# CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY

# KANPUR

## Three-Year Undergraduate Programme

## Syllabus of

## B.Sc. (HONOURS) BIOTECHNOLOGY

## THREE-YEAR B.Sc. (HONOURS)

## IN BIOTECHNOLOGY

## SESSION 2025-2026

## ONWARDS

Prof. Neelam Pathak (ONLINE)
Prof. Ram Narain (ONLINE)
Prof. B.N. Mishra (ONLINE).

**CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR**
**STRUCTURE OF SYLLABUS FOR THE**
**Program: B.Sc. (Honours) Biotechnology**

| Syllabus Developed By | | | |
|---|---|---|---|
| **Name of BoS convenor/BoS member** | **Designation** | **Department** | **College/University** |
| Prof. S. K. Awasthi | Dean, Faculty of Life Sciences | Department of Life Sciences, School of Life Sciences and Biotechnology | CSJM University, Kanpur |
| Prof. Varsha Gupta | Director, School of Life Sciences and Biotechnology | Department of Life Sciences, School of Life Sciences and Biotechnology | CSJM University, Kanpur |
| Prof. Neelam Pathak | External Expert | Department of Biochemistry | R.M.L. Awadh University, Ayodhya |
| Prof. Ram Naraian | External Expert | Department of Biotechnology | V.B.S. Purvanchal University, Jaunpur |
| Prof. B. N. Mishra | External Expert | Department of Biotechnology | Instt. of Engineering and Technology, Lucknow |
| Prof. Rolee Sharma | Professor | Department of Life Sciences, School of Life Sciences and Biotechnology | CSJM University, Kanpur |
| Dr. Shilpa D. Kaistha | Associate Professor | Department of Biotechnology, School of Life Sciences and Biotechnology | CSJM University, Kanpur |
| Dr. Alok Pandey | Head, Department of Biotechnology | Department of Biotechnology, School of Life Sciences and Biotechnology | CSJM University, Kanpur |

**FIRST YEAR**

| Semester – I | | | |
|---|---|---|---|
| **Code** | **Paper** | **Courses** | **Credits** |
| BH100101T | Core Course - I | Cell Biology | 4 |
| BH100102T | Core Course -II | Biochemistry & Metabolism | 4 |
| BH100103P | Practical -I | Practical-I | 4 |
| VOCxxx | Skill Enhancement course (SEC)/ Vocational Course | As per University Guidelines | 3 |
| Z011101 | Co-curricular Course | First Aid and Basic Health | 2 |
| | | **Total credits** | **17** |

| Semester - II | | | |
|---|---|---|---|
| **Code** | **Paper** | **Courses** | **Credit** |
| BH100201T | Core Course - I | Mammalian Physiology | 4 |
| BH100202T | Core Course -II | Plant Physiology | 4 |
| BH100203P | Practical -II | Practical-II | 4 |
| BH100204M | Minor Course | IPR Entrepreneurship Bioethics & Biosafety | 6 |
| VOCxxx | Skill Enhancement Course (SEC) / Vocational Course | As per University Guidelines | 3 |
| Z021201 | Co-curricular Course | Human Values and Environment Studies | 2 |
| | | **Total Credits** | **23** |

**Note:**

1. **Total Credits 40 till semester II**
2. **Student is entitled for certificate in Faculty after successful completion of first two semesters**

**SECOND YEAR**

| Semester - III | | | |
|---|---|---|---|
| **Code** | **Paper** | **Courses** | **Credits** |
| BH100301T | Core Course - I | Genetics | 4 |
| BH100302T | Core Course -II | General Microbiology | 4 |
| BH100303P | Practical -III | Practical-III | 4 |
| VOCxxx | Skill Enhancement course (SEC) / Vocational Course | As per University Guidelines | 3 |
| Z031301 | Co-curricular Course | Physical Education and Yoga | 2 |
| | | **Total credits** | **17** |

| Semester - IV | | | |
|---|---|---|---|
| **Code** | **Paper** | **Courses** | **Credit** |
| BH100401T | Core Course - I | Molecular Biology | 4 |
| BH100402T | Core Course -II | Immunology | 4 |
| BH100403P | Practical -IV | Practical-IV | 4 |
| BH100404M | Minor Course | Medical Biotechnology | 6 |
| BH100405R | Project | Research Project/Internship/Field Work | 3 |
| Z041401/ Z041402 | Co-curricular Course | Social Responsibility and Community Engagement/Indian Language | 2 |
| | | **Total Credits** | **23** |

**Note:**

1. **Total Credits 80 till semester IV**
2. **Student is entitled for Diploma in Faculty after successful completion of four semesters**

**THIRD YEAR**

| Semester -V | | | |
|---|---|---|---|
| **Code** | **Paper** | **Courses** | **Credits** |
| BH100501T | Core Course - I | Bio Analytical Tools | 4 |
| BH100502T | Core Course -II | Recombinant DNA Technology | 4 |
| BH100503T | Core Course – III | Biostatistics | 4 |
| BH100504T | Core Course -IV | Bioinformatics | 4 |
| BH100505P | Practical - V | Practical-V | 4 |
| BH100506R | Research Project | Research Project on topics which are Inter/Intra faculty | 5 |
| | | **Total credits** | **25** |

| Semester - VI | | | |
|---|---|---|---|
| **Code** | **Paper** | **Courses** | **Credit** |
| BH100601T | Core Course - I | Bioprocess Technology | 4 |
| BH100602T | Core Course -II | Genomics and Proteomics | 4 |
| BH100603T | Core Course – III | Animal Biotechnology | 4 |
| BH100604T | Core Course -IV | Plant Biotechnology | 4 |
| BH100605P | Practical - VI | Practical-VI | 4 |
| BH100606R | Research Project | Research Project on topics which are Inter/Intra faculty | 5 |
| | | **Total Credits** | **25** |

1. **Total Credits 130 till semester VI**
2. **Student is entitled for Three Year B.Sc. (Honours) Biotechnology UG Degree after successfully completion of six semesters.**

| Subject Prerequisite | |
|---|---|
| The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject. | |
| **Programme Outcomes (POs)** | |
| After completion of the B. Sc. Biotechnology programme, the candidate should be able to: | |
| **PO1** | Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology research, Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia. |
| **PO2** | Demonstrate skills to use modern analytical tools/ software/ equipment and analyse and solve problems in various courses of biotechnology. |
| **PO3** | Execute their professional roles in society as biotechnology professionals, employers and employees in various industries, researchers and educators. |
| **PO4** | Design, perform experiments, analyze and interpret data for investigating complex problems in biotechnology and related fields. |
| **PO5** | Demonstrate learning skills to work as a team in a multidisciplinary environment. |
| **PO6** | Design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools. |
| **PO7** | Develop skills, attitude and values required for self-directed, lifelong learning and professional development. |
| **PO8** | Acquire knowledge and understanding of norms and ethics in the field of biotechnology. |

| PROGRAMME SPECIFIC OUTCOMES (PSOS) | |
|---|---|
| **CERTIFICATE IN TOOLS AND TECHNIQUES OF BIOTECHNOLOGY** | |
| **First Year** | This course introduces the knowledge of cell biology, genetics, molecular biology and genetic engineering. After completion of this certificate course, students will be able to –<br>**PSO1:** demonstrate and apply their knowledge of cell biology and Biochemistry to solve the problems related to the field of biotechnology.<br>**PSO2:** learn about the cell theory, cell cycle mechanisms, various cellular organelles and their fractionation<br>**PSO3:** learn the chemistry, structure and functions of major bio-molecules and metabolism of carbohydrate, protein etc<br>**PSO4:** understand the significance of Biochemistry and basics of enzymes.<br>**PSO5:** Develop an understanding of the inter relationships within and between anatomical and physiological systems of the human body.<br>**PSO6:** Understand anatomy of different Plant organ and tissues and the role of Physiological processes for plant growth and development. |
| **DIPLOMA IN TOOLS AND TECHNIQUES IN BIOTECHNOLOGY** | |
| **Second Year** | After completion of diploma course, students will be able to-<br>**PSO1:** familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.<br>**PSO2:** gain knowledge about the application of various types of microscope, karyotyping, banding techniques, chromosome painting and FACS.<br>**PSO3:** understand the basic concepts of genetics and molecular biology such as inheritance pattern, DNA replication, transcription and translation<br>**PSO4:** Understand Microbial taxonomy and Morphology and microbes in extreme environments and microbial interactions•<br>**PSO5:** understand basics of Control of Microorganisms and different methods of sterilization<br>**PSO6:** apply at technical positions in different research laboratories, diagnostic centres and industries..<br>**PSO6:**<br>**PSO7:** understand and also able to perform different immunological techniques like agglutination reaction, ABO typing and ELISA |
| **DEGREE IN BACHELOR OF SCIENCE HONOURS** | |
| **Third Year** | After completing the three years degree with honours course in Biotechnology, the students will be able to –<br>**PSO1:** understand and perform various recent molecular and recombinant DNA technology techniques in early diagnosis and prognosis of human diseases.<br>Perform experiments of DNA isolation, agarose gel electrophoresis, gene clning, transformations, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.<br>**PSO2:** demonstrate the concepts in computational Biology. Understand the interrelationship between Biology and Computer<br>acquire knowledge in different domains of biotechnology enabling their application in industry, research and academia.<br>**PSO3:** perform and analyse the results of experiments using basic laboratory techniques of cell biology, molecular biology, genetic engineering, biochemistry, immunology, microbiology, bioinformatics, biostatistics, animal and plant biotechnology and Food biotechnology.<br>**PSO4:** recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant technology. |

| | |
|---|---|
| | **PSO5:** develop an ability to properly understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.<br>**PSO6:** exhibit ability to do research independently as well as in collaboration.<br>**PSO7:** recognize the importance of Bioethics, IPR, and entrepreneurship. |

| Programme / Class | Certificate | Year | B.Sc. 1st year | Semester | I |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100101T | | Course Title | Cell Biology | |

- **Course Outcome-** Students will learn about cell theory, cell cycle mechanisms, various cellular organelles and their fractionation
- Students will acquire insight into the processes of transport across cell membranes
- Students will gain knowledge about the concepts of various cellular signal transduction pathways

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| Unit-I | **Cell:** Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. **Cell Membrane and Permeability:** Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. IKS: Contribution of Indian scientists. | 10 |
| Unit-II | **Membrane Vacuolar system, cytoskeleton and cell motility:** Structure and function of microtubules, Microfilaments, Intermediate filaments. **Endoplasmic reticulum:** Structure, function, including role in protein segregation. **Golgi complex:** Structure, biogenesis and functions including role in protein secretion. | 15 |
| Unit-III | **Lysosomes:** Vacuoles and micro bodies: Structure and functions **Ribosomes:** Structures and function including role in protein synthesis. **Mitochondria:** Structure and function, genomes, biogenesis. **Chloroplasts:** Structure and function, genomes, biogenesis, Light Reactions **Nucleus:** Structure and function, chromosomes and their structure. | 20 |
| Unit-IV | **Extracellular Matrix:** Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix, macromolecules, regulation of receptor expression and function. **Signal transduction:** Second messengers - cAMP, cGMP, IP3, diacylglycerol, Ca2+, NO. Brief account of their importance and role in signalling and signal transduction. **Cancer:** Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer. | 15 |

**Suggested Readings:**


1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

| Programme / Class | Certificate | Year | B.Sc. 1st year | Semester | I |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100102T | | Course Title | Biochemistry And Metabolism | |

- **Course Outcome-** After successful completion of the course, student will be able to:
- Understand the significance of Biochemistry.
- Learn the chemistry of carbohydrates, lipids, proteins and amino acids.
- Understand the basics of enzymes
- .Know the chemical structure of nucleotides including their components
- Understand the metabolism of carbohydrate and proteins

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | **Introduction to Biochemistry: (10 Periods)**<br>A historical prospective.<br>**Amino acids & Proteins:** Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Levels of structural organization of proteins. Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.<br>**Carbohydrates:** Structure, Function and properties of Monosaccharides, Disaccharides, and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Glycoprotein's and their biological functions; IKS: Contribution of Indian scientists. | 15 |
| UNIT-II | **Lipids:** Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.<br>**Nucleic acids:** Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA | 15 |
| UNIT-III | **Enzymes:** Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions | 15 |
| UNIT-IV | **Carbohydrates Metabolism:** Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids. Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle | 15 |

**Suggested Readings:**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

| Programme / Class | Certificate | Year | B.Sc. 1st year | Semester | I |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | | BH100103P | Course Title | Practical-I | |

- **Course Outcome-** After successful completion of the course, student will be able to perform:
- Qualitative tests of different Biomolecules
- Preparation of buffer
- Microscopy of Prokaryotic and Eukaryotic cells for structure and shape analysis
- Preparation of Nuclear, Mitochondrial, & cytoplasmic Fractions

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 0-0-4**

| Unit | Topic | No of Lectures/ Demonstrations |
|---|---|---|
| | • Qualitative tests for Carbohydrates, lipids and proteins<br>• Preparation of buffers.<br>• Principles of Colorimetry: **(i)** Verification of Beer's law, estimation of protein. **(ii)** To study the relation between absorbance and % transmission.<br>• To study the activity of any enzyme under optimum conditions.<br>• Estimation of blood glucose by the glucose oxidase method.<br>• Study of the structure of any Prokaryotic and Eukaryotic cell.<br>• Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.<br>• Cell division in onion root tip/ insect gonads.<br>• Preparation of Nuclear, Mitochondrial, & cytoplasmic Fractions | 30 + 30 |

**Suggested Readings:**


- An Introduction to Practical Biochemistry, David T. Plummer (2006)Tata McGraw Hill Education, 3rd edition
- Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.


**VOCxxx: {Skill Enhancement course (SEC)}: Vocational Skill Enhancement course: As per Univ. Syllabus**

**Z011101 (Co-curricular Course): First Aid and Basic Health: As per Univ. Syllabus**

| Programme / Class | Certificate | Year | B.Sc. 1st year | Semester | II |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100201T | | Course Title | Mammalian Physiology | |

- **Course Outcome-**
- After the successful course completion, learners will develop following attributes
- Develop an understanding of the inter relationships within and between anatomical and physiological systems of the human body.
- Develop the understanding of basic concepts of physiology and biochemistry of Digestion, Respiration, Circulation, Excretion, and Neurotransmission.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | **Digestion and Respiration**<br>**Digestion:** Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice<br>**Respiration:** Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift. IKS: Contribution of Indian scientists. | 15 |
| UNIT-II | **Circulation:** Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat. | 15 |
| UNIT-III . | **Muscle physiology and osmoregulation (15 Periods)**<br>Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation. | 15 |
| UNIT-IV | **Nervous and endocrine coordination (15 Periods)**<br>Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters<br>**Mechanism of action of hormones (insulin and steroids)\ Different endocrine glands**– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions. | 15 |

**Suggested Readings:**

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

| Programme / Class | Certificate | Year | B.Sc. 1st year | Semester | II |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100202T | | Course Title | Plant Anatomy And Physiology | |

**Course Outcome-** After the completion of the course the students will be able to:

- Understand anatomy of different Plant organ and tissues and the role of Physiological processes for plant growth and development.
- Learn Mechanism of imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.
- Understand criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport
- Assimilate Knowledge about Photosynthesis pigments, photophosphorylation, calvin cycle, CAM plants, photorespiration, and Nitrogen metabolism.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | **Anatomy**<br>The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf). IKS: Contribution of Indian scientists. | 10 |
| UNIT-II | **Plant water relations and micro & macro nutrients**<br>Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.<br>Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport | 12 |
| UNIT-III | **Carbon and nitrogen metabolism**<br>Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point<br>Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants. | 20 |
| UNIT-IV | **Growth and development**<br>Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization | 18 |

**Suggested Readings:**


1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4 th edition, Sinauer Associates Inc .MA, USA

| Programme / Class | Certificate | Year | B.Sc. 1st year | Semester | II |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | | BH100203P | Course Title | Practical-II | |

- **Course Outcome-** After successful completion of the course, student will be able to perform: experiments related to plant and animal physiology and can analyse blood samples.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 0-0-4**

| Unit | Topic | No of Lectures/ Demonstrations |
|---|---|---|
| | • Determination of blood groups, Determination of Haemoglobin,<br>• Finding the coagulation time of blood<br>• Counting of mammalian RBCs<br>• Determination of TLC and DLC<br>• Demonstration of serum alkaline Phosphatase enzyme activity<br>• Preparation of stained mounts of anatomy of monocots and dicots' roots, stems & leaves.<br>• Demonstration of plasmolysis by Tradescantia leaf peel.<br>• Demonstration of opening & closing of stomata<br>• Separation of photosynthetic pigments by paper chromatography.<br>• Demonstration of aerobic respiration. | 30 + 30 |

**Suggested Readings:**

Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkarth
Medical Laboratory Technology by Ramniksood, 5 Edition, 1999, Jaypee publishers.
Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.

| Programme / Class | Certificate | Year | B.Sc. 1st year | Semester | II |
|---|---|---|---|---|---|
| Subject | | | | | |
| Course Code | BH100204M | | Course Title | I.P.R. Entrepreneurship Bioetihcs & Biosafety | |

**Course Outcome- Students-**

- Will able to understand Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.
- Learn about Entrepreneurship, Bioethics, Biosafety

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks:33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations. | 15 |
| UNIT-II | Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc. | 20 |
| UNIT-III . | Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International.<br>Ethical issues against the molecular technologies. | 10 |
| UNIT-IV | Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). | 15 |

**Suggested Readings:**

- Entrepreneurship: New Venture Creation : David H. Holt Patterns of Entrepreneurship : Jack M. Kaplan
- Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
- Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
- Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international
- Publisher.

**VOCxxx: {Skill Enhancement course (SEC)} As per Univ. Syllabus**

**Z021201: Co-curricular Course): Human Values and Environment Studies: As per Univ. Syllabus**

| Programme / Class | Diploma | Year | B.Sc. 2nd year | Semester | III |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100301T | | Course Title | General Microbiology | |

- **Course Outcome-** After the completion of the course the students will be able to:
- **Learn** about Fundamentals, History and Evolution of Microbiology.
- Understand Microbial taxonomy andMorphology and cell structure of major groups of microorganisms e. g. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses. Course outcomes:
- understand basics of Control of Microorganisms
- Study microbes in extreme environments and microbial interactions
- Know the basics of recombination in Prokaryotes Basics of virology
- Understand basics of **Microbial growth and Microbial Metabolism**

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Fundamentals, History and Evolution of Microbiology. **Classification of microorganisms:** Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Bacterial Cell Wall Structure. **Microbial Diversity:** Morphology and cell structure of major groups of microorganisms e. g. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses. IKS: Contribution of Indian scientists. | 10 |
| UNIT-II | Cultivation and Maintenance of microorganisms: Nutritional categories of Microorganisms, methods of isolation, Purification and preservation. | 10 |
| UNIT-III | **Microbial growth:** Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth, and factors affecting the growth of bacteria. **Microbial Metabolism:** Metabolic pathways, amphi-catabolic and biosynthetic pathways, Fermentation **Bacterial Reproduction:** Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. | 20 |
| UNIT-IV | Control of Microorganisms: By physical, chemical and chemotherapeutic Agent Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Preservation of various types of foods. Fermented Foods. Major food and waterborne infections and intoxications. | 20 |

**Suggested Readings:**


- Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
- Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
- Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

| Programme / Class | Diploma | Year | B.Sc. 2nd Year | Semester | III |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100302T | | Course Title | Genetics | |

- Course Outcome-
- Understand the structure and chemical composition of chromatin and concept of cell division.
- Interpret the Mendel's principles; acquire knowledge on cytoplasmic inheritance and sex-linked inheritance, mutations.
- Understand the concept Non allelic interactions, Genetic organization of prokaryotic and viral genome
- Understand Linkage and Recombination of genes in a chromosome, Cytological basis of crossing over, and Extra chromosomal inheritance.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. IKS: Contribution of Indian scientists. | 12 |
| UNIT-II | Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.<br>Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.<br>**Genetic organization of prokaryotic and viral genome.**<br>Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function. | 18 |
| UNIT-III | **Chromosome and gene mutations:** Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.<br>Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance. | 15 |
| UNIT-IV | **Genetic linkage, crossing over and chromosome mapping:** Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.<br>**Extra chromosomal inheritance:** Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic | 15 |

| | | |
|---|---|---|
| | imprinting.<br>Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection. | |

**Suggested Readings:**


- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition.
- Benjamin Cummings.
- Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.


| Programme / Class | Diploma | Year | B.Sc. 2nd year | Semester | III |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100303P | | Course Title | Practical-III | |

- **Course Outcome-** After successful completion of the course,
- The students will be able to perform different tests related to genetics and microbiology.
- Students will learn basic molecular and microbial techniques required for analysis of different pathological samples.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 0-0-4**

| Unit | Topic | No of Lectures/ Demonstrations |
|---|---|---|
| | • Permanent and temporary mount of mitosis and meiosis.<br>• Mendelian deviations in dihybrid crosses<br>• Karyotyping with the help of photographs<br>• Pedigree charts of some common characteristics like blood group, color blindness and PTC tasting.<br>• Study of polyploidy in onion root tip by colchicine treatment.<br>• Preparation of media & sterilization methods.<br>• Methods of isolation of bacteria from different sources & their biochemical characterization.<br>• Staining methods: simple staining, Gram staining, Endospore staining, negative staining,<br>• Enumeration of microorganism - total & viable count. | 30 + 30 |

**Suggested Readings:**


- Hartl, D. L., & Jones, E. W. (1998). **Genetics: Principles and Analysis**. Sudbury,
- MA: Jones and Bartlett.
- Roskam's J. Rodgers L.(2002). **Lab Ref: A Handbook of Recipes, Reagents, and other reference tools for use at the Bench.** Cold Spring Harbor Laboratory Press. USA.
- Barker K (2004). **At the Bench: A laboratory Navigator**. Cold Spring Harbor Laboratory Press. USA


**VOCxxx: {Skill Enhancement course (SEC)}: Vocational Skill Enhancement course: As per Univ. Syllabus**

**Z031301: (Co-curricular Course): Physical Education and Yoga: As per Univ. Syllabus**

| Programme / Class | Diploma | Year | B.Sc. 2nd year | Semester | IV |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | | BH100401T | Course Title | Molecular Biology | |

**Course Outcome- Students-**

- Will able to understand details of central dogma of life and DNA structure and replication
- Get proper knowledge about DNA damage, repair and homologous recombination.
- Gain knowledge about Transcription and RNA processing, Prokaryotic and eukaryotic translation

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | **DNA structure and replication (15 Periods)**<br>DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication. IKS: Contribution of Indian scientists. | 15 |
| UNIT-II | **DNA damage, repair and homologous recombination (10 Periods)**<br>DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism. | 15 |
| UNIT-III | **Transcription and RNA processing (17 Periods)**<br>RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains<br>**Transcription in eukaryotes:** Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing. | 15 |
| UNIT-IV | **Regulation of gene expression and translation (18 Periods)**<br>**Regulation of gene expression in prokaryotes:** Operon concept (inducible and repressible system), Genetic code and its characteristics.<br>**Prokaryotic and eukaryotic translation:** ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Posttranslational modifications of proteins. | 15 |

**SUGGESTED READING**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

| Programme / Class | Diploma | Year | B.Sc. 2nd year | Semester | IV |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100402T | | Course Title | IMMUNOLOGY | |

**Course Outcome-**

- Understand the principles of immunology
- Learn about structural features of components of immune system as well as their function and development of immune system and mechanisms by which our body elicits immune response.
- Predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.
- Understand different tools and techniques of immunology
- Understand the biology of different vaccines against infectious agents

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | **Immune Response -** An overview, components of the mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T- lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination. IKS: Contribution of Indian scientists. | 20 |
| UNIT-II | **Regulation of immunoglobulin gene expression** – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity. | 15 |
| UNIT-III | **Major Histocompatibility complexes –** class I & class II MHC antigens, antigen processing.<br>**Immunity to infection** – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS. | 13 |
| UNIT-IV | **Vaccines & Vaccination** – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA. | 12 |

**Suggested Readings:**


- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
- Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
- Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

| Programme / Class | Diploma | Year | B.Sc. 2nd year | Semester | IV |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100403P | | Course Title | Practical-IV | |

- **Course Outcome-** After successful completion of the course,
- The students will be able to perform different tests related to Molecular Biology and Immunology.
- Students will learn basic molecular and Immunological techniques required for analysis of different pathological samples.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 0-0-4**

| Unit | Topic | No of Lectures/ Demonstrations |
|---|---|---|
| | • Preparation of solutions for Molecular Biology experiments.<br>• Isolation of chromosomal DNA from bacterial cells.<br>• Isolation of Plasmid DNA by alkaline lysis method<br>• Agarose gel electrophoresis of genomic DNA & plasmid DNA<br>• Qualitative and quantitative analysis of DNA using spectrophotometer<br>• Haemagglutination assay<br>• Haemagglutination inhibition assay<br>• Separation of serum from blood<br>• Double immunodiffusion test using specific antibody and antigen.<br>• Radial immunodiffusion<br>• ELISA. | 30 + 30 |

- **Suggested Readings:**

- Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 1998,
- Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010
- William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York.
- William, R. Clark (1991) the Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
- Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company
- Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins
- Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell).

**Minor Course: Medical Biotechnology: As proposed by the concerned dept.**

| BH100404M | Minor Course | Medical Biotechnology |
|---|---|---|

Unit I: Vaccine technology: Immunity and vaccine; Childhood immunization program, Herd Immunity; Active immunization, Attenuated; Inactivated; Subunit vaccines; Recombinant and protein based vaccines, plant-based vaccines; conjugate vaccines; Passive Immunization; Monoclonal Antibody concept and applications.

Unit II: Important therapeutic proteins: Functions, Uses and Production of Insulin, Growth Hormone, Factor VIII, Tissue-Plasminogen Activator, Erythropoietin; Interferon basic concept and application.

Unit III: Biotechnological methods of disease diagnosis and treatment- Microbiological; Immunological-agglutination, ELISA, Western blotting; Serological; Molecular diagnostics-PCR, Real time PCR, $C_T$ value and viral load, Forensic medicine: DNA fingerprinting and DNA profiling, Imaging technologies

Unit IV: Drug targeting and delivery; In vitro fertilization and Embryo Transfer, Assisted Reproductive Technologies; Cryopreservation of sperm and ovum; Banking concept in Biotechnology, Stem Cell therapy; Gene therapy; Concept of Tissue engineering, Organoids development; 3D Bioprinting, Production of Artificial tissues and organs, Commercialized products.

**Texts/References**

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
2. S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Selected Methods for Antibody and Nucleic Acid probes, Volume 1, Cold Spring Harbor Laboratory Press, 1993.
3. Ed Harlow, David Lane, Antibodies Laboratory Manual, Cold Spring Harbor, Laboratory Press, 1988.
4. Gupta V et al (2016). Basics and Applied Aspects of Biotechnology, Springer International.
5. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.

**BH100405R: Project: Research Project/Internship/Field Work**

**Z041401/Z041402: (Co-curricular Course): Social Responsibility and Community Engagement/Indian Language: As per Univ. Syllabus**

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | V |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100501T | | Course Title | Bio-Analytical Tools | |

- **Course Outcome-**
- The objective of the course is to introduce various techniques to the students, which are used in biological research.
- Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
- Students will learn about the principle and application of electrophoresis, centrifugation techniques, microscopic and molecular biological techniques.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy, IKS: Contribution of Indian scientists. | 10 |
| UNIT-II | Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles. | 15 |
| UNIT-III | Introduction to the principle of chromatography. Paper chromatography, thin layer Chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC. | 15 |
| UNIT-IV | Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications. | 20 |

**Suggested Readings:**

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | V |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100502T | | Course Title | Recombinant DNA Technology | |

- **Course Outcome-**
- Gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.
- Understand gene concept, plasmids, and wide range of techniques, especially modern molecular tools in diagnosis.
- Acquainted with various techniques of genetic engineering and their applications in biological research, diagnostics as well as in biotechnology industries.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR. IKS: Contribution of Indian scientists. | 15 |
| UNIT-II | Restriction and modification system, restriction mapping. Southern and Northern hybridization.<br>Preparation and comparison of Genomic and c-DNA library, screening of recombinants, reverse transcription. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each). | 20 |
| UNIT-III | Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two). | 10 |
| UNIT-IV | Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors. | 15 |

**Suggested Readings:**

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | V |
|---|---|---|---|---|---|
| Subject | | | | | |
| Course Code | BH100503T | | Course Title | BIOSTATISTICS | |

- **Course Outcome-**
- Learn the need of statistical approach, identify the different axiomatic approach.
- Learn to study the variability of observation.
- know effective use of Office package –word, excel, ppt. and publisher etc
- understand simple calculation using excel

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis. IKS: Contribution of Indian scientists. | 12 |
| UNIT-II | Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions. | 18 |
| UNIT-III | Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA) | 18 |
| UNIT-IV | Correlation and Regression. Emphasis on examples from Biological Sciences. | 12 |

**Suggested Readings:**

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc..

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | V |
|---|---|---|---|---|---|
| Subject | | | | | |
| Course Code | BH100504T | | Course Title | BIOINFORMATICS | |

**Course Outcome-**

- Understand the basic theories and practical's of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts. critically analyse and interpret results of their studies with the help of bioinfomatical tools.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. IKS: Contribution of Indian scientists. | 12 |
| UNIT-II | Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry. | 18 |
| UNIT-III | Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis. | 18 |
| UNIT-IV | Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools. | 12 |

**Suggested Readings:**

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | V |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | | BH100505P | Course Title | Practical-V | |

- **Course Outcome-** After successful completion of the course,
- Students will learn different Bioanalytical techniques and tools and techniques for genetic Engineering
- Students learn about techniques of Biostatistics and Bioinformatics

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 0-0-4**

| Unit | Topic | No of Lectures/ Demonstrations |
|---|---|---|
| | • Preparation of the sub-cellular fractions of rat liver cells.<br>• Preparation of protoplasts from leaves.<br>• Separation of amino acids by paper chromatography; To identify lipids in a given sample by TLC.<br>• To verify the validity of Beer's law and determine the molar extinction coefficient.<br>• Restriction digestion of DNA<br>• Competent Cells: Preparation and Transformation of Competent Cells.<br>• Demonstration of PCR<br>• Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,<br>• Understanding and using: PDB, SwissProt, TREMBL<br>• Using various BLAST and interpretation of results; Sequence alignment using BLAST; Multiple sequence alignment using Clustal W.<br>• Practicals Based on measures of Central Tendency & Dispersion, graphical Representation, Distributions, Binomial, Poisson, Normal, t, f, z, and Chi-square | 30 + 30 |

**Suggested Readings:**


- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
- Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
- Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
- Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
- Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
- Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
- Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
- Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
- Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.


**BH100506R: (Research Project): Research Project on topics which are Inter/Intra faculty**

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | VI |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100601T | | Course Title | BIOPROCESS TECHNOLOGY | |

- **Course Outcome-**
- Understand the problems in isolation, strain improvement and growth of microorganisms in industrial processes.
- Isolate and improve the industrially important microorganisms.
- Understand design and types of fermenters and operation of fermenters.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture. IKS: Contribution of Indian scientists. | 10 |
| UNIT-II | Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization. | 20 |
| UNIT-III. | Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control. | (15 |
| UNIT-IV | Introduction to downstream processing, product recovery and purification. Effluent treatment.<br>Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins. | 15 |

**Suggested Readings:**

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | VI |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100602T | | Course Title | GENOMICS & PROTEOMICS | |
| • Course Outcome- | | | | | |
| Credits – 4 | | Max. Marks : 100 (25 + 75) | | Min. Passing Marks :33 | |
| Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0 | | | | | |

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software. IKS: Contribution of Indian scientists. | 15 |
| UNIT-II | Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases | 10 |
| UNIT-III | Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation | 20 |
| UNIT-IV | Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data. | 15 |

**Suggested Readings:**


1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition,
4. B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
8. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
9. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
10. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
11. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | VI |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | BH100603T | | Course Title | ANIMAL BIOTECHNOLOGY | |

**Course Outcome- Students**

- will learn about Gene transfer methods in Animals
- Understand the concept of Transgenic Animals, Stem Cell Technology , gene therapy

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer. IKS: Contribution of Indian scientists. | 10 |
| UNIT-II | Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis. | 20 |
| UNIT-III | Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications. | 10 |
| UNIT-IV | Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics. | 20 |

**Suggested Readings:**


Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.

2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.

4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.

5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

| Programme / Class | Honours | Year | B.Sc. 3rd year | Semester | VI |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | | BH100604T | Course Title | Plant Biotechnology | |

- **Course Outcome-**
- Understand the principles, practices and applications of plant biotechnology, transgenic
- Plant generation, plant tissue culture, plant genomics, and genetic transformation.
- Understand applications of stem cells and tissues engineering.
- Learn different gene delivery methods to deliver foreign gene in plants
- Know about different products of transgenic animals, plants and microbes.

| Credits – 4 | Max. Marks : 100 (25 + 75) | Min. Passing Marks :33 |
|---|---|---|

**Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0**

| Unit | Topic | No of Lectures |
|---|---|---|
| UNIT-I | Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation. IKS: Contribution of Indian scientists. | 15 |
| UNIT-II | In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals. | 20 |
| UNIT-III | Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclature, methods, applications basis and disadvantages. | 15 |
| UNIT-IV | Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation,<br>Biocontrol of pathogens, Growth promotion by free-living bacteria. | 10 |

**Suggested Readings:**


1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

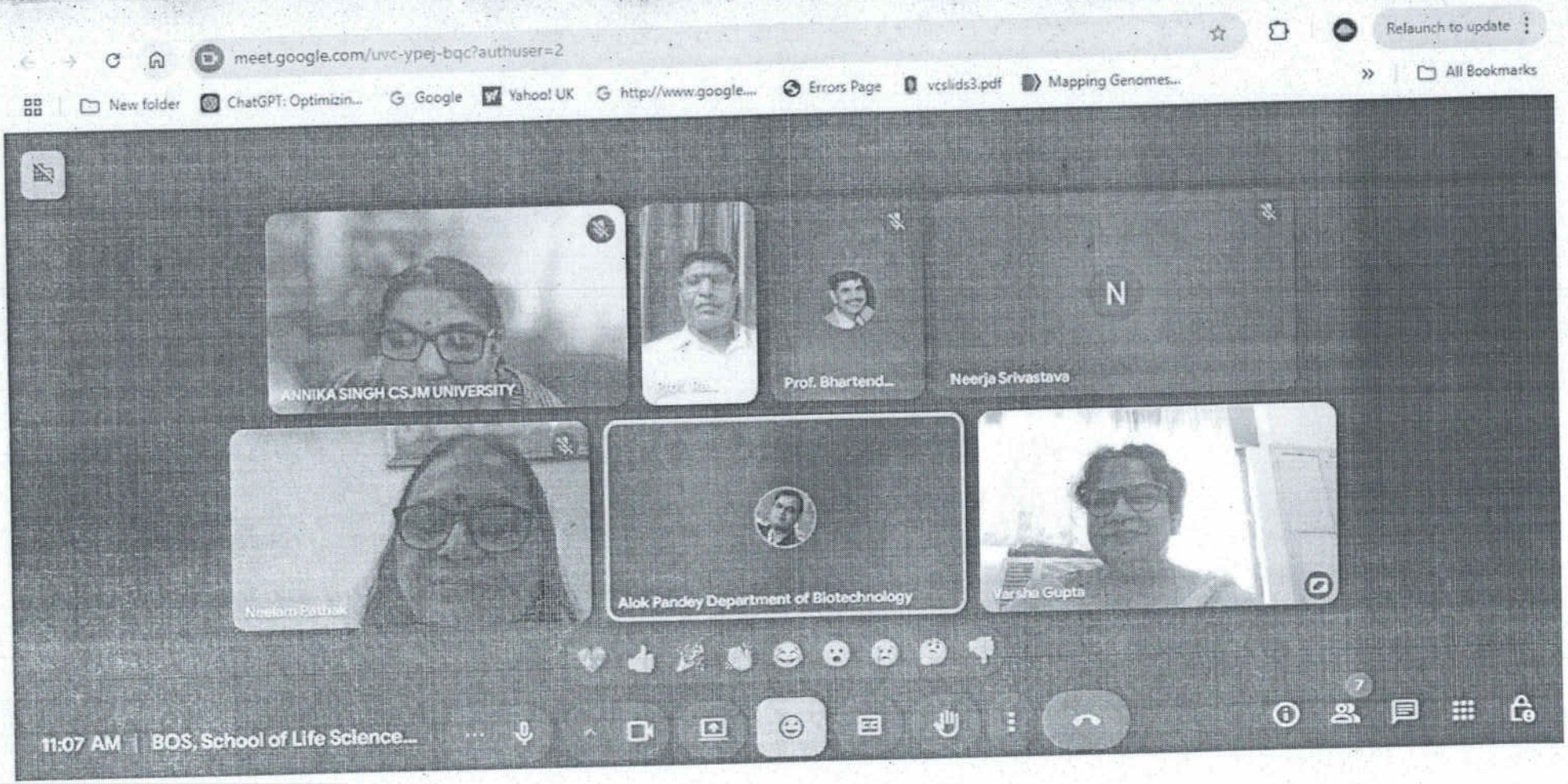
| Programme / Class | Honours | Year | B.Sc. Third year | Semester | VI |
|---|---|---|---|---|---|
| Subject | | | B.Sc. (HONOURS) BIOTECHNOLOGY | | |
| Course Code | | BH100605P | Course Title | Practical-VI | |
| • **Course Outcome-** After successful completion of the course, student will be able to perform: experiments related to plant and animal physiology and can analyse blood samples. | | | | | |
| Credits – 4 | | Max. Marks : 100 (25 + 75) | | Min. Passing Marks :33 | |
| Total No. of Lectures - Tutorials - Practical (in hours per week) : 0-0-4 | | | | | |

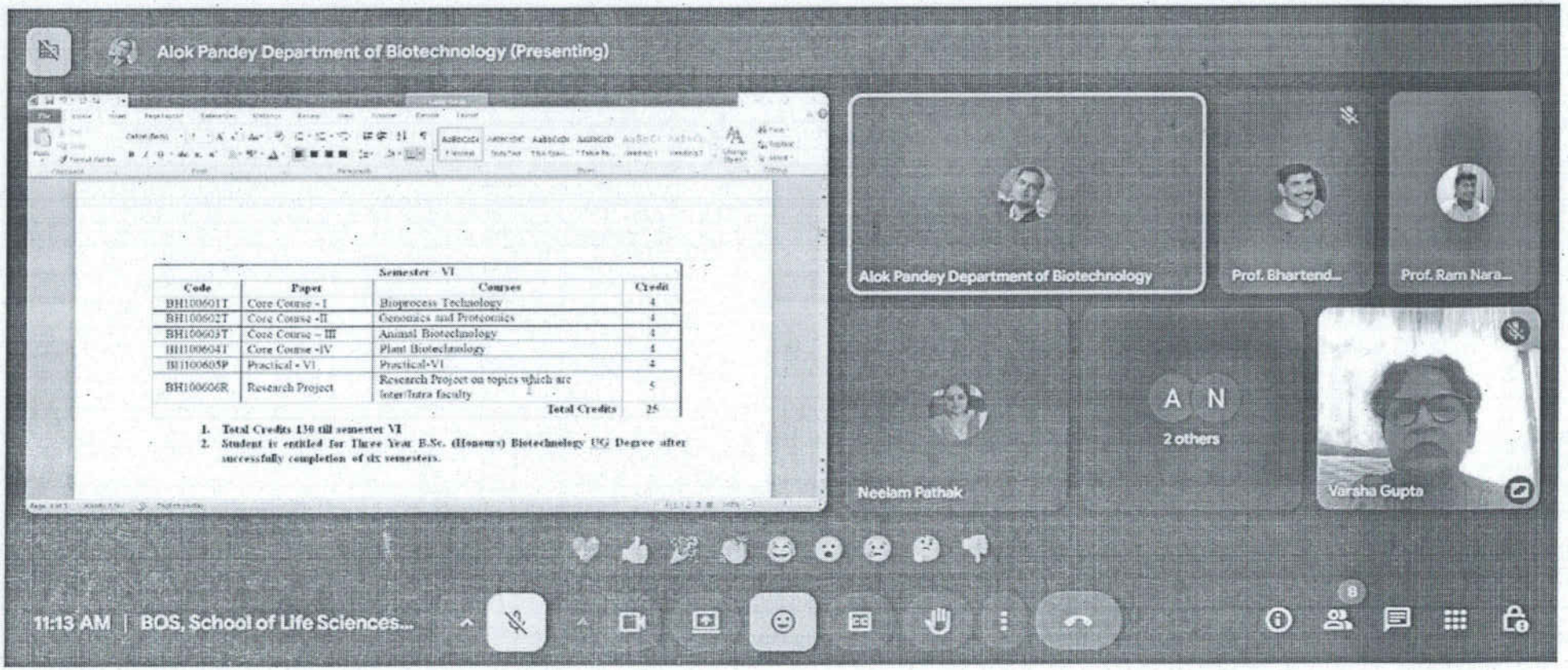
| Unit | Topic | No of Lectures/ Demonstrations |
|---|---|---|
| | • Isolation of an industrially important microorganism from a natural resource. Bacterial growth curve.<br>• Calculation of thermal death point (TDP) of a microbial sample.<br>• Production and analysis of ethanol and lactic acid.<br>• Production and analysis of amylase.<br>• Use of SNP databases at NCBI and other sites; Use of OMIM database<br>• Detection of Open Reading Frames using ORF Finder; Proteomics 2D PAGE database<br>• Software for Protein localization.; Hydropathy plots<br>• Native PAGE and SDS-PAGE<br>• Sterilization techniques: Glassware sterilization, Media sterilization, Laboratory sterilization; Sources of contamination and decontamination measures.<br>• Preparation of Hank's Balanced salt solution; Preparation of Minimal Essential Growth medium<br>• Isolation of lymphocytes for culturing<br>• DNA isolation from animal tissue<br>• Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid, and liquid.<br>• Preparation of complex nutrient medium (Murashige & Skoog's medium); Significance of growth hormones in culture medium.<br>• Selection, Pruning, sterilization, and preparation of an explant for plant tissue culture.<br>• To demonstrate various steps of Micropropagation. | 30 + 30 |

**Suggested Readings:**


- Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 1998,
- Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010
- Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.


**BH100606R: (Research Project): Research Project on topics which are Inter/Intra faculty**


meet.google.com/uvc-ypej-bqc?authuser=2
Relaunch to update
New folder
ChatGPT: Optimizin...
Google
Yahoo! UK
http://www.google....
Errors Page
vcslids3.pdf
Mapping Genomes...
All Bookmarks
ANNIKA SINGH CSJM UNIVERSITY
Prof. Bhartend...
N
Neerja Srivastava
Neelam Pathak
Alok Pandey Department of Biotechnology
Varsha Gupta
11:07 AM | BOS, School of Life Science...


meet.google.com/uvc-ypej-bqc?authuser=2
Relaunch to update
New folder
ChatGPT: Optimizin...
Google
Yahoo! UK
http://www.google....
Errors Page
vcslids3.pdf
Mapping Genomes...
All Bookmarks
Alok Pandey Department of Biotechnology (Presenting)
Semester - VI
Code | Paper | Courses | Credit
BH100601T | Core Course - I | Bioprocess Technology | 4
BH100602T | Core Course -II | Genomics and Proteomics | 4
BH100603T | Core Course – III | Animal Biotechnology | 4
BH1006041 | Core Course -IV | Plant Biotechnology | 4
BH1006059 | Practical - VI | Practical-VI | 4
BH100606R | Research Project | Research Project on topics which are inter/Intra faculty | 5
Total Credits | 25
1. Total Credits 130 till semester VI
2. Student is entitled for Three Year B.Sc. (Honours) Biotechnology UG Degree after successfully completion of six semesters.
Alok Pandey Department of Biotechnology
Prof. Bhartend...
Prof. Ram Nara...
Neelam Pathak
A N
2 others
Varsha Gupta
11:13 AM | BOS, School of Life Sciences...