**The Kelkar Education Trust's**

**Vinayak Ganesh Vaze College of Arts, Science & Commerce (Autonomous)**

Mithaghar Road, Mulund East, Mumbai-400081, India

***College with Potential for Excellence***

# Syllabus for B. Sc. Third Year Program in

## BIOTECHNOLOGY

Syllabus as per Choice Based Credit System (NEP-2020)

(June 2025 Onwards)

## Board of Studies in Biotechnology

## V. G. Vaze College of Arts, Science and Commerce (Autonomous)

**Submitted by**

Department of Biotechnology

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**Vinayak Ganesh Vaze College of Arts, Science & Commerce**

(Autonomous)

## ❖ Syllabus as per Choice Based Credit System (NEP 2020)

# Syllabus for Approval

Subject: BIOTECHNOLOGY

| Sr. No. | Program | Particulars |
|---|---|---|
| 1 | Title of Programme | **Third Year B.Sc. Biotechnology: Semester V and VI** |
| 2 | Eligibility for Admission | The Second Year B.Sc. examination of this University with Biotechnology as a Major & Minor subject or any other university recognized as equivalent thereto subject to availability of seats. |
| 3 | Passing marks | Minimum D Grade or equivalent minimum marks for passing at the Graduation level. |
| 4 | Ordinances/Regulations (if any) | --- |
| 5 | No. of Years/Semesters | One year/Two semester |
| 6 | Level | U.G. Part-III: Level- 5.5 |
| 7 | Pattern | Semester |
| 8 | Status | Revised |
| 9 | To be implemented from Academic year | 2025-2026 |

# Third Year B. Sc. Program in Biotechnology (Level 5.5)

| Semester | Core Course & Credits | | NSQF Course & Credits | |
|---|---|---|---|---|
| Sem - V | **MAJOR** | No. of Lectures | **VSC/SEC** | No. of Lectures |
| | **Mandatory*Credits 10 (5 x 2)** | | **VSC Credits 2** | |
| | Course 1 Cr. 2: Theory 60+40 | 2L | Course 1 Cr. 2: Theory 60+40 | 2L |
| | Course 2 Cr. 2: Theory 60+40 | 2L | | |
| | Course 3 Cr. 2: Theory 60+40 | 2L | | |
| | Course 4 Cr. 2: Practical 100 | 4L | | |
| | Course 5 Cr. 2: Practical 100 | 4L | | |
| | **Electives (select anyone) Credits 4 (2+2)** | | **OJT/FP/CEP/CC/RP** | |
| | Course 1 Cr. 2: Theory 60+40 | 2L | **FP Credits 2** | |
| | Course 2 Cr. 2: Practical 100 | 4L | Course 1 Cr. 2: Practical 100 | 4L |
| | Course 3 Cr. 2: Theory 60+40 | 2L | | |
| | Course 4 Cr. 2: Practical 100 | 4L | | |
| | **MINOR Credits 4 (2+2)** | | | |
| | Course 1 Cr. 2: Theory 60+40 | 2L | | |
| | Course 2 Cr. 2: Practical 100 | 4L | | |
| | | | | |
| Sem - VI | **MAJOR** | | | |
| | **Mandatory*Credits 10 (5 x 2)** | | | |
| | Course 1 Cr. 2: Theory 60+40 | 2L | | |
| | Course 2 Cr. 2: Theory 60+40 | 2L | | |
| | Course 3 Cr. 2: Theory 60+40 | 2L | | |
| | Course 4 Cr. 2: Practical 100 | 4L | | |
| | Course 5 Cr. 2: Practical 100 | 4L | | |
| | **Electives (select anyone) Credits 4 (2+2)** | | **OJT/FP/CEP/CC/RP** | |
| | Course 1 Cr. 2: Theory 60+40 | 2L | **OJT Credits 4** | |
| | Course 2 Cr. 2: Practical 100 | 4L | Course 1 Cr. 2: Practical 100 | 8L |
| | Course 3 Cr. 2: Theory 60+40 | 2L | | |
| | Course 4 Cr. 2: Practical 100 | 4L | | |
| | **MINOR Credits 4** | | | |
| | Course 1 Cr. 2: Theory 60+40 | 2L | | |
| | Course 2 Cr. 2: Practical 100 | 4L | | |
| Total Cumulative credits = **20 + 08 + 06 + 04 + 06 = 44 Credits** | | | | |
| Exit option: *Award of UG Degree in Major with 132 credits* **OR** *continue with Major* | | | | |

# Program Specific Outcomes Biotechnology

**PSO 1 Apply Biotechnological Principles:** Graduates will be able to apply fundamental principles of biotechnology, including molecular biology, genetics, and biochemistry, to solve problems and develop innovative solutions.

**PSO 2 Design and Conduct Experiments:** Graduates will be able to design, conduct, and analyze experiments in biotechnology, including molecular biology, cell culture, and bioanalytical techniques.

**PSO 3 Communicate Biotechnological Concepts**: Graduates will be able to effectively communicate biotechnological concepts, principles, and research findings to both technical and non-technical audiences through written, oral, and visual presentations.

**PSO 4 Apply Biotechnological Tools and Techniques:** Graduates will be able to apply biotechnological tools and techniques, including genetic engineering, gene editing, and bioinformatics, to solve real-world problems and develop innovative solutions.

**PSO 5 Integrate Biotechnology with Other Disciplines**: Graduates will be able to integrate biotechnology with other disciplines, including chemistry, physics, mathematics, and engineering, to develop innovative solutions to complex problems.

**PSO 6 Demonstrate Professional and Ethical Responsibility**: Graduates will be able to demonstrate professional and ethical responsibility in the practice of biotechnology, including respect for intellectual property, adherence to regulatory guidelines, and consideration of social and environmental implications.

# Program Outcomes Biotechnology

**1. Knowledge and Understanding**

- Graduates will have a strong foundation in the principles of biotechnology, including molecular biology, genetics, biochemistry, and microbiology.
- Graduates will understand the applications of biotechnology in various fields, including healthcare, agriculture, and industry.

**2. Practical Skills**

- Graduates will be able to design and conduct experiments, collect and analyze data, and draw meaningful conclusions.
- Graduates will be proficient in various laboratory techniques, including DNA manipulation, protein analysis, and cell culture.

**3. Critical Thinking and Problem-Solving**

- Graduates will be able to critically evaluate scientific information, identify problems, and develop creative solutions.
- Graduates will be able to analyze complex biological systems and processes, and develop innovative approaches to address biotechnology-related challenges.

**4. Communication and Collaboration**

- Graduates will be able to effectively communicate scientific information to various audiences, including peers, professionals, and the general public.
- Graduates will be able to work collaboratively in teams, including interdisciplinary teams, to achieve common goals.

**5. Professionalism and Ethics**

- Graduates will understand the ethical implications of biotechnology and its applications.
- Graduates will be able to apply ethical principles and professional standards in their work.

# Career Outcomes Biotechnology

**1. Research and Development**

- Graduates can pursue careers in research and development in biotechnology industries, academic institutions, or government laboratories.

**2. Industry and Manufacturing**

- Graduates can work in biotechnology industries, including pharmaceuticals, agriculture, and food processing.

**3. Healthcare and Diagnostics**

- Graduates can pursue careers in healthcare, including diagnostics, therapeutics, and personalized medicine.

**4. Regulatory Affairs and Policy**

- Graduates can work in regulatory affairs, policy-making, or advocacy related to biotechnology.

**5. Further Education and Academia**

- Graduates can pursue higher education, including master's or doctoral degrees, or careers in academia.

## The Detailed Semester and Course Wise Syllabus as follows:

The total minimum credits required for completing the B.Sc. in Biotechnology is **132**

| SEMESTER - V | | | | | |
|---|---|---|---|---|---|
| **Code** | **Course of Study - Major** | **L** | **T** | **P** | **Cr.** |
| VBCB300 | Course 1 Cr. 2: CELL BIOLOGY | 2 | - | - | 2 |
| VBMB301 | Course 2 Cr. 2: MOLECULAR BIOLOGY | 2 | - | - | 2 |
| VBSW302 | Course 3 Cr. 2: SCIENTIFIC WRITING & PRESENTATION SKILLS | 2 | - | - | 2 |
| VBPR303 | Course 4 Cr. 2: CELL BIOLOGY PRACTICALS | - | - | 4 | 2 |
| VBPR304 | Course 5 Cr. 2: MOLECULAR BIOLOGY PRACTICALS | - | - | 4 | 2 |
| | **Electives** | | | | |
| | Course 1 Cr. 2: MARINE BIOTECHNOLOGY | 2 | - | - | 2 |
| | Course 2 Cr. 2: MARINE BIOTECHNOLOGY PRACTICALS | - | - | 4 | 2 |
| VBB305 | Course 3 Cr. 2: BIOSAFETY | 2 | - | - | 2 |
| VBPR306 | Course 4 Cr. 2: BIOSAFETY PRACTICALS | - | - | 4 | 2 |
| | **MINOR Credits 4** | | | | |
| VBMM309 | Course 1 Cr. 2: MEDICAL MICROBIOLOGY | 2 | - | - | 2 |
| VBPR310 | Course 2 Cr. 2: MEDICAL MICROBIOLOGY PRACTICALS | - | - | 4 | 2 |
| | **~~VSC~~ /SEC ~~C~~ Credits ~~2~~** | | | | |
| VBFB311 | Course 1 Cr. 2: FOOD BIOTECHNOLOGY | 2 | - | - | 2 |
| | **FP Credits 2** | | | | |
| VBFP312 | Course 1 Cr. 2: | - | - | 4 | 2 |
| **Total** | | 18 | - | 22 | **22** |

**Note:** Students are allowed to select one elective out of the two given in curriculum.

| SEMESTER - VI | | | | | |
|---|---|---|---|---|---|
| **Code** | **Course of Study - Major** | **L** | **T** | **P** | **C** |
| VBB350 | Course 1 Cr. 2: BIOCHEMISTRY | 2 | - | - | 2 |
| VBIM351 | Course 2 Cr. 2: INDUSTRIAL MICROBIOLOGY | 2 | - | - | 2 |
| VBEB352 | Course 3 Cr. 2: ENVIRONMENTAL BIOTECHNOLOGY | 2 | - | - | 2 |
| VBPR353 | Course 4 Cr. 2: BIOCHEMISTRY PRACTICALS | - | - | 4 | 2 |
| VBPR354 | Course 5 Cr. 2: INDUSTRIAL MICROBIOLOGY PRACTICALS | - | - | 4 | 2 |
| | **Electives** | | | | |
| VBPB355 | Course 1 Cr. 2: PHARMACEUTICAL BIOTECHNOLOGY | 2 | - | - | 2 |
| VBPR356 | Course 2 Cr. 2: PHARMACEUTICAL BIOTECHNOLOGY PRACTICALS | - | - | 4 | 2 |
| | Course 3 Cr. 2: AGRICULTURAL BIOTECHNOLOGY | 2 | - | - | 2 |
| | Course 4 Cr. 2: AGRICULTURAL BIOTECHNOLOGY PRACTICALS | - | - | 4 | 2 |
| | **MINOR Credits 4** | | | | |
| VBPN359 | Course 1 Cr. 2: PHARMACOLOGY & NEUROCHEMISTRY | 2 | - | - | 2 |
| VBPR360 | Course 2 Cr. 2: PHARMACOLOGY & NEUROCHEMISTRY PRACTICALS | - | - | 4 | 2 |
| | **OJT Credits 4** | | | | |
| VBPR361 | Course 1 Cr. 2: | - | - | 8 | 4 |
| **Total** | | 18 | - | 22 | **22** |

**Note:** Students are allowed to select one elective out of the two given in curriculum.

# Syllabus for

# T.Y. B. Sc. Biotechnology Semester V and VI

**Choice Based Credit System (NEP 2020)**

**(To be implemented from the academic year 2025-2026)**

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Cell Biology (MAJOR) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| 2 | - | 2 | 40 M | 60 M |

**Learning Objectives:**

The objective of this course is to have a firm foundation in the fundamentals of Cell Biology.

Explain the principles and role of receptors of cell signaling

Describe different stages of development.

Understand embryogenesis and morphogenesis.

**Course Outcomes:**

Understand cell cycle and its regulation.

Understand molecular genetics of cancer.

Describe signaling pathways involved in cell growth and differentiation.

Understand the scope of developmental biology.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| **1** | Cell Cycle | 10 |
| **2** | Cell Signaling | 10 |
| **3** | Developmental biology | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I<br>Cell Cycle | Cell cycle Introduction: Prokaryotic and Eukaryotic<br>The Early Embryonic Cell Cycle and the Role of MPF<br>Yeasts and the Molecular Genetics of Cell-Cycle Control<br>Apoptosis, Cell-Division Controls in Multicellular Animals<br>Cancer: Introduction, The Molecular Genetics of Cancer | **10** |
| II<br>Cell Signaling | Cell signaling and signal transduction: Introduction General Principles of Cell Signaling<br>Signaling via G Protein-linked Cell-Surface Receptors<br>Signaling via Enzyme-linked Cell-Surface Receptors<br>Target-Cell Adaptation, The Logic of Intracellular | **10** |
| III<br>Developmental Biology | Model organisms in Developmental biology<br>Stages of development- zygote, blastula, gastrula, neurula cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map<br>Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development<br>Pattern formation-- axis specification, positional identification (regional specification), Morphogenetic movements. | **10** |

References


1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., K Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
5. Developmental Biology; Scott Gilbert; 9th Edition


| Program: Biotechnology | Semester: V |
|---|---|

| Course: Cell Biology Practical (Major) | | | Course Code: | |
|---|---|---|---|---|
| **Teaching Scheme** | | | **Evaluation Scheme** | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| - | 4 | 2 | - | 100 |

1. Chick embryo candling and inoculation methods.
2. Study of developmental stages of chick embryo.
3. Animal tissue culture: Tissue dissociation by trypsinization and estimate viability
4. Plant tissue culture: Callus production, Protoplast preparation and estimate viability by activity staining.
5. Separation of mononuclear cells using density gradient centrifugation and determination of its viable count.
6. Determination of cell viability in pollen grains / yeast using dye exclusion test.
7. Study of osmotic fragility of RBCs.

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Molecular Biology (MAJOR) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 M | 60 M |

**Learning Objectives:**

Define cloning vectors and their purpose.

Explain different types of cloning vectors.

Outline the techniques used for cloning.

Describe basic principles of DNA sequencing.

Explain the concept of gene editing and its importance in molecular biology and genetics.

**Course Outcomes:**

Understand types of cloning vectors.

Explain the advantages and disadvantages of plasmid vectors in molecular cloning.

Understand different cloning strategies.

Understand the principles of DNA sequencing.

Explain different methods of gene editing and their applications.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| **1** | Cloning Vectors | 10 |
| **2** | cDNA and Genomic DNA Cloning | 10 |
| **3** | Gene sequencing and Editing | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I<br>Tools in Molecular Biology | Enzymes in gene cloning.<br>Cloning vectors: Plasmids (pBR322, pUC series), Cosmids, phagemids M13, shuttle vectors, YAC vectors, expression vectors pET, Agrobacterium based vectors, Plant and Animal transgenesis vectors and their methodology. | **10** |
| II<br>Cloning strategies | Gene cloning: Isolation and purification of DNA; Isolation of gene of interest: Restriction digestion, electrophoresis, blotting, cutting, and joining DNA, methods of gene transfer in prokaryotes and eukaryotes Recombinant selection and screening methods.<br>Expression of cloned DNA molecules and maximization of expression<br>Cloning strategies: genomic DNA libraries, cDNA libraries, chromosome walking and jumping | **10** |
| III<br>Gene sequencing and Editing | Maxam Gilbert's method, Sanger's dideoxy method,<br>Automated DNA sequencing, Pyrosequencing.<br>Human genome mapping and its implications in health and disease.<br>RNAi, ZNF (Zinc finger nucleases), TALENS (Transcription Activator Like Effector<br>Nucleases), CRISPER/Cas system (Clustered Regularly Interspersed Repeats) | **10** |

References


1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell.
2. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.
3. Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.
4. Biotechnology 3rd Edition S.S. Purohit.
5. Gene Cloning and DNA Analysis 6th Edition T.A. Brown.
6. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Molecular Biology Practical (Major) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| - | 4 | 2 | - | 100 |

1. Plasmid DNA extraction.
2. Restriction enzyme digestion and ligation.
3. Transformation in Escherichia coli.
4. Blue-white selection strategy for recombinants.
5. Bacterial gene expression.
6. Reading of Sanger's dideoxy DNA sequencing autoradiogram.
7. Polymerase chain reaction.

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Scientific Writing and Presentation Skills (MAJOR) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 M | 60 M |

**Learning Objectives:**

Master the principles and ethics of scientific writing, including structuring and clarity.

Develop and refine research questions, literature reviews, and effective abstracts.

Enhance presentation skills, utilizing visual aids and effective communication techniques.

Navigate the publication process, from manuscript writing to responding to reviewer feedback.

**Course Outcomes:**

Explain and understand key features of scientific writing including clarity, conciseness and accuracy.

Write clear and concise scientific abstracts that effectively summarize a research paper.

Write scientific papers that effectively communicate research findings.

Critically evaluate scientific papers.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Scientific writing- Introduction | 10 |
| 2 | Scientific writing- Research Design, Data Collection and Reporting | 10 |
| 3 | Scientific writing-Publication. | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/Credits |
|---|---|---|
| I Scientific writing-Overview | Purpose, audience, and style of scientific writing; primary vs. secondary sources; peer review process., Structuring documents: abstracts, introductions, methods, results, discussions, conclusions., Effective communication principles: clarity, conciseness, coherence., Ethical considerations: plagiarism, authorship, conflicts of interest. | **10** |
| II Scientific writing-Research Design, Data Collection and Reporting | Developing research questions and hypotheses., Literature review: searching databases, evaluating sources, synthesizing information., Crafting titles and abstracts; writing methods sections., Presenting results: tables, figures, statistical analysis. | **10** |
| III Scientific writing-Publication. | Publication process: journal selection, manuscript submission, peer review., Manuscript writing: structure, titles, abstracts, formatting., Responding to reviewer comments, revising manuscripts., Ethical publishing: authorship, conflicts of interest, data integrity. Scientific posters and presentations for conferences., Professional online presence: academic profiles, social media, networking., Career development in science communication: writing, editing, journalism. | **10** |

**REFERENCES**


1. Day, R. A., & Gastel, B. How to Write and Publish a Scientific Paper (8th Edition). Cambridge University Press, 2016.
2. Alley, M. The Craft of Scientific Writing (4th Edition). Springer, 2013.
3. Katz, M. J. From Research to Manuscript: A Guide to Scientific Writing (2nd Edition). Springer, 2009.
4. Matthews, J. R., & Matthews, R. W. Successful Scientific Writing: A Step-by Step Guide for the Biological and Medical Sciences (4th Edition). Cambridge University Press, 2014.

| **Program: Biotechnology** | | | **Semester: V** | |
|---|---|---|---|---|
| **Course: Medical Microbiology (MINOR)** | | | **Course Code:** | |
| **Teaching Scheme** | | | **Evaluation Scheme** | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| 2 | - | 2 | 40 M | 60 M |

**Learning Objectives:**

Understand host-pathogen interactions.

Describe different types of bacterial pathogens.

To provide the conceptual basis for understanding viruses and mechanisms of their pathogenicity.

Explain the mode of action of antimicrobial agents employed to prevent diseases including infection.

**Course Outcomes:**

Analyze laboratory diagnosis of bacterial infections.

Use laboratory techniques to diagnose and identify bacterial pathogens.

Understand appropriate use of antimicrobial agents and common mechanisms of antimicrobial action and resistance.

**Outline of Syllabus:**

| **Unit** | **Topics** | **No of Hours** |
|---|---|---|
| **1** | Bacteriology | 10 |
| **2** | Virology | 10 |
| **3** | Principles of antimicrobial therapy | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I Bacteriology | Host-Parasite relationship,<br>Patterns of Infection;<br>Types of Infections; Signs and Symptoms;<br>Epidemiology and Epidemiological Markers.<br>Bacteriological Infections of the Skin, Respiratory tract, Gastrointestinal tract, Urogenital tract, Nosocomial Infections. | **10** |
| II Virology | Virus: introduction, morphology and growth.<br>Viral replication Viral diversity<br>Overview of bacterial viruses<br>Overview of plant viruses<br>Overview of animal viruses<br>Subviral entities | **10** |
| III Principles of antimicrobial therapy | Antibacterial agents<br>Antifungal agents<br>Antiparasitic agents<br>Antiviral agents<br>Interactions between microbes and drugs<br>Interactions between drugs and hosts | **10** |

References


1. Mim's Medical Microbiology 5th edition
2. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill
3. Medical Microbiology Jawetz,E, Brooks,G.E, Melnick,J.L., Butel, J.S Adelberg E. A 18th edition
4. Medical Microbiology by Patrick Murray 5th edition
5. Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown
6. Understanding Viruses by Teri Shors

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Medical Microbiology Practical (Minor) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| - | 4 | 2 | - | 100 |

1. Study of *Pseudomonas aeruginosa*.
2. Study of *Klebsiella pneumoniae*.
3. Bacteriophage titration.
4. MIC and MLC of any one antibiotic
5. Antibiotic sensitivity test using agar cup method
6. Antibiotic sensitivity test using paper disc method
7. Antibiotic sensitivity test using ditch method.
8. Synergistic activity of drugs.

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Food Biotechnology ( VSC / SEC ) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 M | 60 M |

**Learning Objectives:**

Understand the principles of food biotechnology.

Describe the different types of functional foods and nutraceuticals.

Develop an understanding of the complex issues surrounding functional foods and nutraceuticals.

Understand the importance of food safety and standards.

**Course Outcomes:**

Analyze the benefits and risks of food biotechnology.

Apply knowledge of functional foods and nutraceuticals to real-world scenarios.

Describe the key food safety regulations and standards.

Critically evaluate impact of food safety regulations and standards on food industry.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Introduction to Food Biotechnology | 10 |
| 2 | Functional food and nutraceuticals in management of health and disease | 10 |
| 3 | Food standards & Safety regulations | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I Introduction to Food Biotechnology | Fermentative production of enzymes used in food industry; recovery of enzymes from natural sources.<br>Role of enzymes in baking, meat and meat processing; biosensors; enzymatic approach to tailor made fats; use of lipases and reactions in organic solvents and two phases.<br>Prebiotics and Probiotics.<br>Food preservation. | **10** |
| II Functional food and nutraceuticals in management of health and disease | Nutraceuticals and functional foods -Definition, characteristic features, and classification.<br>Applications of nutraceuticals in human health and nutrition- health effects of commonly used nutraceuticals and functional foods (case studies),<br>Nutraceuticals in management of health and disease. Development of designer foods for specific chronic diseases; Nutraceutical adjuvants<br>Nutrigenomics- Concept and examples. | **10** |
| III Food standards & Safety regulations | Salient features of Food Safety & Standards Act, 2006, Structure of FSSAI, Administrative set up at the State level.<br>Introduction to Food Safety,<br>Food Contaminants (Microbial, Chemical, Physical),<br>Food Adulteration (Common adulterants),<br>Food Additives (functional role, safety issues),<br>Food Packaging & labelling, Nutritional labelling, labelling requirements for pre-packaged food as per CODEX Biosecurity in Food and Agriculture. | **10** |

References


1. Murray Robert, Harper`s Biochemistry, 24th Ed, Prentice Hall International UK Ltd, 1990.
2. Krause's Food, Nutrition and Diet Therapy, 10th Edition by Mahan, L.K. & Scott Stump, S. (2000), W.B. Saunders Ltd.
3. Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean - Richard Neeser & J. Bruce German, Marcel Dekker, Inc., 2004.
4. Regulations and Quality: Pharmaceutical Manufacturing Handbook, Shayne Cox God (Ed.), Wiley Interscience 2008

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Marine Biotechnology (Elective) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2L | - | 2 | 40 | 60 |

**Learning Objectives:**

Understand the key principles of marine biotechnology.
Describe different types of marine biotechnology applications.
Evaluate the environmental impact of marine biotechnology.

**Course Outcomes:**

Apply knowledge of marine biotechnology to real world scenarios.
Analyze potential impact of marine biotechnology on environment.
Explain the role of marine biotechnology in addressing various challenges.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Marine Biotechnology Introduction & Bioprospecting | 10 |
| 2 | Marine Drugs and Enzymes | 10 |
| 3 | Marine Bioresources | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I<br>Marine Biotech-nology Introduc-tion & Biopros-pecting | Introduction to Marine Biotechnology.<br>The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal & deep-sea ecosystems. Hydrothermal vents.<br>Bioprospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms.<br>Methods for Microbial Bioprospecting in Marine Environments.<br>Biotechnological Potential of Marine Microbes.<br>Bioactive compounds from Marine organisms: fungi, microalgae, seaweeds, Actinomycetes, sponges. | **10** |
| II<br>Marine Drugs and Enzymes | Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents.<br>Approved Marine Drugs as Pharmaceuticals.<br>Marine Natural products and its Challenges.<br>Marine Microbial Enzymes-Marine Extremozymes and Their Significance.<br>Current Use of Marine Microbial Enzymes. | **10** |
| III<br>Marine Bioresources | Marine Bioresources, Marine Secondary Metabolites, Marine Proteins, Marine Lipids.<br>Marine-Derived Ingredients with Biological Properties.<br>Marine Bioactives as Potential Nutraceuticals.<br>Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry.<br>Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals, Treatments Based on Marine Resources, Products Based on Marine Resources. | **10** |

References


1. Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.
2. Blanca Hernández-Ledesma, Miguel Herrero-Bioactive Compounds from Marine Foods-Plant and Animal Sources-Wiley-Blackwell (2013)
3. W. Evans-Trease and Evans Pharmacognosy 15th ed.-Saunders (2010)

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Marine Biotechnology Practical (Elective) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| - | 4 | 2 | - | 100 |

1. Study of any 5 marine bacteria.
2. Study of any 5 marine algae (Macro and micro).
3. DPPH assay for antioxidant extracted from marine algae
4. Extraction of carotenoids from marine algae/Bacteria/Fungi
5. Extraction and estimation of Gelatin.
6. Extraction and estimation of Collagen.
7. Extraction of alkaloids from marine organisms and their separation by TLC.

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Biosafety (Elective) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| 2 | - | 2 | 40 | 60 |

**Learning Objectives:**

Explain the principles of biosafety.
Explain the importance of GLP in biotechnology.
Use biosafety principles to design and implement safe biotechnology practices.
Risk assessment including identification of potential hazards and development of mitigation strategies.

**Course Outcomes:**

Understand the risks associated with biological agents and measures to mitigate those risks.
Understand GLP including the principles of quality assurance, quality control and documentation.
Evaluate the effectiveness of biosafety measures in biotechnology.
Develop a biosafety manual for a biotechnology laboratory.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| **1** | Introduction to Biosafety. | 10 |
| **2** | GLP | 10 |
| **3** | Biosafety - Applications | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/Credits |
|---|---|---|
| I<br>Introduction to biosafety | Introduction - Biological Risk Assessment; Hazardous Characteristics of an Agent**;** Genetically modified agent hazards; Cell cultures**;** Hazardous Characteristics of Laboratory Procedures**;** Potential Hazards Associated with Work Practices**;** Safety Equipment and Facility Safeguards; Pathogen risk and management. | **10** |
| II<br>GLP | Concept of GLP**;** Practicing GLP; Guidelines to GLP**;** Documentation of Laboratory work**;** Preparation of SOPs; Calibration records**;** Validation of methods**;** Documentation of results; Audits & Audit reports. | **10** |
| III<br>Biosafety-Applications | Microbial Contamination in food and pharma product; Some common microbial contaminants**;** Microbiological Assays for pharmaceutical products; Regulatory Microbiological testing in pharmaceuticals**.** Biosafety in Biotechnology. | **10** |

References


1. Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific Publishers.
2. Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. Casey Chosewood Deborah E. Wilson U.S. Department of Health and Human Services Centers for Disease Control and Prevention National Institutes of Health.
3. Molecular Biotechnology –Principles and Applications of Recombinant DNA Glick, B.R, Pasternak, J.J Patten, C.L 3rd edition ASM press

| Program: Biotechnology | | | Semester: V | |
|---|---|---|---|---|
| Course: Biosafety Practical (Elective) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| - | 4 | 2 | - | 100 |

1. Validation of micropipette, measuring cylinders, colorimeters.
2. Calibration of pH meter and weighing balance.
3. Vitamin B12 bioassay.
4. Testing for adulterants in food.
5. Drafting SOP for any two major laboratory instruments.
6. Sterility of injectables.

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Biochemistry (MAJOR) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 | 60 |

**Learning Objectives:**

Explain the structure and function of proteins and describe different types of protein interactions
Evaluate the role of carbohydrate metabolism.
Explain the principles of endocrinology.
Analyze the role of hormones in regulating physiological processes.

**Course Outcomes:**

Develop a critical thinking approach to protein biochemistry.
Analyze protein structure and functions.
Analyze carbohydrate metabolism in bacteria, plants and animals.
Describe major endocrine systems and their functions.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Protein Biochemistry | 10 |
| 2 | Metabolism | 10 |
| 3 | Endocrinology | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I<br>Protein<br>Biochemistry | Protein structure: Protein Tertiary and<br>Quaternary Structures<br>Protein Denaturation and Folding<br>Protein Function: Reversible Binding of a Protein to a Ligand:<br>Oxygen-Binding Proteins<br>Complementary Interactions between<br>Proteins and Ligands: Immunoglobulins<br>Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors<br>Protein purification | **10** |
| II<br>Metabolism | Carbohydrate biosynthesis and its regulation:<br>Peptidoglycan in Bacteria<br>Starch and sucrose in Plants<br>Glycogen in Animals<br>Biosynthesis and regulation of Cholesterol,<br>Atherosclerosis | **10** |
| III<br>Endocrinology | Mechanism of action of group I and II<br>Hormones Structure, storage, release,<br>transport, biochemical functions<br>and disorders associated with hormones secreted by Hypothalamus - Anterior Pituitary gland - GH, stimulating hormones)<br>Posterior Pituitary gland – oxcytocin and vasopressin<br>Thyroid gland – Thyroxine, calcitonin<br>Parathyroid gland – PTH<br>Adrenal medulla – epinephrine and<br>norepinehprine<br>Adrenal cortex – Glucocortocoids<br>Pancreas – insulin and glucagon<br>Female Gonads – estrogen and progesterone<br>Male gonads – testosterone Placenta – hCG | **10** |

References:


1. The Cell-A Molecular Approach- Geoffrey Cooper, Robert Hausman Fourth edition (2007).ASM press Sinauer Associates Inc USA.
2. Molecular Biology of the Cell- Bruce Alberts et al Sixth Edition (2008). Garland Science USA.
3. Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and Michael Cox *W.H. Freeman* and Company, New York.
4. Biochemistry, 4th edition (2010), Voet and Voet, John Wiley and sons, USA

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Biochemistry Practical (Major) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| - | 4 | 2 | - | 100 |

1. Study of protein denaturation using viscometer.
2. Protein purification by ammonium sulphate precipitation and dialysis.
3. Estimation of purified protein by Bradford's method.
4. Estimation of blood glucose levels for detection of diabetes mellitus.
5. Estimation of serum cholesterol (Total and HDL: LDL ratio)
6. Estimation of starch by Willstater's method.
7. Study of working of a Glucometer.

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Industrial Microbiology (MAJOR) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 | 60 |

**Learning Objectives:**

Understand the different types of fermentation processes.
Know the different types of downstream processing techniques.
Describe the different types of quality control tests, including microbiological, chemical, and physical tests.

**Course Outcomes:**

Design and optimize fermentation processes.
Design and optimize downstream processing protocols.
Design and implement quality control protocols

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Fermentation Process. | 10 |
| 2 | Downstream Processing (DSP). | 10 |
| 3 | QA-QC. | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I: Fermentation Process | Dairy technology Preservation methods Pasteurization; Starter Cultures; Fermented products-Production process and spoilage of Cheese: Swiss and Cheddar; Butter; Yogurt and Buttermilk. Introduction to Inoculum development; Bacterial and fungal inoculum development with one example each, scale up, scale down. Production of: Streptomycin; Protease; Mushroom; Glutamic acid; Semi-synthetic Penicillin. Biotransformation. | **10** |
| II: Down-stream Processing (DSP) | Introduction of DSP; Foam separation; Types of Precipitation; Filtration; Centrifugation. Chromatography in DSP; Cell disruption- physical and chemical methods; Solvent recovery, membrane processes; Drying; Crystallization and Whole broth Processing. | **10** |
| III QA-QC | Concept of GMP; Requirements of GMP implementation; Documentation of GMP practices; Regulatory certification of GMP; Quality Control (QC): Concept of QC; Requirements for implementing QC; QA concepts: Concept of QA; Requirements for implementing. | **10** |

References


1. Applied Dairy Microbiology Elmer H Marth and James L Steele Mercel Dekker Inc New York, 2nd edition
2. Microbial Technology Peppler,H.J and Perlman,D 2nd Academic Press Practicals
3. Industrial Microbiology Prescott and Dunn CBS publishers
4. Dairy technology by Yadav and Grower
5. Fermentation technology by Stanbury and Whittkar
6. Pharmaceutical Microbiology by Russel and Hugo

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Industrial Microbiology Practical (Major) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| - | 4 | 2 | - | 100 |

1. Estimation of Milk protein-Pynes method.
2. Isolation of Normal flora from Milk and curd.
3. Isolation of antibiotic producing bacteria by:
   (a)Wilkins overlay method.
   (b) Crowded plate technique.
4. Microbiological assay of penicillin.
5. Microbiological assay of vitamin B12.
6. Fermentative production of alcohol.
7. Estimation of alcohol in the sample.
8. Visit to any food / fermentation industry.

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Environmental Biotechnology (MAJOR) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 | 60 |

**Learning Objectives:**

Describe the different types of renewable energy sources.
Explain the principles of industrial effluent treatment: physical, chemical and biological processes.
Explain the principles of hazardous waste management, including waste minimization, recycling and disposal.

**Course Outcomes:**

Evaluate the environmental impacts of renewable energy sources.
Understand the guidelines for industrial effluent treatment.
Analyze the risks associated with hazardous waste, including human health risks and environmental risks.
Develop a critical thinking approach to waste treatment and management.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Renewable sources of energy. | 10 |
| 2 | Industrial Effluent Treatment. | 10 |
| 3 | Hazardous Waste Management. | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I: Renewable sources of energy | Energy sources renewable – solar energy, wind power, geothermal energy and hydropower, biomass energy**;** Biogas technology- biogas plant & types, biodigester. Biogas- composition, production and factors affecting production, uses**;** Biofuels – ethanol production. Microbial hydrogen production Biodiesel, Petrocrops**.** | **10** |
| II Industrial effluent treatment | Biological processes for industrial effluent treatment, aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR**;** Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB**;** Solid waste treatment**;** pollution indicators & biosensors**;** biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation**;** Use of immobilized enzymes or microbial cells for treatment**.** | **10** |
| III Hazardous waste Management | Heavy metal pollution-techniques used for heavy metal removal**;** biosorption by bacteria, fungi and algae**.** Biodegradation of waste from tanning industry**;** petroleum industry**;** paper & pulp industry**;** Dairy**;** Distillery**;** Dye industry**;** Antibiotic industry**;** Removal of oil spillage & grease deposits. | **10** |

References:


1. Environmental Biotechnology Allan Scragg Oxford University press
2. Environmental Biotechnology (Basic concepts and applications) Indu Shekar Thakur IK International

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Pharmacology and Neurochemistry (Minor) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| 2 | - | 2 | 40 | 60 |

**Learning Objectives:**

Understand the general principles of pharmacology.
Know the principles of drug absorption and distribution.
Understand the chemical composition and structure of the brain.
Understand the role of neurochemistry in neurological and psychiatric disorders.

**Course Outcomes:**

Evaluate the factors that influence drug absorption and distribution
Analyze the dose-response relationship of drugs.
Design and optimize drug delivery systems.
Analyze the chemical signaling pathways in the brain.
Analyze the chemical signaling pathways in the brain.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| **1** | General principles of Pharmacology. | 10 |
| **2** | Drug Absorption and Distribution. | 10 |
| **3** | Neurochemistry | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I<br>General principles of Pharmacology | Mechanism of drug action**;** drug receptors and biological responses**;** second-messenger systems, the chemistry of drug–receptor binding**;** dose–response relationship: therapeutic index**;** ED, LD**;** Potency and Intrinsic Activity **;** Drug antagonism**.** | **10** |
| II<br>Drug Absorption and Distribution | Absorption of drugs from the alimentary tract **;** factors affecting rate of gastrointestinal absorption**;** absorption of drugs from lungs**;** skin**;** absorption of drugs after parenteral administration; factors influencing drug distribution**;** binding of drugs to plasma proteins**;** Physiological barriers to drug distribution**.** | **10** |
| III<br>Neurochemistry | Anatomy and functioning of the brain**;** Neuronal pathways –Propogation of nerve impulses **;** Neuronal excitation and inhibition**;** Synapses and gap junctions**;** Action of Neuro toxins and neurotransmitters**.** | **10** |

References:


1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
2. Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition
3. Clinical Pharmacology Bennet,PN,Brown,M.J, Sharma,P 11th edition Elsevier
4. Biochemistry Metzler, D.E Elsevier

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Pharmacology and Neurochemistry Practical (Minor) | | | Course Code: | |
| **Teaching Scheme** | | | **Evaluation Scheme** | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| - | 4 | 2 | - | 100 |

1. Evaluation of LD50 using suitable models.
2. To study the combined effect of two drugs on bacteria.
3. Determination of Minimum Inhibitory Concentration (MIC) of antibiotic.
4. Determination of Minimum Lethal Concentration (MLC) of antibiotic.
5. Study of different regions of brain using models.
6. Stroop test and Blind spot test.
7. Colour blindness and Optical illusions.

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Pharmaceutical Biotechnology (ELECTIVE) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 | 60 |

**Learning Objectives:**

To introduce the basic concepts of pharmaceutical biotechnology.
Explain the strategies and various steps of the new drug discovery process.
To provide the basic information about various terms, concepts, production processes and analytical techniques in pharmaceutical biotechnology.

**Course Outcomes:**

Gain basic knowledge about the applications of biotechnology in the field of pharmaceuticals.
Will understand the concept of drug discovery and drug designing.
Will get knowledge of various medicinally important secondary metabolites.
Understand the role of recombinant DNA technology for the improvement of productivity and efficacy.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Introduction to pharmaceutical biotechnology | 10 |
| 2 | Secondary metabolites of plant and microorganisms | 10 |
| 3 | Advances in pharmaceutical biotechnology | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I<br>Introduction to pharmaceutical biotechnology | Introduction to pharmaceutical biotechnology/ Biopharmaceuticals.<br>Introduction to drug design and discovery<br>Stages in the drug discovery process.<br>Computer-Aided Drug Design (CADD)<br>Concept of Prodrug<br>Bioassay guided fractionation methods- TLC, GC, and HPLC,<br>Role of NMR and Mass spectrometry in drug discovery. | **10** |
| II<br>Secondary metabolites of plant and microorganisms | Introduction to secondary metabolites– Phenolics, Alkaloids, Saponins, Terpenes, Lipids and Carbohydrates.<br>Secondary metabolites of microorganisms – Antibiotics, Antitumor agents, Pharmacological and nutraceutical agents, Enzymes and enzyme inhibitors and agricultural and animal health products<br>Pharmacological Assays –<br>In-vitro assays - chemical (anti-oxidant),<br>Biological (anti- cancerous and assay system based on enzymes and cells), and<br>immunological (RIA and ELISA) –<br>In vivo assays (Anti-inflammatory and Anti-analgesic). | **10** |
| III<br>Advances in pharmaceutical biotechnology | Recombinant DNA technology (RDT)<br>Techniques of gene manipulation, cloning strategies, cloning and expression vectors, recombinant selection and screening, expression in *E. coli* and yeast.<br>Applications of the RDT in the production of recombinant proteins:<br>Regulatory proteins interferon, interleukins etc.<br>Blood products – Erythropoietin.<br>Hormones: Insulin. | **10** |

References


1. Liljefors, T., Krogsgaard-Larsen, P., & Madsen, U. (Eds.). (2002). Textbook of drug design and discovery. CRC Press.
2. Crommelin Daan J. A., Sindelar D. Robert (3rd edition) Pharmaceutical Biotechnology: Fundamentals and Applications, CRC Press, 2007.
3. Walsh, G. Biopharmaceuticals: Biochemistry and Biotechnology (2nd Edition), Wiley-Blackwell, 2013.
4. Satoskar R.S., Nirmala N. Rege, and Bhandarkar S. D. Pharmacology and Pharmacotherapeutics (Revised 23rd Edition), Popular Prakashan, Mumbai.

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Pharmaceutical Biotechnology Practical (Elective) | | | Course Code: | |
| **Teaching Scheme** | | | **Evaluation Scheme** | |
| **Lecture (Hours per week)** | **Practical (Hours per week)** | **Credit** | **Continuous Assessment (Internal)** | **Semester End Examinations** |
| - | 4 | 2 | - | 100 |

1. Sterility checking of pharmaceutical products injectable /ophthalmic solution.
2. Validation of autoclave using biological indicator.
3. Microbial limit test (MLT) of pharmaceutical product.
4. Microbiological assay of penicillin.
5. Microbiological assay of vitamin B12.
6. Qualitative study of secondary metabolites (TLC).
7. HPLC method validation.
8. Visit to pharmaceutical industry.

| Program: Biotechnology | | | Semester: VI | |
|---|---|---|---|---|
| Course: Agricultural Biotechnology (ELECTIVE) | | | Course Code: | |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| 2 | - | 2 | 40 | 60 |

**Learning Objectives:**

Understand the principles of precision agriculture.
Know the different types of molecular markers.
Understand the benefits and challenges of biofertilizers and biopesticides.

**Course Outcomes:**

Analyze the use of precision agriculture systems in different contexts.
Analyze the use of molecular markers in plant breeding programs.
Evaluate the effectiveness of biofertilizers and biopesticides.

**Outline of Syllabus:**

| Unit | Topics | No of Hours |
|---|---|---|
| 1 | Precision Agriculture and Agriculture Systems. | 10 |
| 2 | Molecular Markers in Plant Breeding. | 10 |
| 3 | Biofertilizers and Biopesticides. | 10 |
| | **Total** | 30 |

| Unit | Topic | Hours/ Credits |
|---|---|---|
| I: Precision Agriculture and Agriculture Systems | Introduction to Agriculture and Agriculture systems**;** Green house Technology-- Types of green house, importance, functions and features of green house, Design criteria and calculation**;** Construction material, covering material and its characteristics, growing media, greenhouse irrigation system, nutrient management**;** Greenhouse heating, cooling and shedding and ventilation system, Computer controlled environment; Phytotrons, fertigation and roof system**;** Precision Cultivation- tools, sensors for information acquisition. | **10** |
| II: Molecular Markers in Plant Breeding | Genetic markers in plant breeding-- Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP)**;** Application of Molecular Markers to Plant Breeding quantitative trait locus (QTL) mapping**;** Plant DNA Barcoding- Barcoding Markers (matK, rbcl, ITS, tmH-psbA), steps, recent advances, Benefits, Limitations **.** | **10** |
| III: Biofertilizers and Biopesticides | Biofertilizer: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers**;** Nonsymbiotic Nitrogen Fixers; Plant Growth Promoting Microorganisms-Phosphate- Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance**;** Plant Growth Promotion by Fungi—Mycorrhizae, Arbuscular Mycorrhizae, Ectomycorrhizae**;** Microbial Inoculants-Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations**;** Biopesticides– types, Bacillus thuringiensis, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application)**.** | **10** |

References:


1. M. Ajmal Ali, G. Gyulai, F. Al-Hemaid -Plant DNA Barcoding and Phylogenetics, LAP Lambert Academic Publishing ( 2015)
2. P. Parvatha Reddy (auth.)-Sustainable Crop Protection under Protected Cultivation- Springer Singapore (2016)
3. S.B. Anderson (ed.), Plant Breeding from Laboratories to Fields, InTech,2013
4. Henry Leung, Subhas Chandra Mukhopadhyay (eds.) - Intelligent Environmental Sensing (2015, Springer International Publishing)
5. Travis R. Glare, Maria E. Moran-Diez - Microbial-Based Biopesticides_ Methods and Protocols (2016, Humana Press)

| Program: Biotechnology | | | | Semester: VI |
|---|---|---|---|---|
| Course: Agricultural Biotechnology Practical (Elective) | | | | Course Code: |
| Teaching Scheme | | | Evaluation Scheme | |
| Lecture (Hours per week) | Practical (Hours per week) | Credit | Continuous Assessment (Internal) | Semester End Examinations |
| - | 4 | 2 | - | 100 |

1. RAPD analysis demonstration experiment.
2. Isolation of *Rhizobium.*
3. Isolation of *Azotobacter.*
4. Isolation of Phosphate solubilising bacteria.
5. Study of Mycorrhizae.
6. Estimation of antioxidants and antioxidant enzymes – Ascorbic acid, Catalase, and Peroxidase.
7. Visit to green house facility.