# VIVEKANANDHA

## COLLEGE OF ARTS AND SCIENCES FOR WOMEN

## [AUTONOMOUS]

An ISO 9001:2008 Certified Institution
Affiliated to Periyar University
(Approved by AICTE and Re-accredited with „A“ Grade by NAAC)
Recognized Under 2(f) and 12 (b) of UGC Act, 1956.
Elayampalayam, Tiruchengode-637 205, Namakkal Dt., Tamil Nadu, India

# DEPARTMENT OF BIOTECHNOLOGY

## PG SYLLABUS

[*For the Candidates admitted on 2019-2020 onwards under Autonomous, CBCS & OBE pattern*]

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**ANGAMMAL EDUCATIONAL TUST**
**ELAYAMPALAYAM – 637 205, TIRUCHENGODE Tk., Namakkal Dt., Tamil Nadu**
**VEERACHIPALAYAM – 637 303, SANKARI Tk., Salem Dt., Tamil Nadu**

**Tel.: 04288 234670 (4 lines), Fax: 04288 234894**

**Website: www.vivekanandha.ac.in**

VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN
(AUTONOMOUS)

DEPARTMENT OF BIOTECHNOLOGY

**CBCS SYLLABUS – PG (OBE PATTERN)**

1. **Aim of the Program:**
   - Understanding various disciplines in biotechnology and acquire methodological knowledge in them.
   - Application of this knowledge in a suitable manner in required fields.

2. **Eligibility for Admissions**

   A candidate seeking admission to M.Sc Biotechnology must have at least 50% marks in any branch of Life Sciences viz. Zoology, Botany, Biochemistry, Biotechnology, Microbiology, Biological Techniques & Specimen Preparation and Microbiology or Chemistry at the graduate level; Candidates having B.Sc., degree in Industrial Microbiology / Medical Microbiology/ MLT with 50% marks are also eligible. MBBS/ B.Sc., Agriculture/ BVSc/ B.F.Sc/ B.Tech (Biotechnology) Degree holders can also apply.

3. **Duration of the course:** The duration of the course is 2 years. First year consists of I and II semester and second year consists of III and IV semester.

4. **Medium of Instruction and Assessment** : English.- External and Internal evaluation as per university regulations.

5. **Faculty under which the Degree is Awarded:** Faculty of Science

6. **Specializations offered, if any** : NIL

7. **Programme Outcomes:**
   - **PO1.** Nurturing novel ideas and meaningful insights through scientific thinking and its practical skill in biotechnological aspects
   - **PO2.** Enabling critical analysis of problems and situations to reach solutions.
   - **PO3.** Development of communication skills to present scientific data in oral and written formats.
   - **PO4.** Providing a platform for individual and collective work.
   - **PO5**. Understanding the significance of sustainable scientific processes to support the enviro$^{2}$nment.

**8. Programme Specific Outcome:**

- **PSO1.** Imparting basic knowledge in interdisciplinary fields of biotechnology.
- **PSO2**. Using modern tools to study and analyse biological data
- **PSO3.** To equip the candidates to meet the demands of the society to get sustainable products and processes through biotechnology.
- **PSO4**. To be aware of the ethical issues, personal and environmental safety during biotechnology practices.
- **PSO5**. Promoting scientific discoveries and familiarizing research methodology through implementation of projects.

**9. Assessment:**

Assessment of the students would be made through Continuous Internal Assessment (CIA) and External Assessment (EA) for passing each subject both theory and practical papers.

A candidate would be permitted to appear for the External examinations only on earning 75% of attendance and only when His/ Her conduct has been satisfactory. It shall be open to grant exemption to a candidate for valid reasons subject to conditions prescribed.

9A. **Continuous Internal Assessment** (CIA):

The performance of the students will be assessed continuously by the teacher concern and the Internal Assessments Marks will be as follows:

**Distribution of CIA Marks:**

| Activity | Period (Working days) | Marks (25) | Activity | Marks (40) |
|---|---|---|---|---|
| Attendance | 90 | 5 | Attendance | 10 |
| CIA I | 30-35 | 2.5 | Observation Note | 10 |
| CIA II | 60 – 65 | 2.5 | Performance | 10 |
| Model Examination | After90 | 10 | Model Examination | 10 |
| Assignment | 15-20 | 5 | | |
| Total | | 25 | | 40 |

**Distribution of Attendance Marks:**

| **Sl.No** | **Percentage** | **Marks** | |
|---|---|---|---|
| | | **Theory** | **Practical** |
| 1 | 76-80 | 1 | 2 |
| 2 | 81-85 | 2 | 4 |
| 3 | 86-90 | 3 | 6 |
| 4 | 91-95 | 4 | 8 |
| 5 | 96-100 | 5 | 10 |

9B. **External Assessment:**

The performance of the students would be assessed by examinations at the end of each semester with a written test for theory for three hours and practical examinations

at the end of even semesters for Six hours. Question papers would be set by the selected External examiners in the prescribed format and valuated by the external examiners with the help of the teacher concern.

**The pattern of assessment is as follows:**

**Distribution of Final assessment marks (75/60):**

| Sl.No | Activity | Marks (75) | Activity | Marks(60) |
|---|---|---|---|---|
| | **Theory** | | **Practical** | |
| 1 | One Marks (Objective types 20x1=20) | 20 | Record | 5 |
| 2 | Five Marks (Either of Choice 5x5=25) | 25 | Viva-voce | 5 |
| 3 | Ten marks (Either or Choice 3 out of 5) 3x10=30 | 30 | Spotter | 20 |
| | | | Major (Performance, Write up and result) | 20 |
| | | | Minor (Performance, Write up and result) | 10 |
| **Total** | | **75** | **Total** | **60** |

**10. Project:**

Project work shall be assigned individually and must be carried out under the guidance of a faculty from the same college with or without an external guide OR in an external institution under the combined guidance of internal and external guides. The student has to submit the dissertation before the examiner for evaluation and may give a presentation on the project work, if asked for.

**11. Project Evaluation:**

The evaluation of the project (Both CA and ESA) (through oral presentation or Viva-voce as decided by the Chairman, Board of examinations).

| | **Marks** |
|---|---|
| **Project presentation OR Viva Voce on Project** | 60 |
| **C A** | 40 |
| **Maximum marks (including CA)** | **100** |

**VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)**

**DEPARTMENT OF BIOTECHNOLOGY**

**CBCS AND OBE PATTERN SYLLABUS-PG**

**(For Candidates admitted from 2019-2020 onwards)**

| Sem | Subject code | Part | Course | Title | Hrs/ week | Credit | Internal | External | Total |
|---|---|---|---|---|---|---|---|---|---|
| **SEMESTER I** | | | | | | | | | |
| **I** | 19P1BTC01 | I | Core I | Cell Biology and Genetics | 5 | 5 | 25 | 75 | 100 |
| | 19P1BTC02 | I | Core II | Molecular Biology | 5 | 5 | 25 | 75 | 100 |
| | 19P1BTC03 | I | Core III | Biological Chemistry | 5 | 5 | 25 | 75 | 100 |
| | 19P1BTCP01 | I | Core Practical I | Lab in Cell Biology and Molecular Biology | 5 | 4 | 40 | 60 | 100 |
| | 19P1BTCP02 | I | Core Practical II | Lab in Biological Chemistry and Microbiology | 5 | 4 | 40 | 60 | 100 |
| | 19P1BTE01 | II | Elective I | Microbiology | 4 | 4 | 25 | 75 | 100 |
| | | | | Library | 1 | - | - | - | - |
| | **Total** | | | | **30** | **27** | **180** | **420** | **600** |
| **SEMESTER II** | | | | | | | | | |
| **II** | 19P2BTC04 | I | Core IV | Genetic Engineering | 5 | 5 | 25 | 75 | 100 |
| | 19P2BTC05 | I | Core V | Immunology | 5 | 5 | 25 | 75 | 100 |
| | 19P2BTC06 | I | Core VI | Microbial Technology | 5 | 5 | 25 | 75 | 100 |
| | 19P2BTCP03 | I | Core Practical III | Lab in Genetic Engineering and Immunology | 5 | 4 | 40 | 60 | 100 |
| | 19P2BTCP04 | I | Core Practical IV | Lab in Microbial Technology and Bioinformatics | 5 | 4 | 40 | 60 | 100 |
| | 19P2BTE02 | II | Elective II | Bioinformatics | 4 | 4 | 25 | 75 | 100 |
| | | | | Library | 1 | - | - | - | - |
| | **Total** | | | | **30** | **27** | **180** | **420** | **600** |
| | **Grand total of first year** | | | | **60** | **54** | **360** | **840** | **1200** |
| **SEMESTER III** | | | | | | | | | |
| **III** | 19P3BTC07 | I | Core VII | Plant Biotechnology | 5 | 5 | 25 | 75 | 100 |
| | 19P3BTC08 | I | Core VIII | Animal Biotechnology | 5 | 5 | 25 | 75 | 100 |
| | 19P3BTC09 | I | Core IX | Environmental Biotechnology | 5 | 5 | 25 | 75 | 100 |
| | 19P3BTCP05 | I | Core Practical V | Lab in Plant and Animal Biotechnology | 5 | 4 | 40 | 60 | 100 |
| | 19P3BTCP06 | I | Core Practical VI | Lab in Environmental Biotechnology | 5 | 4 | 40 | 60 | 100 |
| | 19P3BTE03 | II | Elective III | Genomics & Proteomics | 4 | 4 | 25 | 75 | 100 |
| | | | | Human Rights | 1 | 1 | - | - | - |
| | **Total** | | | | **30** | **28** | **180** | **420** | **600** |
| **SEMESTER IV** | | | | | | | | | |
| **IV** | 19P4MBED1 | III | EDC | Plant and animal cell culture techniques | 2 | 2 | 25 | 75 | 100 |
| | 19P4BTE04 | II | Elective IV | Research Methodology | 5 | 3 | 25 | 75 | 100 |
| | 19P4BTPR01 | I | Project work | Project & Viva Voce | 23 | 5 | 40 | 60 | 100 |
| | **Total** | | | | **30** | **10** | **90** | **200** | **300** |
| **Grand total of second year** | | | | | **60** | **38** | **270** | **660** | **900** |
| **Grand total of four semesters** | | | | | **120** | **92** | **810** | **1500** | **2100** |

**Semester I (Students admitted on 2019-2020 onwards)**

**Name of the paper – CELL BIOLOGY AND GENETICS**

**Paper code – 19P1BTC01**

**Aim**

1. To give a detailed and comprehensive knowledge on the various aspects of cell biology and genetics including cell structure and its functions, Mendelian genetics, and population genetics in detail.

**Course Objectives:**

- The course gives the life activities at cellular and molecular level and basic functions of the various cellular compartments and organelles.
- It also gives the structural- functional and biochemical details of all cellular activities.
- This explains the basic principles of Mendelian, population genetics and heredity and gives an overview on the classical genetics- Linkage & Crossing over.

**Course Outcome:**

On completion of the course, students shall be able to,

- Identify and present relevant information from research publications dealing with issuesof cell biology and genetics.
- They will be able to assess and relate the information to the context of cell biology.
- Plan and carry out simple experiments on the basis of cell.
- The course enables students to analyse hereditary data and apply fundamental coupling analyses and genetic calculations.

## Course Content:

**UNIT I: CELL DIVISION, CELL DIFFERENTIATION, CELL CYCLE & CELL DEATH:** Molecular events in mitosis and meiosis. ,cell differentiation. Cell cycle: phases & regulation by cyclins and cyclin-dependent kinases. Cell death-types.Necrosis-causes & mechanism of necrosis.Apoptosis, morphology, mitochondrial & death receptors pathways.Difference between apoptosis and necrosis.

**UNIT II: CELL SIGNALING:** Fundamental concepts of general features of cell signalling. Endocrine, paracrine, autocrine& plasma membrane attached protein signalling. G-protein coupled receptors. Secondary messengers:C-AMP, C-GMP, Inositol triphosphate (IP3), Receptor tyrosinekinases, Insulin signalling. RAS-MAP kinase pathway. JAK-STAT pathway.

**UNIT III: BASIC PRINCIPLES OF GENETICS:** Definitions (Phenotype, genotype, heterozygous, homozygous, allele-dominant & recessive, wild type mutant), character, gene, gene locus, hybrids. Mendelian principles (mono & dihybrid crosses), Test cross & back cross. Epistasis. Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, tight junctions, communicating junctions, extracellular matrix, integrins, neurotransmission and its regulation. Regulation of hematopoiesis, differentiation and development.

**UNIT IV: BASIC PRINCIPLES OF GENETICS**: Definitions (Phenotype, genotype, heterozygous, homozygous, allele-dominant & recessive, wild type mutant), character, gene, gene locus, hybrids. Mendelian principles (mono & dihybrid crosses), Test cross & back cross. Epistasis.Mutation and its type: Point mutation, frame shift mutation and suppressor mutations. Recombinations: Homologous recombination (Holliday recombination). Site-specific recombination. McClintok's work consequences and applications of transposition. **Gene mapping methods:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

**UNIT V: SEX CHROMOSOMES & INHERITED DISEASES**. Chromosomal theory of sex determination. XX-XY, XX-XO, ZZ-ZW, chromosomal disorders, sex linked inheritance of molecular diseases. Haemoglobinopathies, disorder of coagulation. Color blindness, Haemophilia, Chromosomal mapping. Interference and Co-incidence.Hormonal control of sex determination. Behavioral genetics, Hardy Weinberg principle- natural selection, genetic drift,

**REFERENCES:-+**


1. Paul, A. 2007. Text book of cell and molecular biology, Books and Allied (P) Ltd. 2nd edition, Kolkata 700 009, pp-1310.
2. Lodish et al Molecular Cell biology 8th ed. Freeman, 2016.
3. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 7 th ed. 2017.
4. Krebs JE et al. Lewin's. Genes XI. Jones & Bartlett Publ, 2017.
5. Alberts et al Molecular biology of the cell. 6th ed. Garland Sci. 2014.
6. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu, 2013.
7. Problems on Genetics, Molecular Genetics and Evolutionary Genetics by Pranab Kr. Banerjee, New Central Book Agency.
8. Genes and Genomes by M Singer, and P Berg, Blackwell Scientific Pub.

**MOLECULAR BIOLOGY**

**19P1BTC02**

**Aim**

- To understand biological activities and metabolism at DNA and protein level

**Course Objectives**

- The course gives an in-depth insight into the molecular aspects of life - the central dogma.
- It explains molecular aspects of genes and its regulation- genome- gene expressions- heredity- recombination- protein synthesis- molecular basis of diseases- mutations- genetic analysis etc.

**Course Outcome**

At the end of the course,

- The student will get an idea about the principles behind molecular biology which makes students to understand the basic molecular tools and its application in basic research and applied research in various fields of life sciences.

## Course Content:

**UNIT I: CHEMISTRY OF NUCLEIC ACIDS:** Introduction to nucleic acids. Nucleic acid as genetic materials, structure, chemical composition of nucleotides and nucleosides.Differences and physiochemical properties of elements in DNA and RNA. Primary structure of DNA: chemical and structural qualities of 3'-5' phosphodiester bonds. Secondary structure of DNA: Watson & Crick model, chargaff's rule, X-ray diffraction analysis of DNA. Triple helix, quadrapule helix, Reversible denaturation and hyperchromic shift. Tertiary structure of DNA: DNA super coiling.

**UNIT II: DNA REPLICATION AND REPAIR**: Overwies of central dogma. DNA replication: Meselson& Stahl experiment. Bi-directional DNA replication. Okazaki fragments. Protoemics of DNA replication, fidelity of DNA replication, Inhibitors of DNA replication.Overview of differences in prokaryotic and eukaryotic DNA replication.Telomere replication in eukaryotes.D-loop and rolling circle mode of replication, mutagens.DNA mutation and their mechanisms. Various types and mechanisms of DNA repair models.

**UNIT III: TRANSCRIPTION**: Structure and function of mRNA, rRNA&tRNA. Characteristics of promoter and enhancer sequences, RNA synthesis.Initiationm Elongation and termination.Inhibitors of transcription.Difference between prokaryotic and eukaryotic transcription.Basic concepts of RNA world. Ribozymes, RNA processing: 5' capping, Splicing-alternative splicing, Poly A tail additio8n and base modification.

**UNIT IV: TRANSLATION**: Introduction to genetic code: Elucidation of genetic code, codon degeneracy, Wobble hypothesis and its importance, prokaryotic and eukaryotic ribosomes. Steps involved in translation: Initiation, elongation and termination of protein synthesis. Inhibitors of protein synthesis.Post-translational modifications and its importance.

**UNIT V: REGULATION OF GENE EXPRESSION**: levels of gene expression, housekeeping genes, upregulation and downregulation. Regulation of gene expression in prokaryotes: *lac* and *trp* operons. Regulation of gene expression in eukaryotes.Organization of genes in prokaryotic and eukaryotic chromosomes.Hierarchial levels of gene regulation. Prokaryotic gene regulation.Regulation of gene expression with reference to lambda phage life cycle.

**REFERENCES:**


1. David Freifelder . 1990. Molecular Biology, 2nd Edition. Narosa Publishing house
2. George M. Malacinski. 2008. Essentials of Molecular Biology, 4th Edition. Narosa Publishing house
3. Veer Bala Rastogi. 2010. Fundamentals of Molecular Biology. Ane Books India
4. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losile. 2008. Molecular Biology of the gene, 5th Edition. Pearson Education.
5. Lodhish, Berk, Matsundairg, Kaiser, Krieger, Scott, Zipursky and Darnell. 2004. Molecular Cell Biology, 5th Edition. W. H. Freeman and Company
6. Robert F. Weaver. 1999. Molecular Biology. WCB McGraw Hill
7. E. D. P. De Robertis& E. M. F De Robertis, Jr. 2001. Cell and Molecular Biology, 8th Edition. Lipincott William and Wilkins
8. Lehninger. 2005. Principles of Biochemistry. Nelson Cox, CBS Publishers
9. Alexander McLenna, Andy Bates, Puil Turner & Mike White. 2015. Molecular Biology, 4th Edition. GS Garlan Sciences, Taylor and Francis Group
10. George M. Malacinski& David Freifelder. 1998. Essentials of Molecular Biology, 3rd Edition. Jones and Bartcett Publishers
11. Richard R. Sinden.1994. DNA Structure and function. Academic press
12. R.C. Rastogi. 2010. Cell and Molecular Biology. New Age International Publishers
13. PragyaKhana. 2008. Cell and Molecular Biology. IK International Publishing House
14. William D. Stanfield, Jaine S. Colome and Raul J. Cano. 2008. Shaum's Outline-Molecular Cell Biology. Tata McGraw Hill
15. H.S. Bhamrah&KavitaJuneja. 2002. Molecular Cell Biology. Anmol Publications
16. G. P. Jeyanthi. 2009. Molecular Biology. MJP Publishers
17. N. Vidhyarasthi& D. M. Chelan. 2007. Molecular Biology. IK International Publishing House
18. P.S. Verma& V. K. Agarwal. 1998. Concepts of Molecular Biology. S. Chand and Company Ltd
19. Phil Turner, Alexander McLennan, Andy Bates & Mike White. 2001. Molecular Biology, 3rd Edition. Bios Instant Notes
20. H. D. Kumar.2000. Molecular Biology, 2nd Edition. Vikas Publishing House
21. AVSS Sambamurhty. 2008. Molecular Biology. Narosa Publishing House

**Name of the paper – BIOLOGICAL CHEMISTRY**

**Paper code – 19P1BTC03**

**Aim**

1. To give an introduction about the basic biochemistry related to the biological molecules, their diversity and biosynthesis, degradation and role in the biological systems.
2. This also aims to develop a thorough knowledge among the students about the various biochemical reactions- metabolic pathways- responsible for the manifestation of life disease and metabolic errors.

**Course Objectives**

- The overall objective of the course is for the student to gain a basic working knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavors.
- This course gives an idea on different biological molecules, their origin, biological role and its degradation according to the needs and demand of the system under various conditions.
- The interrelation of each of these metabolic pathways and their contribution invarious metabolic disorders are also explained in detail.
- The application of the knowledge generated in the practical aspects of Biotechnology.

**Course Outcome**

On completion of the course, the student should achieve an understanding of the following:

- The structures of amino acids, their chemical properties and their organizationinto polypeptides and proteins.
- Methods for isolating and characterizing proteins the basic elements of protein structure key
- Principles of protein function.
- Enzymes and how they catalyze reactions as well as enzyme kinetics
- Structure of fundamental monosaccharides and polysaccharides structure
- Basic function of nucleotides structure of different classes of lipids and their rolesin biological systems

## Course Content:

**UNIT I: CHEMISTRY OF CARBOHYDRATES AND PROTEINS**: Definition and classification of carbohydrates. Properties and types of monosaccharides (Glucose, fructose and xylose).Disaccharides (sucrose, lactose and maltose) and polysaccharides (starch, lactose and maltose) and polysaccharides (Starch, glycogen, cellulose and pectin).Glycoconjugates.Definition and classification of amino acids.Optical isomerism and

chemical properties.Acid-base properties and polyionic nature.Zwitter ions, pKa'spIs.Peptide bond formation and properties. Classification of proteins based on structural and functional properties. Structural organization of proteins.

**UNIT II: CHEMISTRY OF LIPIDS AND VITAMINS**: Definition and classification of lipids. Structure, functions and properties of simple, compound and derived lipids.Essential and non-essential fatty acids, triacyl glycerol, membrane lipids & steroids (Cholesterol-structure of steroid nucleus & its biological role). Definition and classification, occurrence, physiological function. Co-enzymmatic activities and deficiency symptoms of fat & water soluble vitamins.

**UNIT III: CHEMISTRY OF ENZYMES**: Classification and nomenclature of enzymes. Active site and theories of enzyme – substrate complex formation.Factors affecting enzyme activity.Enzyme kinetics (MM equation and LB plot equation) and enzyme inhibition (Reversible, competitive, non-compatitive, un-compatitive and irreversible inhibition).Co-enzymes-structures and functions.Isozymes-LDH.Allosteric action of lysozyme.

**UNIT IV: METABOLISM OF CARBOHYDRATES AND PROTEINS**: Chemical reactions, energetics and regulation of glycolysis, TCA cycle, glycogenolysis, glycogenesis, gluconeogenesis. HMP shunt & pentose phosphate pathway.Glycogen storage diseases (Von Gierke syndrome, Pompe's diseases, Mcardle's disease).Aminoacid breakdown mechanisms – transamination, deamination reactions & Urea cycle.Synthesis & degradation of heme, histamine and Glutathione.

**UNIT V: METABOLISM OF LIPIDS AND NUCLEIC ACIDS**: Basic principles of lipid metabolism, digestion of lipids. Esterification of lipolysis of triglycerides.Oxidation of saturated (alpha, beta & gamma), unsaturated & odd chain containing fatty acids.Biosynthesis of lecithin, cephalin and cardiolipin. Ketone body formation, cholesterol biosynthesis & its importance.biosynthesis and breakdown of purines and pyrimidine bases (*denovo* & *salvage* pathways).

**REFERENCE:**


1. Principles of Biochemistry – Smith et al., McGraw Hill International book Company 8th ed 1998.
2. Principles of Biochemistry – Lehninger, Nelson, Cox, CBS publishers. 2005.
3. Fundamentals of Biochemistry – Voet et al., Jhon Wiley and Sons Inc. 2000.
4. Biochemistry – Zubay, WCB Publishers. 4th edition, 1998.
5. Harpers Biochemistry, R.K. Murray, D.K.Granner, P.A Mayes and V.W. Rodwell, Practise Halt International. 1993.
6. Biochemistry – Stryer. 5th 2002.
7. Text book of Biochemistry with clinical Correlations – Homas. M.Devlin.H.John Wiley & sons. Publications. 6th edition 2006.
8. Biochemistry – U. Satyanarayana, Books & Allied (P) Ltd, Kolkata.

**Name of the paper – MICROBIOLOGY (Elective)**

**Paper code – 19P1BTE01**

**Aim**

1. To give an introduction about the microbial world- their distribution- morphology and reproduction and about the role of microorganism in various fields of human life and Industry.

**Course Objectives**

- Imparts advanced training in Microbiology for the students
- Makes the student aware the role of microbes in the daily life as well as in the various fields of science. How it can be controlled is also dealt with.

**Course outcome**

At the end of this course,

- The students get trained in all aspects of microbiology as it is required for Biotechnology.

## Course Content:

UNIT I: HISTORY OF MICROBIOLOGY: History and classification of microoganisms. Hirtory of microscopy and development of microbiology: Contributions of Louis Pasteur, Robert Koch and Edward Jenner.

UNIT II: MICROSCOPY: Compound microscopy: Numerical aperture & its importance, resolving power, oil immersion, objectives & their significance, principles & applications off Dark field, Phase contrast, Fluorescent microscopy. Electron microscopy: Principle, ray diagram and applications of transmission and scanning electron microscopes. Limitations of electron microscopes.

UNIT III: BACTERIA: Bacterial morphology & subcellular structures, general morphology of bacteria. Slime layer & capsule. Difference between structure, function and their position of flagella and fimbriae.Chromatin material, plasmids, definition and types of plasmids (conjugative & non-conjugative) F, R & Col plasmids, Basic mechanism of bacterial drug resistance.

UNIT IV: VIRUSES: General characteristics of viruses, difference between virus & typical microbial cell, structure, different shapes & symmetric. Classification of viruses based on nucleic acid composition, phage viruses.General account on lytic and lysogenic cycle

UNIT V: MICROBIAL NUTRITION: Basic nutritional requirements: Water, carbon, nitrogen, sulphur, and vitamins etc. Natural and synthetic media.Nutritional classification of bacteria.Selective and differential media.Enriched media, enrichment media.Stains and staining methods. Acidic, basic and neutral stains. Gram staining, Acid fast staining, flagella staining and Endospore staining.

**REFERENCES:**


1. Lansing M. Prescott, John P Harley, Donald A. Klein; Microbiology, McGraw Hill.Ed. 6; 2005.
2. Ananthanarayanan R & CK JeyaramPaniker; Textbook of Microbiology; Orient Longman. Ed. 7; 2005.
3. Michael T, Madigan, John M Martinko; Brock's Biology of Microorganisms, Pearson Prentice Hall, Ed, 11; 2006.
4. Roger Y, Stainer, John L. Ingraham, Mark L. Wheelis. Page R. Painter. General Microbiology, MacMillan Press. Ed. 5; 2004.
5. Topley& Wilson's: Principles of Bacteriology, Virology & Immunology, Edward Arnold. Ed.9; 2002.

**YEAR I – SEMESTER I**
**LAB IN CELL BIOLOGY & MOLECULAR BIOLOGY**

| | | | |
|---|---|---|---|
| Paper | : Core Practical I | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 4 | Internal | : 40 |
| Paper Code | : 19P1BTP01 | External | : 60 |

**Subject description**
This lab provides hands on skill in handling cell and its molecules to study their function and also their aberrations. Further the lab work also provides skill in estimating their biochemical compounds in knowing their normal and abnormal function.

**Goal**
Goal of the present lab is to convert the knowledge acquired through core paper 1 cell and molecular biology into skill.

**Objective**
- Impart skill in isolating and differentiating cell and its components
- Impart skill isolating and analyzing their bio molecule
- Imparting skill in improving the bio molecules
- Impart skill in identifying normal and abnormal cell multiplication
- Impart skill in estimating the cell health in normal and abnormal conditions

**Cell Biology**
1. Demonstration of various stages of mitosis using onion root tip.
2. Demonstration of various stages of meiosis using grasshopper testis squash
3. Preparation of Buccal Smear squash.
4. Observation of specialized cells

**Molecular Biology**

5. Isolation of Genomic DNA from bacteria
6. Isolation of Genomic DNA from plant tissue.
7. Isolation of Genomic DNA from animal tissue.
8. Isolation of Total RNA from Bacterial cells.
9. Separation of DNA & RNA by Agarose gel Electrophoresis.
10. Separation of Protein by SDS-PAGE.

**REFERENCE**

1. Janarthanan, S and Vincent, S. (2007). Practical Biotechnology: Methods and Protocols.
2. Jayaraman, J. (2007). Practical Biochemistry.
3. Palanivelu, P. (2001). Analytical biochemistry and separation techniques- Laboratory Manual, 2nd edition. Tulsi book centre publication, Madurai, Tamilnadu.
4. Sambrook, J. Fritsch, E.F. Maniatis, T. (1989). Molecular cloning: a laboratory manual.
5. Sadasivam., et al. (1991). Practical Biochemistry.
6. Wilson, K. and Walker, J. (2003). Practical Biochemistry-Principles and Techniques. 5th edition, Cambridge University Press.
7. Swamy, P. M. 2009. Laboratory manual on Biotechnology, Ist Edition, Rastogi publications, India, P-618.

**YEAR I – SEMESTER I**
**LAB IN MICROBIOLOGY**

| | | | |
|---|---|---|---|
| Paper | : Core Practical I | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 4 | Internal | : 40 |
| Paper Code | : 19P1BTCP02 | External | : 60 |

**Subject Description**

This course deals with the Basic laboratory techniques and skill in Microbiology, for isolation, identification and characterization of microorganisms.

**Goal**

To learn the various techniques in microbiology

**Objectives**

After the successful completion of the course the students will be aware of handling of microorganisms and production of enzymes antibiotics etc.

| Exp.No | CONTENT | HOURS |
|---|---|---|
| | **Major Practical** | |
| 1 | Biochemical tests-IMViC, TSI, Catalase, Oxidase & Urease | **10** |
| 2 | Antibiotic Sensitivity test-Kirby Bauer Method | **10** |
| 3 | Enumeration of microbes from air by settle Plate Method | **10** |
| 4 | Enumeration of bacteria from Soil. | **10** |
| 5 | Examination of Water-MPN | **10** |
| | **Minor Practical** | |
| 6 | Introduction to Principle of Sterilization Techniques. Biosafety measures GLPs & SoPs | **5** |
| 7 | Media Preparation-Liquid media, Solid media, Slants, Agar tubes, Agar Plates. Basal, Enriched & Selective Media Preparation | **5** |
| 8 | Staining techniques-Smear Preparation Simple, Grams, Acid fast, Fungal staining-KOH & LCB | **5** |
| 9 | Hanging drop technique - Determination of Motility | **5** |
| 10 | Pure culture techniques-Streak plate, Pour plate, Spread Plate &Serial dilution methods | **5** |

**REFERENCE**


1. Aneja, K.R. (2009). Experiments in Microbiology.
2. Dubey, R.C. and Maheswari, D.K. (2005). A Text book of Microbiology. S.Chand and Company Ltd., New Delhi.
3. James, G. Cappuccino. and Natalie, S. (2004). Microbiology: A laboratory Manual.
4. Kannan, N. (2000). Microbiology manual. Palani Paramount Publ.
5. Pelczar, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. MC Graw-Hill Inc., New York.
6. Prescott, L.M. Harley, J.P. and Klein, D.A. (1993). Microbiology. 2nd edition, WM, C Brown Publishers.

**Name of the paper: GENETIC ENGINEERING**

**Paper code – 19P2BTC04**

**Aim**

- To acquaint the students to the versatile tools and techniques employed in genetic engineering and recombinant DNA technology.

**Course objectives**

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.

**Course outcome**

At the end of the course,

- The student will achieve a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in in basic and applied fields of life science researches.

**Unit I**

**Introduction and tools for genetic engineering:**

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

**Unit II**

**Different types of vectors:**

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion

bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors**.**

**Unit III**

**Different types of PCR techniques:**

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

**Unit IV**

**Gene manipulation and protein-DNA interaction:**

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

**Unit V**

**Gene silencing and genome editing technologies:**

Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies. (*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

**Recommended Textbooks and References**:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.

2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*.
6.Biotechnology-Fundamentals and Applications S.S. Purohit & S.K Mathur Agrobotanica , India

7. Agricultural Biotechnology S.S. Purohit Agrobotanica , India

8. Biotechnology -Fundamentals and Applications S.S. Purohit & S.K Mathur S.S. Purohit & S.K Mathur

9. Molecular Biotechnology S.B. Primrose Panima Publishing Corporation, New Delhi

10. Text Book of Biotechnology C.R. Chhatwal Anmol Publications pvt Ltd, New Delhi

11. Applied Molecular Genetics R .L. Miesfeld , Wiley Liss ,New York

**Name of the paper – IMMUNOLOGY**

**Paper code – 19P2BTC05**

**Aim:**

1. To get introduced to the principles of immune systems of animals.
2. To introduce to the world of molecular and diagnostic techniques of immunology, immune-techniques and its application.

**Course Objectives:**

- This course is designed to impart the students the importance of immunology and its theoretical aspects and on the principles of immunology and immune-technology
- The application of immunology in medicines is also dealt with.
- It also explains the various antigen-antibody reactions involved in diseases, stem cell technology and vaccine development.

**Course Outcome:**

At the end of the course the students will,

- Get a deep foundation in the immunological processes.
- Students will gain knowledge on how the immune system works and also on the immune system network and interactions during a disease or pathogen invasion.

**Unit I**

**Immunology: fundamental concepts and overview of the immune system:**

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

**Unit II**

**Immune responses generated by B and T lymphocytes:**

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

**Unit III**

**Antigen-antibody interactions:**

Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

**Unit IV**

**Clinical immunology:**

Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

**Unit V**

**Vaccinology:**

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

**Recommended Textbooks and References:**

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub.
*3.* Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology.* New York: Garland Science.
4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press.
*5.* Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press.
6. Parham, P. (2005). *The Immune System*. New York: Garland Science.

7. Immunology Joshi. Osma Agro Botanica N.Delhi

8. Instant notes in Immunology Lydyard, helean, Fanger Viva Books N.Delhi

9. An introduction to Immunology CV Rao Narosa N.Delhi

10. Immunology Janus Kuby Freeman NY

11. Principles of cellular and molecular Immunology Jonathan Austin, Kathyryn Wood Oxford NY

12. Immunology Goldsby, Kindt, Osborne, Janus Kuby Freeman NY

13. Medical Immunology Parslow, Stites, Tera, Imboden Mc Graw Hill NY

14. Cellular and molecular Immunology Abbas, Lichman, Pobea, Harcourt & Brace Co.

**YEAR I – SEMESTER II**
**LAB IN IMMUNOLOGY**

| | | | |
|---|---|---|---|
| Paper | : Core Practical III | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 4 | Internal | : 40 |
| Paper Code | : 19P2BTP03 | External | : 60 |

| Exp. No | Content | Hours |
|---|---|---|
| 1 | Study on blood cells | 5 |
| | a) Identification of blood cells | |
| | b) Identification of lymphocytes by rosette assay | |
| | c) Nitroblue tetrazolium (NBT) reduction by neutrophiles | |
| 2 | Preparation of specimen for immunology | 5 |
| | a) Preparation of serum | |
| | b) Preparation of plasma | |
| | c) Preparation of blood antigens | |
| 3 | Agglutination teast | 5 |
| | a) ABO blood grouping | |
| | b) Widal test for typhoid fever (qualitative and quantitative test) | |
| | c) Haemagglutination test | |
| 4 | Passive agglutination test | 5 |
| | a) Anti- streptolysin (ASO) test | |
| | b) C- reactive protein (CRP) test | |
| | c) Rhematoid arthritis (RA) test | |
| 5 | Agglutination inhibition test | 5 |
| | a) Pregnancy test – Detection on HCG | |
| 6 | Flocculation test | 5 |
| | a) Rapid PlasmaReagin test (RPR) | |
| 7 | Precipitation test | 5 |
| | a) Ouchterlony double immunodiffusion technique (ODD) | |
| | b) Counter current immunoelectrophoresis(CIE) | |
| | c) Immuno Electrophoresis (IE) | |
| | d) Radial Immuno diffusion (RID) | |
| | e) Rocket Immuno Electrophoresis (RIE) | |
| 8 | Animal handling in Immunology and immunotechnology (Demonstration) | 10 |
| | a) Inoculation routes in Laboratory animals | |
| | b) Raising of antiserum in laboratory animals | |
| 9 | Antibody purification by column chromatography (DEMO) | 10 |

| | | |
|---|---|---|
| 10 | ELISA | 10 |
| 11 | Western Blotting | 10 |

**Text Manual**

1. G. P. Talwar and S. K. Gupta, 2006, Hand Book of Practical and Clinical Immunology. CBS Publishers

**REFERENCE**

1. Arti Nigam, 2007, Lab Manual in Biochemistry, Immunology and Biotechnology. Tata Mc Graw Hill.

| YEAR I – SEMESTER II | | | |
|---|---|---|---|
| **LAB IN GENETIC ENGINEERING** | | | |
| Paper | : Core Practical IV | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 4 | Internal | : 40 |
| Paper Code | : 17P2BTP04 | External | : 60 |

| Exp. No. | Content | Hours |
|---|---|---|
| 1. | Isolation of DNA, RNA and Plasmids | |
| 2. | Separation and Characterization of protein by SDS PAGE | |
| 3. | Western Blotting | |
| 4. | Designing cloning strategies | |
| 5. | Cloning using restriction enzymes | |
| 6. | Cloning of PCR products | |
| 7. | Cloning in expression vector | |
| 8. | Induction of expression of recombinant protein | |
| 9. | Purification of recombinant proteins using His Tag | |
| 10. | Automated DNA sequencing (demonstration) | |

**REFERENCES**


1. Primrose.S.B and Twyman.R.M, "Principles of Gene Manipulation and Genomics", Blackwell Publishing Company, Oxford, UK Third Edition (2006).
2. Brown.T.A and Gene Cloning "DNA Analysis: An Introduction", Wiley-Blackwell, UK. Fifth Edition (2006).
3. Innis.M, White.T and Sninsky.J.J, PCR Protocols: A Guide to "Methods and Applications", Academic Press First Edition (1990).
4. Ying.S, Generation of cDNA Libraries: "Methods and Protocols", Humana Press First Edition (2003).


**MANUALS**


1. Sambrook, and Russel D.W, "Molecular Cloning. A Laboratory Manual", Cold Spring Harbor Laboratory Press, New York, USA. Volume 1-3. Third Edition(2001).
2. 2 Ausubel.F.M, Brent.R, Kingston.R.E and Moore.D.D, "Current Protocols in Molecular Biology", John Wiley & Sons, Inc., Brooklyn, New York., First Edition (1987).

| YEAR I – SEMESTER II | | | |
|---|---|---|---|
| **LAB IN BIOPROCESS AND MICROBIAL TECHNOLOGY** | | | |
| Paper | : Elective Practical II | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 3 | Internal | : 40 |
| Paper Code | : 19P2BTEP02 | External | : 60 |

**Subject description**

This lab provides hands on skill in producing organic acids, wine, and about fermented food products. Further the lab work provides skill in the commercial production of beneficial products from microorganisms.

**Goal**

Goal of the present lab is to convert the knowledge acquired through bioprocess and microbial technology into skill.

**Objectives**

- To Impart skill in production and estimation of organic acids
- To Impart skill in fermented food products
- To Impart skill in the process of immobilization
- To Impart skill in production of antibiotics
- To Impart skill in the production and estimation of biomass

| Experiment | CONTENT | HOURS |
|---|---|---|
| 1 | Fermentor –parts and its function | 5 |
| 2 | Media sterilization | **5** |
| 3 | Batch fermentation and Continuous fermentation | **5** |
| 4 | Wine production | 10 |
| 5 | Yoghurt Preparation | **5** |
| 6 | Production of Saurkraut | 5 |
| 7 | Immobilization of Yeast cell using by Sodium alginate Method | 5 |
| 8 | Production of Azolla and its nutrient estimation | **5** |
| 9 | Production of Spirullina and its nutrient estimation. | **5** |
| 10 | Production and estimation of acetic acid | **10** |
| 11 | Penicillium production | **5** |
| 12 | Microbial production and estimation of Citric acid | **10** |

**Name of the paper – MICROBIAL TECHNOLOGY**

**Paper code – 19P2BTC06**

## Course Objectives:

The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.

**Course Outcome:**

- On completion of this course, students would develop deeper understanding of the microbial technology and its applications.

UNIT-I

**Introduction to microbial technology:** Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (*e.g.*, engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/strains and their applications; Strain improvement to increase yield of selected molecules, *e.g.*, antibiotics, enzymes, biofuels.

UNIT-II

**Environmental applications of microbial technology:** Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.

UNIT-III

**Pharmaceutical applications of microbial technology:** Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (*Streptomyces* sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (*Streptomyces*/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces* sp., Yeast).

UNIT-IV

**Food applications of microbial technology:** Application of microbes and microbial processes in food and healthcare industries – food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Nonrecombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (*e.g.*, Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution).

UNIT-V

**Advances in microbial technology:** Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts –tools and techniques for discovery/identification of novel enzymes, drugs (*e.g.*, protease, antibiotic).

Recommended Textbooks and References:

1. Lee, Y. K. (2013). *Microbial Biotechnology: Principles and Applications*. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). *Comprehensive Biotechnology*. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. *Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools*. Boston, MA: Springer US.
4. *The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet*. (2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology, (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research)
6. Websites: http://jgi.doe.gov/our-science/

**RECOMMENDED TEXTBOOKS AND REFERENCES:**

1. Discovering Genomics, Proteomics, and Bioinformatics, 2 nd Edition, Campbell AM & Heyer LJ, Pearson, 2007.

2. Bioinformatics: Sequence and Genome Analysis, 2 nd Edition, Mount D, CSHL Press, 2004.

3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Baxevanis AD & Francis BF, Wiley, 2004.

4. A Bioinformatics Guide for Molecular Biologists, Aerni S & Sirota M, CSHL Press, 2014.

5. Genomes, 2nd Edition, Brown TA, Oxford, Wiley, 2002.

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| YEAR I – SEMESTER II | | | |
|---|---|---|---|
| **LAB IN BIOPROCESS AND MICROBIAL TECHNOLOGY** | | | |
| Paper | : Elective Practical II | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 3 | Internal | : 40 |
| Paper Code | : 17P2BTEP02 | External | : 60 |

**Subject description**

This lab provides hands on skill in producing organic acids, wine, and about fermented food products. Further the lab work provides skill in the commercial production of beneficial products from microorganisms.

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Goal of the present lab is to convert the knowledge acquired through bioprocess and microbial technology into skill.

**Objectives**

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- To Impart skill in fermented food products
- To Impart skill in the process of immobilization
- To Impart skill in production of antibiotics
- To Impart skill in the production and estimation of biomass

| Experiment | CONTENT | HOURS |
|---|---|---|
| 1 | Fermentor –parts and its function | 5 |
| 2 | Media sterilization | **5** |
| 3 | Batch fermentation and Continuous fermentation | **5** |
| 4 | Wine production | 10 |
| 5 | Yoghurt Preparation | **5** |
| 6 | Production of Saurkraut | 5 |
| 7 | Immobilization of Yeast cell using by Sodium alginate method | 5 |
| 8 | Production of Azolla and its nutrient estimation | **5** |
| 9 | Production of Spirullina and its nutrient estimation. | **5** |
| 10 | Production and estimation of acetic acid | **10** |
| 11 | Penicillium production | **5** |
| 12 | Microbial production and estimation of Citric acid | **10** |

Name of the paper – **PLANT BIOTECHNOLOGY**

Paper code – 19P3BT07

**Aim**

To give an idea of plant tissue culture

To introduce the various plant genetic engineering and transformations and its applications in various fields.

**Course Objectives**

- It gives introduction to the various transformation techniques employed in plant systems.
- It also describes the application of genetically modified plants in the various fields of science.

**Course Outcome**

At the end of the course,

- The students will gain an insight into the concepts and techniques of plant biotechnology and its application to crop plants
- They can also go for further research works during M.Phil and PhD courses

UNIT I: PLANT TISSUE CULTURE: History - principle - media composition, preparation and application. Micropropagation, meristems culture, callus cultures, suspension cultures, Organogenesis, somatic hybridization & somatic embryogenesis - shoot formation, Root formation & hardening, protoplast isolation and fusion. Somaclonal variation.Germplasm storage and cryopreservation.

UNIT II: PLANT MOLECULAR BIOLOGY: Plant genomic DNA-organelle DNA: Mitochondrial DNA & chloroplast DNA. Gene expression in higher plants: post transcription processing of plant RNA. Communication in plant cells: nucleus - mitochondria interaction and chloroplast - mitochondria evolved by endosymbiosis. Plant transformation technology: agrobacterium mediated gene transfer, and particle bombardment.

UNIT III: MEDICINAL PLANTS APPLICATION: Diversity of medicinal plants in India**:** *Phyllanthusamarus, Casia augustifolia, Aloe verra, Bacopa monnieri, Saracaasoca, Withania somnifera, Ocimum tenuiflorum, Allium cepa , Piper betle and Cinnamomum zeylanicum.*

UNIT IV: AGRICULTURE & FOREST BIOTECHNOLOGY: seed production technology. Genetically modified plant:Resistances: herbicides- insect pest –pathogen . Metabolic engineering: secondary metabolic production, molecular farming. Risk assessment of transgenic plants**:** impact on agriculture development and insect protected crops. Agroforesty.Transgenic trees.Biotechnology production of wood composites. Biological control of forest pest.

UNIT V: INTELLECTUAL PROPERTY RIGHTS:IPR in context with PBT .Patenting in PBT. International treaty on plant genetic resources for food and agriculture.IPR on

biological resources & access to germplasm. Agriculture legislations. National biodiversity authority. Plant biotechnology in developing countries: Asia and India. Revocation of turmeric and neem patent.

**References**

1. Modern Concepts of Biotechnology H.D. Kumar Vikas Publishing House Pvt. Ltd., New Delhi .

2. Role of Biotechnology in Medicinal and Aromatic Plants Irfan A. Khan and AtiyaKhanumUkaaz Publications, Hydreabad

3. Plant Tissue Culture Kalyan Kumar D. New Central Book Agency (P) Ltd, Calcutta

4. An introduction to Plant tissue Culture M.K. Razdan Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

5. Biotechnology B.D. Sigh Kalyan Publishers New Delhi

6. Introduction to Plant Biotechnology H.S. Chawla Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

7. Plant Biotechnology Recent Advances P.C. TrivediPanima Publishing Corporation, New Delhi

8. Biotechnology J.E. Smith Cambridge University Press

9. Plant Biochemistry and Molecular Biology Hans, Walter Held Oxford, NY 10. Plant Cell, Tissue, and Organ Culture- Fundamental Methods.

Name of the paper – **ANIMAL BIOTECHNOLOGY**

Paper code – 19P3BT08

**Aim**

- To give an idea of animal tissue culture
- To introduce the various genetic and transformation techniques in animals and and its applications in various fields.

**Course Objectives:**

- It gives introduction to the various transformation techniques employed in animal systems.
- It also describes the application of genetically modified animals in the various fields of science.
- The techniques of animal cell culture and its industrial and medical applications are described.

**Course Outcome**

At the end of the course,

- The students will gain an insight into the concepts and techniques of animal biotechnology and its wide industrial and medicinal applications.
- They can also go for further research works during M.Phil and PhD courses

**UNIT I:** Animal Tissue culture history, Laboratory design, aseptic conditions, methodology and Media: Balanced salt solutions and simple growth medium, Chemical, physical and metabolic functions of different constituents of culture medium. Role of Carbon di oxide, Role of serum, and supplements. Serum & protein free defined media and their applications: equipments and materials for animal cell culture technology. Basic techniques of mammalian cell culture in vitro.

UNIT II: Biology and characterization of the cultured cells, measuring parameters of growth. Cell synchronization.Somatic cell fusion, organ and histotypic Culture.Tissue engineering. Applications of animal cell culture , stem cell cultures, embryonic stem cells and their applications .cell culture based vaccines.

UNIT III: Invitro fertilization and embryo transfer, Sex determination or sex specific markers, Assisted reproductive technology, Intracytoplasmic sperm injection, Cryopreservation of gametes and embryo. Animal cloning – reproductive cloning, therapeutic

cloning, Xenotransplantation, Animal genes and their regulation, some specific promoters for tissue specific expression.

UNITIV**:** Improvements of animals using transgenic approach with specific examples, Animals as bioreactors: applications of biotechnology in sericulture , production of transgenic fishes. General steps to make and analyze transgenic fish .Genetically improved tilapia ,Genetic engineering for production of regulatory proteins and blood products.

UNIT V: Hormone production, Invitro culture of tissues and organs, Stem cell technology, Embryonic stem cells, maintenance of stem cell culture, Characterization of stem cells, Gene therapy, Cancer Gene therapy, mechanism of gene therapy, Somatic versus germ line gene therapy, Immunotherapy. Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

**REFERENCES:**


1. Freshney RI. (2005). Culture of animal cells: A manual of basic techniques, 5th Edition, John Wiley and Sons.
2. John R W Masters. (2000). Animal cell culture, 3rd Edition, Oxford University Press.
3. Florence PR. (2006). Animal Biotechnology, Dominant Publishers and Distributors.
4. Sandy Primrose, RichardTwyman and Bob Old. (2001). Principles of Gene Manipulation, 6th Edition, Blackwell Science Ltd. p: 174-319.
5. Ranga MM. (2006). Animal Biotechnology.
6. Animal Biotechnology by Professor P.K. Gupta
7. Text Book of Animal biotechnology - B Singh, S K Gautam and M S Chauhan

Name of the paper – **ENVIRONMENTAL BIOTECHNOLOGY**

Paper code – 19P3BT09

**Aim:**

To give an introduction to the various aspects of environmental biotechnology to students.

Course Objectives

- This course aims to introduce fundamentals of Environmental Biotechnology.
- The course will introduce major groups of microorganisms tools in biotechnology and their most important environmental applications.
- The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

**Course Outcomes:**

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

Unit I: **Introduction to environment**

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit II: **Bioremediation**

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT *etc.*), technological aspects of bioremediation (*in situ*, *ex situ*).

Unit III: **Role of microorganisms in bioremediation**

Application of bacteria and fungi in bioremediation: White rot fungi *vs* specialized degrading bacteria: examples, uses and advantages *vs* disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).

Unit IV: **Biotechnology and agriculture**

Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms

(*e.g. Trichoderma*, *Pseudomonas fluorescens*); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

Unit V: **Biofuels**

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Recommended Textbooks and References:


1. G. M. Evans and J. C. Furlong (2003), *Environmental Biotechnology: Theory and Applications*, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), *Environmental Biotechnology: Principle & Applications*, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) *Environmental Biotechnology*. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), *Biofiltration for Air Pollution Control*, CRC Press.
5. H. J. Rehm and G. Reed, (2001), *Biotechnology – A Multi-volume Comprehensive Treatise*, Vol. 11, 2nd Ed., VCH Publishers Inc.
6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), *Environmental Engineering*, McGraw-Hill Inc.

**Name of the paper – GENOMICS AND PROTEOMICS (Elective)**

**Paper code – 19P3BTE03**

**Aim:** The student will be aware of: The structural and functional organization of genome, mapping sequencing Human genomic structure and implications of HGP.
Techniques involved in genomics and their applications**.**

UNIT I: Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. Genomics- Prokaryotic &Eukaryotic Genomes Organization- Nuclear Genomes- - Organelle genomes- origin- Tandem repeats – DNA transposons- Comparative genomics and application of genomics in understanding genetic disease of humans.

UNIT II: Traditional approaches to expression profiling to study genes- SAGE for large scale gene expression and analysis- DNA sequencing- shot gun sequencing – Contig assembly- techniques for gene location – ORF- Next generation sequencing (NGS)- RT-PCR-RACE-S1nuclease mapping – exon trapping- DNA chips and Microarrays, Real time PCR.

UNIT III: Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.

UNIT IV: Proteomics:Definition, Characterization of proteins using 2-D gel electrophoresis, Multidimensional liquid chromatography and Mass spectrometry Tools of Proteomics-MALDI-TOF-ESI – tandem. Mass analyzers-peptide Mass finger printing-protein identification with MS data.

UNIT V: Metabolomics & Global biochemical networks, different levels of metabolite analysis, basic mass spectrometry metabolomics analysis, sample selection and handling for analysis of metabolites, methodology to construct global biochemical network. Protein mining - SALSA algorithm for mining specific features- protein microarrays protein expression profiling.

**REFERENCES:**


1. Old and Primrose, 2006, Principles of Gene manipulation and genomics.
2. Terence A Brown, 2002, Genomes, 2nd Edition, Bios Scientific Publishers.
3. Tom Strachan and Andrew P Read, 1999, Human Molecular Genetics, 2nd edition, Bios Scientific Publishers.
4. Daniel C. Liebler, 2002, Introduction to Proteomics, tools for the New biology- Humana press. Totowa,NJ.
5. Pennington.S, M. Dunn, 2001, Proteomics: From Protein Sequence to Function, 1st edition, Bios Scientific Publishers.
6.

| YEAR II – SEMESTER III | | | |
|---|---|---|---|
| **LAB IN PLANT AND ANIMAL BIOTECHNOLOGY** | | | |
| Paper | : Core Practical V | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 4 | Internal | : 40 |
| Paper Code | : 19P3BTP05 | External | : 60 |

**Subject description**

This lab provides the basic knowledge in plant tissue culture and about the transgenic plant production. Further the lab work provides the skill in micropropagation techniques and also it provides the basic knowledge in animal cell lines.

**Goal**

Goal of the present lab is to provide knowledge about the production of plants through tissue culture. This provides basic skill in the preparation of cell lines

**Objective**

- To impart skill in plant tissue culture, media formulation and sterilization
- To impart knowledge about different tissue culturing methods
- To impart skill in the production fodder by hydrophonics
- To impart skill in animal tissue culturing methods
- To promote knowledge about the cell viability checking by haemocytometer.

| Exp. No. | Content | Hours |
|---|---|---|
| **PLANT BIOTECHNOLOGY** | | |
| 1 | Media preparation and sterilization | 5 Hrs |
| 2 | Micropropagation – Nodal and apical meristems. | 5 Hrs |
| 3 | Callus induction | 5 Hrs |
| 4 | Somatic embryogenesis and preparation of synthetic seeds. | 5 Hrs |
| 5 | Embryo culture | 5 Hrs |
| 6 | Protoplast isolation. | 5 Hrs |
| 7 | Determination of protoplast viability by Evan's blue staining method. | 5 Hrs |
| 8 | Pollen culture. | 5 Hrs |
| 9 | Anther culture. | 5 Hrs |
| 10 | Hydrophonics | 5 Hrs |
| **ANIMAL BIOTECHNOLOGY** | | |
| 11 | Sterilization techniques | 5 Hrs |
| 12 | Preparation of culture media and sera | 5 Hrs |
| 13 | Preparation of primary cell culture | 5 Hrs |
| 14 | Trypsinization and subculturing cells from a monolayer | 5 Hrs |
| 15 | Determining cell umber and viability with a haemocytometer and Trypan blue staining | 5 Hrs |

**Manuals**


- Ian Freshney,R., 2016, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 7th Edition, Wiley-Blackwell
- John H. Dodds, Lorin W. Roberts, 1985, Experiments in Plant Tissue Culture, Cambridge University Press, New York.




Bhojwani , S.S., Razdan, M.K., 1996, Plant Tissue Culture: Theory and Practice, Elsevier Science

## LAB IN ENVIRONMENTAL BIOTECHNOLOGY

| Experiment No. | Content | Hours |
|---|---|---|
| 1 | Isolation of Air Borne Bioparticles | 5 Hrs |
| 2 | Effect of high salt concentration on microbial growth | 5 Hrs |
| 3 | Oligodynamic action heavy metals on microbes | 5 Hrs |
| 4 | Isolation of Coliforms from sewage | 5 Hrs |
| 5 | Estimation of total solids in effluent sample | 5 Hrs |
| 6 | Analysis of TDS of effluent | 5 Hrs |
| 7 | Estimation of total suspended solids of effluent sample | 5 Hrs |
| 8 | Determination of Biological demand | 5 Hrs |
| 9 | Determination of chemical oxygen demand | 5 Hrs |
| 10 | Microbial degradation of cellulose | 5 Hrs |

**REFERENCE**

1. Rajan S. and Selvi Christy R. (2015). Experimental Procedures in Life Sciences. 4th Edition. Anjana Book House, PSR Associates. Chennai.

**YEAR II – SEMESTER III**

**GENOMICS AND PROTEOMICS**

| | | | |
|---|---|---|---|
| Paper | : Elective III | Total Hours | : 75 |
| Hours/Week | : 4 | Exam Hours | : 03 |
| Credit | : 4 | Internal | : 25 |
| Paper Code | : 19P3BTE03 | External | : 75 |

**Subject Description**

The students are able to understand the fundamental principle and techniques in genomics and proteomics which will enable them to sequence and analyze the gene and unlock potential candidate gene that may help to discovery new drugs and therapeutics, to establish evolutionary relationship, study and analyze gene and protein expressions.

**Goal**

The enable the students to understand the concepts and applications of genomics and proteomics

**Objective**

- To understand the basic concepts in genomics and various techniques applied to enumerate genome sequences and its functions
- To understand the fundamentals of proteomics and various techniques supporting the protein sequence and functional analysis

| UNIT | CONTENTS | HOURS |
|---|---|---|
| **I** | Genomics- Prokaryotic &Eukaryotic Genomes Organization- Nuclear Genomes- - Organelle genomes-origin- Repetitive DNA contents-Tandem repeats – DNA transposons- Comparative genomics and application of genomics in understanding genetic disease of humans | **15** |
| **II** | Traditional approaches to expression profiling to study genes- SAGE for large scale gene expression and analysis-DNA sequencing- shot gun sequencing – Contig assembly-techniques for gene location – ORF- Next generation sequencing (NGS)- RT-PCR-RACE-S1nuclease mapping – exon trapping- transcriptome analysis-DNA chips and Microarrays, Real time PCR | **15** |
| **III** | Genome Mapping – Human genome project Genetic Mapping –SNP-AFLP-Human pedigree analysis–FISH – STS mapping –Gene therapy for inherited disorders and infectious diseases. | **15** |
| **IV** | Proteomics: Definition, Characterization of proteins using 2-D gel electrophoresis, Multidimensional liquid chromatography and Mass spectrometry Tools of Proteomics- MALDI-TOF-ESI – tandem Mass analyzers-peptide Mass finger printing-protein identification with MS data. | **15** |
| **V** | Metabolomics & Global biochemical networks, different levels of metabolite analysis, basic mass spectrometery metabolomics analysis, sample selection and handling for analysis of metabolites, methodology to construct global biochemical network.Protein mining - SALSA algorithm for mining specific features- protein microarraysprotein expression profiling – | **15** |

**Text book**

- Old and Primrose, 2006, Principles of Gene manipulation and genomics.

**Reference book**


1. Terence A Brown, 2002, Genomes, 2nd Edition, Bios Scientific Publishers.
2. Tom Strachan and Andrew P Read, 1999, Human Molecular Genetics, 2nd edition, Bios Scientific Publishers.
3. Daniel C. Liebler, 2002, Introduction to Proteomics, tools for the New biology- Humana press. Totowa,NJ.
4. Pennington.S, M. Dunn, 2001, Proteomics: From Protein Sequence to Function, 1st edition, Bios Scientific Publishers.

| YEAR II – SEMESTER III | | | |
|---|---|---|---|
| **LAB IN GENOMICS AND PROTEOMICS** | | | |
| Paper | Elective III Practical | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 3 | Internal | : 40 |
| Paper Code | : 19P3BTEP03 | External | : 60 |

| **Experiment No.** | **Content** | **Hours** |
|---|---|---|
| 1 | Online and offline tools for analysis of genomics and proteomic information | |
| 2 | 16 s rRNA sequence amplification | |
| 3 | Phylogenetic Analysis of gene sequence using MEGA4 software | |
| 4 | Random amplified polymorphic DNA analysis | |
| 5 | Single nucleotide polymorphism | |
| 6 | Chromatographic techniques for proteins separation | |
| 7 | Characterization of proteins & protein profiling | |

**References**


1. R. Simpson (2003). Proteins and Proteomics: A Laboratory Manual. Cold Spring Harbor Laboratory Press, 2003
2. J.F. Sambrook and D.W. Russell, ed., (2001).Molecular Cloning: A Laboratory Manual, 3rd ed., Vols 1,2 and 3. Cold Spring Harbor Laboratory Press

| YEAR II – SEMESTER IV | | | |
|---|---|---|---|
| **PLANT AND ANIMAL CELL CULTURE TECHNIQUES** | | | |
| Paper | : Extra Disciplinary Course I | Total Hours | : 75 |
| Hours/Week | : 4 | Exam Hours | : 06 |
| Credit | : 4 | Internal | : 40 |
| Paper Code | : 19P4BTED01 | External | : 60 |

**Subject Description:**

This course aims to introduce the principles and applications of plant tissue culture, animal tissue as well as the biology of cultured plant cells. Later through the course, Students will be exposed to some molecular techniques using plant systems. The designed experiments will illustrate the principles and ideas discussed in the plant biotechnology, animal biotechnology.

**Goal**

This paper helps the students to learn about the basics of plant and animal cell culture techniques.

**Objectives**

This course was designed to acquaint the students to:

- Work under aseptic conditions to cultivate different plant species and/or parts in vitro. Learn how to subculture and follow the growth pattern of the cultures.
- Practice scientific thinking in analyzing the experiments, keeping records, and presenting results.
- Practice and learn some techniques in plant biochemistry, molecular biology, animal biotechnology.

| UNIT | CONTENT | HOURS |
|---|---|---|
| **I** | **Introduction to plant tissue culture:** Structure and organization of plant cell. Establishment of plant tissue culture laboratory. Preparation of explants. Sterilization techniques. Preparation and composition of Plant tissue culture media. Growth regulators - auxin, cytokinin and other hormones. | **15** |
| **II** | **Tissue culture techniques:** Callus culture - initiation and maintenance of callus. Suspension culture, Meristem tip culture, Anther culture, Embryo and ovule culture Principles of Micropropagation: Direct and indirect morphogenesis, somatic embryogenesis. Synthetic seed production. Protoplast isolation, culture & fusion, somaclonal variations. | **15** |
| **III** | **Gene transfer methods in plants**: Agrobacterium mediated transformation (Ti plasmid & Ri plasmid). Particle bombardment, Electrophoration. Selectable marker, promoter and reporter genes used in plant transgenesis- Genetic engineering for Pest, Herbicide Viral, fungal and Bacterial resistance. | **15** |

| | | |
|---|---|---|
| **IV** | **Introduction to animal cell culture:** ATC Laboratory design- Equipments and materials used in animal cell culture -Balanced salt solutions and Complete medium; Constituents of animal cell culture media and role of serum containing and serum free media and their applications. Primary and established cell line cultures. Applications of animal cell culture. | **15** |
| **V** | **Animal cell culture techniques:** Primary culture Isolation of explants, Disaggregation of explants, Primary explantation techniques - Slide or cover slip cultures, flask cultures, test tube cultures. Organ culture and whole embryo culture. Measurement of cell viability and cytotoxicity, maintenance of cell culture; cell separation. Cryopreservation. Large scale culture of cell lines. | **15** |

**REFERENCE**


1. Bernad, R. G. and John, E.T. (1993). Methods in plant Molecular Biology and Biotechnology. CRC press.
2. Bhowjwani, S. S, (2004). Plant tissue culture- Theory and practice.
3. Chawla. Introduction toPlant Biotechnology. 2nd edition, Oxford Publishers.
4. Dubey, R. C. A text book of Biotechnology. S. Chand and Company Ltd.
5. Iorn, F. Culture of animal cells. 3rd edition, Wiley-liss.
6. Jenni, P. M. and David, B. Methods in cell biology, animal cell culture methods. Vol. 57, Academic Press.
7. John, R.W.M. Animal cell culture. Raifica approach, OXFORD.
8. Martin, C. Animal Cell culture techniques. Springer.
9. Ranga, M. M. (2000). Animal Biotechnology. Agrobios, India.
10. Roberta, S. (2000). Plant tissue culture- Techniques and experiments. 2nd edition, Academic press.
11. Satyanarayana, U. (2008). Biotechnology. Allied (P) Ltd.

**RESEARCH METHODOLOGY,BIOSTSTISTICS AND BIOINFORMATICS**

| | | | |
|---|---|---|---|
| Paper | : Elective IV | Total Hours | : 75 |
| Hours/Week | : 4 | Exam Hours | : 03 |
| Credit | : 4 | Internal | : 25 |
| Paper Code | : 19P4BTE04 | External | : 75 |

**Aim:** To enable the students to learn about the basics of research and application of Bioinformatics

**Objectives:**

To equip the students with basic knowledge of how to do research, problem solving in research and to know about the biological database and tools and its application

| UNIT | CONTENT | HOURS |
|---|---|---|
| **I** | Research definition, Types of Research: Descriptive vs. Analytical Research, Applied vs. Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research, Formulating the Research Problem, Research Methods vs. Research Methodology, Literature Review, Review Concepts and Theories, Current trends in Research, Mono,Trans, Inter-disciplinary Research, Computer & Internet: Its Role in Research, Threats and Challenges to Good Research | **15** |
| **II** | Hypothesis: Formulation, Sources, Characteristics, Role, Test, Research Design, Legal Research, Clinical Trials, Evolutive and Evaluative, Identificatory and Impact studies, Projective and Predictive, Writing an: Article, Essay, Research Paper, Research Project, Legislation Drafting, Judgment Writing, Thesis, Dissertation, Book, Reviews - Book Review; Case Review, Criteria of Good Research, Research Ethics, Citation Methods: Foot Note, Text Note, End Note, Bibliography, Citation Rules | **15** |
| III | Statistics in Research: Sampling Design, Data Collection-Primary and Secondary data, Processing and Analysis of Data, Limitation and uses of Statistics, Graphs, mean, Median, Mode, Standard deviation, Standard error | **15** |
| IV | Biological Data Acquisition: Access, Retrieval and Submission methods for DNA sequence, protein sequence and protein structure information; Databases –Annotated sequence databases, Organism specific databases; Sequence Similarity Searches: Local versus global. Distance metrics, Scoring matrices, Dynamic programming algorithms, Needleman-wunsch and Smith-waterman. | 15 |
| **V** | Genome Analysis: Whole genome analysis, existing software tools; Genome Annotation and Gene Prediction; Structure Prediction, ORF finding, Primer Designing, Phylogenetic Analysis, Gene Disease Associations Database: DisGeNET, GWAS, Open-source Bioinformatics software : Bioconductor, BioPerl, Biopython, BioJava, BioJS, BioRuby, Bioclipse, EMBOSS, .NET Bio, Orange | **15** |

**TEXTBOOKS**

1. Research Methodology: A Step-by-Step Guide for Beginners–by Ranjit Kumar

2. Practical Research: Planning and Design (10th Edition) 10th Edition by Paul D. Leedy, Jeanne Ellis Ormrod
3. Developing Research Proposals (Success in Research) by Pam Denicolo, Lucinda Becker
4. Research Methodology – C.R.Kothari
5. 1.B.K. Mahajan, (1997)Methods in Biostatistics, Sixth Edition, Jaypee Brothers Medical Publishers(p)Ltd
6. 2.S.P. Gupta, (2011)Statistical Methods (41th edition),Sultan Chand & sons, New Delhi
7. Bioinformatics: Databases and Systems, by Stanley I. Letovsky
8. Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC Mathematical Biology & Medicine), by SorinDraghici
9. Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
10. Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

**STUDENT LEARNING OUTCOMES**:

This course gives an idea about the basics of research, research purpose, problem solving in research, writing research articles, essay, review the paper, statistical methods used in research, data description, Bioinformatics tools and its application

| YEAR II – SEMESTER IV | | | |
|---|---|---|---|
| **LAB IN RESEARCH METHODOLOGY, BIOSTASTICS AND BIOINFORMATICS** | | | |
| Paper | Elective IV Practical | Total Hours | : 75 |
| Hours/Week | : 5 | Exam Hours | : 06 |
| Credit | : 3 | Internal | : 40 |
| Paper Code | : 19P4BTEP04 | External | : 60 |

| **Experiment No.** | **Content** | **Hours** |
|---|---|---|
| 1 | Retrieving the data and Blast analysis of the sequence data from Entrez | 5 |
| 2 | Locating the chromosome of a Gene | 10 |
| 3 | Retrieve gene expression data from GEO | 5 |
| 4 | Finding ORF of a Given Sequence | 10 |
| 5 | Retrieving structural data of a protein using PDB database | 10 |
| 6 | Retrieving Motif Information of a Protein Using Prosite | 10 |
| 7 | Retrieving Gene Information from TAIR database | 10 |
| 8 | Designing a primer | 5 |
| 9 | Retrieving genes and variants associated with human diseases from DisGeNET | 5 |
| 10 | Research paper - Review ,Synapsis,summary | 5 |