develop new therapeutics, Identification of drug targets; Vaccine design and validation; synthesis, characterization, mechanism and delivery of nanomedicine; screening, characterization and development of secondary metabolites based herbal medicine; screening of novel antibiotics from novel sites, experimental validation of novel therapeutics in animal model. Diagnosis of bacterial infection: 16S sequencing, PCR, ELISA, microscopy, antimicrobial susceptibility assay, model systems to understand pathogenic mechanisms | |

Reference Books:


- Prescott's Microbiology: Willey & Sherwood. 2008.
- Brock Biology of Microorganism: Madigan & Martinko
- Microbiology; an introduction: Tortora & Funke. 11th Edition. 2016.
- David Freifelder, Physical Biochemistry, 2nd edition, John Wiley and Sons 2005.