M.Sc. Biotechnology

Scheme & Syllabus
For Affiliated Colleges
(Revised)

University of Kerala
Thiruvananthapuram
2018
# SUMMARY OF THE SYLLABUS AND SCHEME

## Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Teaching Hours/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT 101</td>
<td>Cell Biology and Genetics</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 102</td>
<td>Biochemistry</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 103</td>
<td>Biophysics and Biostatistics</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 104</td>
<td>Biochemistry Lab</td>
<td>L 0 T 1 P 4 Total 5</td>
</tr>
<tr>
<td>BT 105</td>
<td>Cell Biology /Genetics and Biostatistics lab</td>
<td>L 0 T 1 P 4 Total 5</td>
</tr>
<tr>
<td></td>
<td><strong>Total Hours /week</strong></td>
<td>L 12 T 5 P 8 Total 25</td>
</tr>
</tbody>
</table>

## Semester II

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Teaching Hours/week</th>
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</thead>
<tbody>
<tr>
<td>BT 201</td>
<td>Basic Microbiology</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 202</td>
<td>Molecular Biology</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 203</td>
<td>Mathematics, Computer Science &amp; Bioinformatics</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 204</td>
<td>Microbiology Lab</td>
<td>L 0 T 1 P 4 Total 5</td>
</tr>
<tr>
<td>BT 205</td>
<td>Molecular Biology Lab</td>
<td>L 0 T 1 P 4 Total 5</td>
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<tr>
<td></td>
<td><strong>Total Hours /week</strong></td>
<td>L 12 T 5 P 8 Total 25</td>
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## Semester III

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Teaching Hours/week</th>
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</thead>
<tbody>
<tr>
<td>BT 301</td>
<td>Plant Biotechnology</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 302</td>
<td>Animal Biotechnology</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 303</td>
<td>Genetic engineering</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 304</td>
<td>Plant BT/ Animal BT Lab</td>
<td>L 0 T 1 P 4 Total 5</td>
</tr>
<tr>
<td>BT 305</td>
<td>Genetic Engineering Lab</td>
<td>L 0 T 1 P 4 Total 5</td>
</tr>
<tr>
<td></td>
<td><strong>Total Hours /week</strong></td>
<td>L 12 T 5 P 8 Total 25</td>
</tr>
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## Semester IV

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Teaching Hours/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT 401</td>
<td>Immunology</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 402</td>
<td>Environmental Biotechnology</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 403</td>
<td>Food and dairy Biotechnology/Basics of Bioprocess Technology</td>
<td>L 4 T 1 P 0 Total 5</td>
</tr>
<tr>
<td>BT 404</td>
<td>Project</td>
<td>L 0 T 0 P 10 Total 10</td>
</tr>
<tr>
<td>BT 405</td>
<td>General Viva -voce</td>
<td>L 0 T 0 P 10 Total 10</td>
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<tr>
<td></td>
<td><strong>Total Hours /week</strong></td>
<td>L 12 T 3 P 10 Total 25</td>
</tr>
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</table>

L –Lecture, T- Tutorial, P-Practical Total Number of Hours /week-25 hrs.
II. MARK DISTRIBUTION

1. PAPER/SEMESTER

<table>
<thead>
<tr>
<th>Semster</th>
<th>Papers</th>
<th>CA</th>
<th>ESA</th>
<th>Total Marks</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>BT-101-105</td>
<td>25 x 5</td>
<td>75 x 5</td>
<td>500</td>
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<tr>
<td>II</td>
<td>BT-201-205</td>
<td>25 x 5</td>
<td>75 x 5</td>
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<tr>
<td>III</td>
<td>BT-301-305</td>
<td>25 x 5</td>
<td>75 x 5</td>
<td>500</td>
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<tr>
<td>IV</td>
<td>BT-401-403</td>
<td>25 x 3</td>
<td>75 x 3</td>
<td>300</td>
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<tr>
<td></td>
<td>BT-404</td>
<td>50 x 1</td>
<td>100 x 1</td>
<td>150</td>
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<td></td>
<td>BT-405</td>
<td>-</td>
<td>50</td>
<td>50</td>
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<tr>
<td></td>
<td>Grand Total (From S-1 to S-IV)</td>
<td>2000</td>
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</table>

CA- Continuous Assessment  
ESA- End Semester Assessment

Total Marks for a semester 500  
Total Maximum marks at the end of IV semester 500 x 4=2000

2. DISTRIBUTION OF MARKS FOR PROJECT EVALUATION

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>A. CA</td>
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<tr>
<td>Attendance</td>
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<tr>
<td>Work progress</td>
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<tr>
<td>Discussion</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>B. ESA</td>
<td></td>
</tr>
<tr>
<td>Project Content</td>
<td>50</td>
</tr>
<tr>
<td>Project presentation OR Viva Voce on Project</td>
<td>50</td>
</tr>
<tr>
<td>Total Marks for Project (CA + ESA)</td>
<td>150</td>
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III. SCHEME OF EXAMINATION PATTERN OF THE COURSE

<table>
<thead>
<tr>
<th>Total Number of Hours /Week</th>
<th>25</th>
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<tbody>
<tr>
<td>One hour (period) for each subject and keep one hour for tutorial, seminar, discussions etc.</td>
<td></td>
</tr>
<tr>
<td>Number of theory papers/semester and duration</td>
<td>3 (5 hrs each)</td>
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<tr>
<td>Number of Lab /Practicals</td>
<td>2 (5 hrs each)</td>
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<tr>
<td>Project</td>
<td>10 hours</td>
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</table>

EXAMINATION AND EVALUATION

<table>
<thead>
<tr>
<th>Examination</th>
<th>CA</th>
<th>ESA</th>
<th>Total</th>
<th>Components of CA</th>
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<tbody>
<tr>
<td>Theory</td>
<td>25</td>
<td>75</td>
<td>100</td>
<td>Attendence 5</td>
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<td></td>
<td></td>
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<td>Seminar 5</td>
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<td>Assignments 5</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Test 10</td>
</tr>
<tr>
<td>Lab/Practical</td>
<td>25</td>
<td>75</td>
<td>100</td>
<td>Attendence 5</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Test 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Viva 5</td>
</tr>
</tbody>
</table>

No. of seminars One seminar/paper/student/semester
No. of assignments One assignment/paper/student/semester
Tutorial hour May be utilized for seminar and discussion

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.

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).

<table>
<thead>
<tr>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Content 50</td>
</tr>
<tr>
<td>Project presentation OR Viva Voce on Project 50</td>
</tr>
<tr>
<td>C A 50</td>
</tr>
<tr>
<td>Maximum marks (including CA) 150</td>
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</tbody>
</table>
4. DETAILED SYLLABUS

SEMIESTER I

BT 101 Cell Biology and Genetics

Aim
- 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 issues of 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

Cell Biology

Module 1

Module 2
3. Tissues- major types of plant tissues- simple tissue, complex tissues and tissue systems. Animal tissues- major types of tissues. Organs and organ systems


Module 3


Genetics

Module 4


Module 5


Module 6


References

1. Genetics AVSS Sambamoorthy Narosa, New Delhi

2. Principles of genetics DP Snustad, MJ Simmons JB Jenkins John Wiley

3. Genetics PK Gupta Rastogi, Meerut

4. Cell & Molecular Biology PK Gupta Rastogi, Meerut

5. Genetics PJ Russell Benjamin Cummings

6. The science of genetics AG Atherly, JR Girton, JF Mc Donald Harcourt Brace College Publishers New York


8. The cell –a molecular approach GM cooper Sinauer Associates Inc, Massachusetts

Semester I
BT 102 Biochemistry

Aim
- To give an introduction about the basic biochemistry related to the biological molecules, their diversity and biosynthesis, degradation and role in the biological systems.
- 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 in various 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 organization into 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 roles in biological systems

Course Content
Module 1
Carbohydrates- Monosaccharides-classification and structure, Isomerism in monosaccharides, Disaccharides- mclassification and types of disaccharides, its biological significance and functions, Oligosaccharides-hetero-oligosaccharides and homo-oligosaccharides, Polysaccharides- classification- hetero-polysaccharides, and homo-polysaccharides, storage polysaccharides and structural polysaccharides.

Module 2
Proteins- classification of proteins, building units of proteins- Amino acids- structure, properties and function, classification of Amino acids, peptide bonds, ramachandran plot, oligo peptides polypeptides, Structure of proteins- primary, secondary and tertiary structures, quaternary structures, supra-secondary structures- motifs and domains,

Module 3

Module 4
3. ETS and bioenergetics of cellular respiration. Redox reactions, standard oxidation reduction potential, mitochondrial electron transport chain, Oxidative phosphorylation, structure of ATP synthase, chemiosmotic hypothesis
4. Metabolism of Lipids- Oxidation of lipids. Beta-oxidation, Biosynthesis of lipids, Ketone bodies

Module 5
6. Metabolism of Nucleotides –biosynthesis, degradation and regulation of nucleotides and related molecules. Energy compounds and its biosynthesis- ATP, NAD, NADP, FAD, Creatin phosphates
7. Secondary metabolism- classification and role of secondary metabolites of plants and microbes - Role of secondary metabolites
8. Metabolic network - Interrelationship of metabolisms Krebs cycle, amino acid synthesis,

Module 6

References

1. Harpers Biochemistry RK Murray, DK Grammer, PA Mayes MC Graw Hill USA VW Rodwell
2. Text Book of Biochemistry DM Vasudevbvan and Sreekumari Jaypee Brothers Medical Publishers New Delhi
3. Biochemistry U Satyanaryana Becks & Allied Kolkotta
4. A text book of plant Physiology and Biochemistry SK Verma S Chand New Delhi
5. Instant notes Biochemistry Hames, Hooper & Houghton VIVA books Pvt ltd, N. Delhi
6. Biochemistry Stryer, Jermy, Berg Freeman Newyork
7. Biochemistry Voet & Voet Wiely & Sons
9. Bioorganic chemistry HR Hortan, LA Moran, RS Ochs Prentice Hall USA
10. Environmental Biochemistry CP Jrasa Saup & Sons N Delhi
11. Biochemistry of Green plants DW Krogman Prentice Hall USA
13. Principles of Biochemistry AL LEHINGER, DL NELSON & COX Worth publishers NY

Online resources:
Authentic Web based resources like NCBI, PubMed, Science direct etc.
SEMESTER I

BT 103  BIOPHYSICS AND BIOSTATISTICS

Aim

- To equip the students with knowledge of thermodynamics of biological system and bioenergetics. Also to give an introduction to the biophysical aspects of various biological physiological activities at cellular and molecular level.
- To get introduced to the fields of various instruments used in biotechnology—including the basic principle - application and working.
- To help students to have an idea on basic mathematical problems and calculations needed in Biotechnology aspects

Course Objective

- The course is designed to train the students in biophysics and bioinstrumentation techniques essential for the understanding of life sciences and biotechnology, for which basic knowledge in physics or Biophysics at graduate level is expected and is necessary for the proper understanding of this topic at postgraduate level.
- This course consists of basics of thermodynamics as applicable in the field of Biological systems- bio energetics- energy trapping and its transactions methods-biophysics of various biological activities.
- The course helps to attain knowledge on mathematical calculations and problems helping in competitive exams.

Course outcome

On completion of the course,
- The students will develop the capability to demonstrate a multiscale nature of biophysics by exploring macroscopic and microscopic applications.
- The students will learn to approach a research problem logically and will be able to do statistical analyses in research.

Course Content

BIOPHYSICS
Module 1
1. Structure of atoms, molecule, Physico-chemical forces- ions, ionic bonds, covalent bonds, Hydrogen bonds, vander Wals forces, hydrophobic interactions, polar and non-polar molecules

Module 2
3. Concept of Energy- matter and energy, thermodynamics- entropy, enthalpy Bioenergetics- life as an energy system- major energy transformations mediated by life- Photochemical reaction of photosynthesis- Oxidative photophosphorylation, ATP, GTP, Creatin phosphate, muscle contraction, generation and transmission of nerve impulse.
4. Biophysics of Muscle movement, Impulse generation and impulse transmission

Module 3

Module 4
8. Centrifugation - Principle and application of various types of centrifugation-sedimentation coefficient, Svedberg unit.
9. Chromatography- Principle and application, Classification of Chromatography Adsorption and Partition chromatography, Paper Chromatography, TLC, Liquid Chromatography - ion exchange chromatography, Gel permeation chromatography, affinity chromatography, HPLC and GC.

Module 5
10. Electrochemical instruments - pH meter and Mass spectrometry.
12. Molecular hybridization Techniques- southern blotting. Northern blotting and Western blotting, Electro blotting
13. Principle and applications of tracer technique in biology: Radioactive Isotopes and half life of isotopes; Effect of radiation on biological system; autoradiography; radiation dosimetry; scintillation counting, safety aspects

BIOSTATISTICS
Module 6
1. General principles, sampling, sampling errors
2. Mean, Median, Mode, standard deviation and standard error
5. Graphs and diagrams - Bar diagrams, pie chart. Histograms and frequency curves

References
1. Principles of Biochemistry  
   AL LEHINGER, DL NELSON & COX  
   Worh publishers NY
2. A text book of Biophysics  
   RN Roy  
   New Central book Agency Kolkotta
3. Biophysics  
   Dr. S Thiravia Raj  
   Saras Publications Tamil Nadu
4. Principles of Biostatistics  
   M Paggana & Gaurveeau  
   Duxbery Australia
5. Essentials of Biophysics  
   P Naryananan  
   New age International PVt ltdN. Delhi
6. Biochemistry  
   Stryer, Jermy, Berg  
   Freeman Newyork
7. Principles of Biochemistry  
   GL Zubay, WW Parson & DE Vance  
   Wm C Brown Publishers Australia
8. Harpers Biochemistry  
   RK Murray, DK Grammer, PA Mayes VW Rodwell  
   MC Graw Hill USA
9. Basic Evaluation methods  
   Breakwell and L Millwart  
   Uty. Press Hyderabad
10. Biophysics An Introduction  
    RMJ Cotterill  
    John Wiely and Sons NYork
11. Basic Biophysics for Biotechnologist  
    M Daniel  
    Agrobios Jodhpur

Online resources:
Authentic Web based resources like NCBI, PubMed, Science direct etc.
SEMESTER I
PRACTICAL
BT 104 BIOCHEMISTRY LAB

Aim

- To train students on the basic techniques of biochemistry

Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains how to prepare buffers and reagents, various methods of estimation of proteins, enzyme extraction and purification

Course Outcomes

At the end of this course,

- The students will equip themselves with the basic biochemistry techniques which can later applied for their laboratory research and also for many other industrial researches.

Course Content

Laboratory techniques

1. Titration curve of acetic acid and Glycine
2. Titration of acetic acid to determine the pKa value.
3. Preparation of buffer of a known pH (phosphate buffer, acetate buffer)
4. Determination of isoelectric pH of a given amino acid.
6. Enzyme extraction and purification - ammonium sulphate precipitation, protein purification by Gel permeation chromatography, ion exchange chromatography
SEMESTER I
BT 105 CELL BIOLOGY, GENETICS AND BIOSTATISTICS LAB

Aim

- To train students on the basic techniques of cell biology and Genetics
- To make aware of the students a basic knowledge on computing biological problems statistically.

Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains how to make slides for cytological examinations, other histochemical analysis, solving problems based on genetics and statistical analysis.

Course Outcomes

At the end of this course,

- The students will equip themselves with the basic cytology aspects to be performed in the laboratory.
- The students will be able to analyze genetic problems and will be able to approach a research problem statistically.

Course Content

Laboratory techniques

1. Cytological and Histological techniques- determination of number of viable cells in a cell population
4. Microtomy and histochemical techniques - Preparation of thin sections of tissues and developing embryos and staining with tissue specific stains
5. Isolation and estimation of chloroplasts
6. Solving the problems of genetics
7. Calculation of mean, standard deviation, standard error and student's t-test
SEMESTER II

BT 201 BASIC MICROBIOLOGY

Aim
- 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

Module 1
1. Ultra structure of bacteria, fungi, algae, protozoa and viruses.
2. Classification of microbes, molecular taxonomy, Artificial and Natural systems of classification, Traditional characters used for the classification of Microorganisms.

Module 2
4. Morphology and Fine structure of bacteria, cultivation of Bacteria, growth of bacteria – growth curve, Reproduction and growth, Pure culture and cultural characteristics. Microbial techniques, Staining techniques

Module 3
5. Characteristic features of eubacteria, archae, fungi- Molds and Yeasts, algae, protozoa and viruses- Viruses of bacteria, Viruses of plants and animals.
Module 4
7. Microbial nutrition. Growth, Microbial metabolism and energy production, mr
8. Microbial interaction (human microbe interaction, normal biota of the human body, plant microbe interaction).

Module 5
9. Control of Microorganisms- Physical chemical methods, Disinfectants, Antibiotics and mechanisms of antibiosis.
10. Microbial physiology and microbial genetics.

Module 6
11. Microbial ecology and Biogeochemical cycles
12. Environmental microbiology

References

1. A text book of Microbiology
   P Chakraborthy
   New central Book agency culcutta
2. Modern Concepts of Microbiology
   H.D. Kumar, S. Kumar
   Vikas Publishing House, Pvt. Ltd. New Delhi
3. Advances in Microbial Biotechnology
   J.P. Tewari, T.N. Lakhanpal, J. Singh, R. Gupta, B.P. chamola
   A.P.H. Publishing Corporation, New Delhi
4. Instant notes in Microbiology
   J. Nicklin, K. Graeme- cook, T. Paget & R. Killington
   Viva books Pvt. Ltd., New Delhi
5. Principles of Microbiology
   R.M. Atlas
   Mc Giraw Hill, NY
6. Introductory Microbiology
   J. Heritage, E.G.V. Evans, R.A. Killington
   Cambridge University Press
7. Human Parasitology
   B.J. Bogitish , T.C. Cheng
   Academic Press, NY
8. Microbiology
   Pelczar, Chan, Krieg, Tala Mc. GrawHill
   Publishing Company, New Delhi
9. Microbiology- An Introduction
   G.J. Tortora, B.R. Funke, C.L. Case
   Wesley Longman, NY
10. Microbiology
    L.M. Prescott, J.P. Harley, D.A. Klein
    Wm. C. Brown Publishers, Australia

Online resources:
Authentic Web based resources like NCBI, PubMed, Science direct etc.
SEMESTER II

BT 202 MOLECULAR BIOLOGY

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.

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

Module 1

1. **Nucleic acids** - DNA and RNA structure and functions, DNA as genetic material. Griffith, Avery- McCarty-MCLEod, Hershy- Chase, Franklin Conrat Experiments

2. **DNA Structure**: Chemistry of DNA, Forces stabilizing DNA structure, Helix parameters, Forms of DNA (A,B,C,D,T and Z), Watson – Crick and Hoogsteen base pairing, Physical Properties of ds DNA (UV absorption spectra Denaturation and renaturation ), Chemical that react with DNA.

Module 2


4. **Organization of DNA into chromosomes**: Packaging of DNA and organization of chromosome in bacteria and eukaryotic cells; packaging of DNA in eukaryotic nucleosome and chromatin condensation assembly of nucleosomes upon replication. Chromatin modification and genome expression.
Module 3


6. DNA – Protein Interactions: General features interaction of Helix- turn Helix motif, B sheet, Zn- DNA binding domain etc with DNA.

Module 4


Module 5


9. Translation- Synthesis and Processing of Proteome: Structure and role of tRNA in protein synthesis, ribosome structure, basic feature of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes), Post translational processing of protein (protein folding, processing by proteolytic cleavage, processing by chemical modification, inteins). Protein degradation.

Module 6

10. Regulation of Gene expression in prokaryotes and eukaryotes: Positive and negative regulation. lac-, ara-, his- and trp- operon regulation; antitermination, global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

11. DNA- transposable elements- types of transposable elements, its importance in variation and evolution. Possible origin of virus, Oncogenes.

References

1. Advanced Molecular H.S. Bhamrah Viva Books, Pvt. Ltd., New
<table>
<thead>
<tr>
<th>#</th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher/Location</th>
</tr>
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<tbody>
<tr>
<td>2</td>
<td>Plant Biochemistry and Molecular Biology</td>
<td>Hans, Walter Held</td>
<td>Delhi</td>
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<tr>
<td>3</td>
<td>Molecular Cell Biology</td>
<td>H.S. Bramrah</td>
<td>Oxford, NY</td>
</tr>
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<td>5</td>
<td>Apoptosis and Cancer chemotherapy</td>
<td>John A. Hickman &amp; Caroline Dive</td>
<td>Humana Press, NJ</td>
</tr>
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<td>6</td>
<td>Molecular Modelling Principles and Application</td>
<td>Andrew R. Leach</td>
<td>Longmann, England</td>
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<td>7</td>
<td>PCR 3</td>
<td>C. Simon Herrington &amp; John O’Leary</td>
<td>Oxford, NY</td>
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<td>8</td>
<td>Essential Molecular Biology</td>
<td>A Practical Approach, T.A. Brown</td>
<td>Oxford, NY</td>
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<td>9</td>
<td>Cell &amp; Molecular Biology</td>
<td>Concepts &amp; Experiments</td>
<td>NY</td>
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<td>Gerald Karp, John Wiley &amp; Sons</td>
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<td>10</td>
<td>Gene VIII</td>
<td>Benjamin Lemin</td>
<td>Oxford University Press</td>
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**Online resources:**
Authentic Web based resources like NCBI, PubMed, Science direct etc.
### SEMESTER II

#### BT 203  MATHEMATICS, COMPUTER SCIENCE AND BIOINFORMATICS

**Aim**
- To understand the essential mathematics needed in Biology learning.
- To basic computational analysis and its applications
- To make the students understand what is Bioinformatics and Computational Biology-
- To make them aware the application of various computational tools in Bioinformatics and related subjects.
- To introduce to the world of various databases and its importance in biological research.

**Course Objectives**
- The introductory mathematics is aimed to understand elementary mathematics needed for study of Biochemistry, biophysics, statistics and genetics.
- The course explains the applications of computer in biotechnology and statistical analysis of experimental data.
- The course gives an introduction on the origin and evolution of Bioinformatics and its importance in Biotechnology, Genomics and Proteomics.
- Various methods of genome analysis and proteome analysis is also described.
- It gives an outline on the various bioinformatics and computational tools used in analyzing protein, gene and genome data bases.

**Course outcome**

At the end of the course,
- The student will be aware with a basic knowledge of modern molecular biology and genomics.
- The student will understand how theoretical approaches can be used to model and analyze complex biological systems.

**Course Content**

**MATHEMATICS**

**Module 1**

1. **Algebra**
   - Complex numbers; algebra of complex numbers; geometrical representation; real and imaginary parts; modulus and arguments of a complex number; conjugate of a complex number- triangle inequality; club roots of unity
2. **Logarithms**

Properties of logarithms- Common and Natural logarithms- Characteristics and Mantissa

3. **Progression** - Arithmetic progression- Geometrical progression- harmonic progression-

4. **Quadratic equations and Expressions**

Theory of quadratic equations- relationship between their roots and coefficients; quadratic expressions; linear and quadratic inequations in one variable;

5. **Binomial Theorem**

Binomial expressions- Permutations and Combinations

6. **Coordinate Geometry**

Basic concepts- straight lines- rectangular Cartesian coordinates- distance between two points- and area of a triangle- Locus- equation of straight lines in various forms- angle between two given lines- conditions for two lines to be parallel or perpendicular- distance of a point from a line- bisectors of angles- lines through the point of intersection of two given lines- concurrency of lines; Circles- equation of circle in various forms- Circles through the points of intersection of two circles- or a circle and straight lines- parametric representation of a circle.

**Set** - Theory and problems

**Trigonometry** - Trigonometric ratios and Identities- Trigonometrical equations and their solutions- Inverse circular functions

7. **Calculus**

Functions- into- onto and one-to-one functions; sum- difference- product and quotient of two functions; composit functions- inverse of a function- constant absolute value- greatest integer- polynomial - rational- trigonometric- exponential and logarithmic functions.

**COMPUTER SCIENCE**

**Module 2**

1. Computers- its application in biology- Basics
2. Basics of computer- Parts of a computer- hardware and software, operating systems- standard operating systems- MS DOS, Windows- Linux, Unix

**Module 3**

3. Programming - algorithms, binary language. Elements of programming languages- Python and Perl
4. Standard software packages- Sigmaplot etc
5. Databases, Internet, Searching databases. Portals

**BIOINFORMATICS**

**Module 4**

1. **History and development of Bioinformatics, Database**: Various types of databases and its importance Use of databases in biology, - sequence databases, structural databases. sequence Analysis- proteins and nucleic acids, structural comparisons, genome projects
2. Sequence alignment—various methods, DNA sequence annotation and various programmes for sequence comparison and analysis.

Module 5

3. **Proteomics**: Sequence analysis of proteins, and nucleic acids, tools and techniques in proteomics, protein-protein interactions; post translational modification, methods of 2D structure predictions.

4. **Genomics**: Structural genomics—sequence analysis software like GCG etc, Functional genomics—Gene finder, genetic mapping, and linkage analysis, application of genetic maps, human genome project.

Module 6

5. **Information theory and biology**: Entropy, Shannon’s formula, Divergence from equiprobability and independence, mark of chains, ergodic processes, redundancy.

References

1. Bioinformatics- Concepts, skills and Application
   S.C. Rastogi, N. Mendiratta, P. Rastogi, CBS Publishers and Distributors, New Delhi
2. Bioinformatics
   M.M. Ranga, Agrobios, Jodhpur
3. A Handbook of Bioinformatics
   N. Yadav, Anmol Publication Pvt. Ltd, New Delhi
4. Fundamentals of Bioinformatics
   I.A. Khan and A. Khanum, Ukaaz Publications, Andra Pradesh
5. Bioinformatics
   The Machine Learning Approach
   S.R. Pennington, M.J. Dunn, The MIT Press, USA
6. Proteomics
   Dov Stekel, Viva Books Pvt. Ltd., New Delhi
7. Microarray Bioinformatics
   Dan Gusfield, Cambridge University Press
8. Alogarithms on strings, trees, and sequences—Computer Science and Computational Biology
   Dan Gusfield, Cambridge University Press
9. Analysis of DNA Microarray data
   Steen Knudsen, Wiley Liss NY
10. Mathematical models in Biology- An Introduction
    E.S. Allman, J.A. Rhodes, Cambridge University Press
11. Bioinformatics- Sequence, structure and databanks
    D. Higgins, W. Taylor, Oxford University Press
12. Bioinformatics for Geneticists
    M.R. Barnes, I.C. Gray, Wiley USA
13. Experimental Design and Data Analysis for Biologist
    G.P. Quinn, M.J. Keough, Cambridge University Press

Online resources:
Authentic Web based resources like NCBI, PubMed, Science direct etc.
Aim

- To train students on the basic techniques of microbiology

Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains the isolation and screening techniques of microbes and quality analysis of water.

Course outcome

On completion of the course candidates will achieve the following objectives,

- A detailed knowledge of structure, function and application of microorganisms.
- Skills in handling microorganisms in the laboratory.
- An understanding of applications of microorganisms in the industry, health-care, environmental protection, food agriculture and research.

Course Content

1. Isolation of bacteria from soil, water and air
2. Gram staining of bacteria
3. Microbial analysis of drinking water by MPN
4. Determination of dissolved oxygen of water
5. Estimation of Biological Oxygen demand (BOD) of wastewater or factory effluents, Determination of chemical oxygen demand (COD) of waste water
7. Study of bacterial flora of environment – Laboratories, soil, water, fermented foods and spoiled foods, commercial samples of water and drinks etc,
8. Bacterial growth - growth curve
SEMESTER II

BT 205 MOLECULAR BIOLOGY LAB

Aim
- To train students on the basic techniques of Molecular biology

Course Objectives
- The course gives hands on training on the practical experiments and techniques in molecular biology

Course outcome
At the end of the course,
- The students will be made proficient in basic molecular biology skills and molecular biology laboratory techniques

Course Content

Laboratory techniques

1. Preparation of Buffers and solution for Molecular biology- TE buffer
2. Isolation of genomic DNA Preparation of Plasmid from known bacteria by alkaline lysis method- Preparation of solutions needed for the experiment
3. Estimation of DNA and purity checking by UV spectrophotometer
4. Agarose gel electrophoresis of plasmid and genomic DNA
5. Restriction analysis of plasmid DNA and evaluation of restriction sites
SEMESTER III

BT 301 PLANT BIOTECHNOLOGY

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

Course Content

Module 1

1. Plant cell - Plant cell and tissue and organ culture, principle - historical background
2. Plant tissue culture practical application and conventional plant breeding
3. Tissue culture media - composition and preparation- solid media and liquid media
4. Micro propagation of plants- initiation and maintenance of callus and suspension cultures- single cell clones.

Module 2

5. Organogenesis and somatic embryogenesis in plant tissue culture- development of whole -plants - Root formation, transfer of plant lets to the soil, hardening
6. Advantages of micropropagation in agriculture and horticulture
7. Shoot-tip meristem culture - raising virus free plants for rapid clonal multiplication of agricultural and horticultural plants

Module 3

8. Cell suspension cultures and its application in the production of secondary metabolites and single cell clones
9. Embryo culture and embryo rescue
10. Protoplast technology - protoplast isolation, fusion, protoplast culture, somatic hybridization, selection of somatic hybrid cells, culturing and development of somatic hybrid plants, symmetric and asymmetric hybrids, cybrids - Application of somatic hybridization plant improvement and breeding
Module 4

11. Somaclonal variation - significance in plant breeding
12. Production of haploid plants - anther and pollen culture, homozygous plants and its importance in genetics and plant breeding
13. Cryopreservation of plant cells, tissues and organs for germplasm conservation

Module 5

15. *Agrobacterium* mediated genetic engineering of plants, *Agrobacterium tumifaciens*, infection and molecular mechanism of tumor formation, Ti plasmids and RI plasmids, binary vectors, genetic markers, reporter genes and its application in genetic engineering,
16. Other methods of plant genetic transformation

Module 6

17. Metabolic engineering, Molecular plant breeding
18. Application of plant genetic engineering in agriculture, forestry and horticulture and industry, industrial application of transgenic plants, transgenic plants as bioreactors Chloroplast transformation.

References

2. Role of Biotechnology in Medicinal and Aromatic Plants  Irfan A. Khan and Atiya Khanum  Ukaaz Publications, Hyderabad
3. Plant Tissue Culture  Kalyan Kumar D.  New Central Book Agency (P) Ltd, Calcutta
5. Biotechnology  B.D. Sigh  Kalyan Publishers New Delhi

Online resources

Authentic Web based resources like NCBI, PubMed, Science direct etc.
SEMESTER III
BT 302 ANIMAL BIOTECHNOLOGY

Aim
- To give an idea of animal tissue culture
- To introduce the various genetic and transformation techniques in animals 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

Course Content
Module 1
1. Animal cell - structure and organization, animal physiology.

Module 2
3. Types of animal cell culture- primary and secondary cell culture, development cell lines or established cultures.
4. Biological characterization of cell cultures, contact inhibition, cell transformation, cancer cells, indefinite cell lines.
6. Screening of cytotoxic compounds and its importance.

Module 3
7. Basic techniques of mammalian cell culture, methods of sub culturing.
8. Scaling up of cell cultures, bioreactors for animal cell cultures.

Module 4
9. Application of animal cell culture- industrial application, and clinical application-
production. Stem cell research- types of stem cells, application of stem cells.
10. Somatic cell genetics, animal cloning and micromanipulation, apoptosis.

Module 5

11. Genetic engineering of farm animals - cloning vectors, viral vectors.
13. Transgenic animals and its uses.

Module 6

14. Gene therapy- methods of gene therapy
15. Ethical issues in animal biotechnology.

References

2. Biotechnology- Fundamentals and Applications  S.S. Purohit & S.KMathur  Agrobotanica, India
3. Agricultural Biotechnology  S.S Purohit  Agrobotanica, India
4. Fungi in Biotechnology  Anil Prakash  CBS Publishers, New Delhi
   University Hydrabad

Online resources
Authentic Web based resources like NCBI, PubMed, Science direct etc.
SEMESTER III

BT 303 GENETIC ENGINEERING

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 basic and applied fields of life science researches.

Course content

Module 1

1. Genetic engineering as tool in biotechnology.
4. DNA ligase, acid phosphatase and other DNA modifying enzymes.
5. Restriction enzymes - restriction analysis of genomes - restriction sites - cloning of blunt end DNA, adapters.

Module 2

8. DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence in situ hybridization, DNA fingerprinting, chromosome walking.

Module 3

9. Techniques for gene expression: Northern and Western blotting, Gel retardation technique, DNA footprinting, Primer extension, S1 mapping, Reporter assays.
10. DNA sequencing and sequence assembly. Maxam-Gilbert’s and Sanger’s methods, techniques of in vitro mutagenesis, Site-directed mutagenesis, gene replacement and gene targeting, Shot gun sequencing, chemical synthesis of oligonucleotides; sequencing strategies for large genomes.

11. PCR- Principle and applications, Various types PCR.

Module 4

12. DNA mapping and DNA fingerprinting: Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting.

Module 5

15. Genetic engineering of eukaryotes- genetic engineering of plants and animals- vectors used for transformations - shuttle vectors.
16. Protein engineering Metabolic Engineering, site directed mutagenesis.
18. Transgenic and gene knockout technologies to study molecular biology, chromosome engineering.

Module 6

19. Molecular markers. DNA based and PCR - based markers, RFLP, RAPD, RLGS, AFLP STS, EST, SSCP, VNTR, Multi locus probes, Microsatellites and minisatellites, STMS, DAF, AP-PCR.
20. Gene therapy.

References

1. Biotechnology -Fundamentals and Applications S.S. Purohit & S.K Mathur Agrobotanica , India
2. Agricultural Biotechnology S.S. Purohit Agrobotanica , India
5. Text Book of Biotechnology C.R. Chhatwal Anmol Publications pvt Ltd, New Delhi

Online resources
Authentic Web based resources like NCBI, PubMed, Science direct etc.
SEMESTER III
Practicals

BT 304 PLANT BIOTECHNOLOGY/ANIMAL BIOTECHNOLOGY LAB

Aim
- To train students on basic and plant and animal cell and tissue culture techniques.

Course Objectives
- The course gives hands on experience in the tissue culture of plant and animal cells.

Course outcome
At the end of the course,
- The student will be well versed with the theoretical as well as practical background knowledge in plant and animal sciences need for understanding plant and animal biotechnology.
- The will gain working knowledge of laboratory techniques used in plant biotechnology.

Course Content
Laboratory techniques
1. Preparation tissue culture Media, methods surface sterilization of explants
2. Stock preparation and calculations
3. Organ culture. Induction of callus, callus propagation, Organogenesis and transfer of plantlets to soil
4. Protoplast isolation, cell counting viability studies
5. Culturing of protoplast and regeneration of plants/tissues from protoplasts
6. Production of haploids by anther culture, cytological examination of chromosomes in regenerated plants
7. Estimation of phenols from callus cultures
8. Preparation media for animal cell culture, sterilization by membrane filtration
9. Cell counting and viability checking by vital staining Sub culturing
10. Cytological examination of cultured cells
Aim
To introduce the students to the concepts and practice of genetic engineering.

Course Objectives
- To understand the basics of genetic engineering.
- To learn different methodologies in genetic engineering.
- To enable students to design a cloning experiment.

Course Outcome
At the end of the course,
- Students obtain a thorough knowledge in basic Molecular biology and genetic engineering methods practiced in research.

Course content
Laboratory techniques
1. Isolation of plasmids and purification
2. Electrophoretic separation of plasmid by agarose gel electrophoresis
3. Quantification and quality checking by UV spectrophometry and electrophoresis
4. Restriction analysis and construction of restriction map of plasmid
5. Preparation of competent *E.coli* cells, Construction of recombinant plasmid
6. Genetic Transformation of *E.coli* with a recombinant plasmid
7. Screening transformed cells for the presence of recombinant plasmid and gene
8. Transformation frequency and cloning efficiency
SEMESTER IV

BT 401 IMMUNOLOGY

Aim

- To get introduced to the principles of immune systems of animals.
- To introduce to the world of molecular and diagnostic techniques of immunology, immunotechniques 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 immunotechnology
- 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.

Course Content

Module 1
2. Immunoglobulins- structure, distribution and function.

Module 2
3. Lymphoid tissues- ontogeny and physiology of immune system- origin and development, differentiation of lymphocytes.

Module 3

Module 4
8. Cytokines in immunity, Interleukines and their role.

**Module 5**

9. Genetic Immuno regulations. Introduction to tumour immunology, autoimmune disorders.
10. Use of transgenic animals in immunology, experimental immunology, vaccine, development, stem cell technology. Immunodiagnostics.

**Module 6**

11. Hybridoma technology and monoclonal antibody production, application and their uses. Cloning for vaccine development

**References**

1. Immunology Joshi. Osma Agro Botanica N.Delhi
2. Instant notes in Immunology Lydyard, helean, Fanger Viva Books N.Delhi
3. An introduction to Immunology CV Rao Narosa N.Delhi
4. Immunology Janus Kuby Freeman NY
5. Principles of cellular and molecular Immunology Jonathan Austin, Kathryn Wood Oxford NY
6. Immunology Goldsby, Kindt, Osborne, Janus Kuby Freeman NY
7. Medical Immunology Parslow, Stites, Tera, Imboden Mc Graw Hill NY

**Online resources**

Authentic Web based resources like NCBI, PubMed, Science direct etc.

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**SEMESTER IV**

**BT 402 ENVIRONMENTAL BIOTECHNOLOGY**
Aim
- To give an introduction to the various aspects of environmental biotechnology to students.

Course Objectives
- The course explains the application of biotechnology in environment.

Course outcome
At the end of the course the students will,
- Obtain knowledge on basic principles and technologies of decontamination of persistent organic pollutants (dangerous contaminants of the environment) mainly by means of the biological approaches i.e. using bioremediation etc.
- The students will know about the principles and techniques underpinning the application of biosciences to the environment

Course Content

Module 1
1. Issues and scopes of environmental biotechnology.

Module 2
3. Biological wastewater treatment- Waste water characterization: COD, BOD,
4. Inorganic constituents, solids, biological components.
5. Principles and aims of biological wastewater treatment processes,

Module 3
7. Suspended growth technologies: Activated sludge, oxidation ditches, waste stabilization ponds etc. Fixed film technologies: Trickling filters, rotating biological contactors, fluidized bed etc.

Module 4
9. Environmental problems and treatment of industrial waste waters: Distillery, tannery, paper pulp etc.
10. Toxicity testing in waste water treatment plants.

Module 5
12. Biodegradation of organic pollutants:
Mechanisms and factors affecting biodegradation. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides.


**Module 6**


15. Microbes in the environment- Biofilms and its relevance in microbial survival, its effect in the environment.

16. Microbial Insecticides: Biopesticides. Bacterial, fungal and viral insecticides

**References**

1. Biotechnology – Fundamentals and application
   SS Purohit
   SK Mathur
   Agrobotanica, India

2. Agricultural Biotechnology
   SS Purohit
   Agrobotanica, India

3. Concepts in Biotechnology
   Balasubraminan, Bryce, Dhramalingam, Jayraman
   UTY Press. Hyderabad

4. Fungi In Biotechnology
   Anil Praksah
   CBS N. Delhi

5. Biotechnology
   BD Singh
   Kalyani Publishers

6. Environmental Biotechnology
   Alan Scragg
   Longman England

7. Biotechnology Unzipped
   EricS grace
   UTY Press. Hyderabad

8. Biotechnology
   JE Smith
   Cambridge UTY Press

**Online resources**
Authentic Web based resources like NCBI, PubMed, Science direct etc.

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**SEMESTER IV**

**BT 403 FOOD AND DAIRY BIOTECHNOLOGY/ BASICS OF BIOPROCESS TECHNOLOGY**
Aim
- To introduce Food and Dairy biotechnology to non-biotechnology students
- To introduce the subject of bioprocess technology in details
- To explain the industrial aspects of Biotechnology for the production of various of industrial products of biological origin.

Course Objectives
- The course explains the role of biotechnology in food and dairy technology.
- It gives details about the conversion of a small scale laboratory process in to a large scale industrial process.
- It also deals with the various important products produced by the bioprocess techniques.

Course Outcome
At the end of the course the students will,
- Get a detailed insight into the industrial processes carrying out in the food and dairy sector as well as how to transfer a small scale laboratory process to a large scale industrial process.

Basics of Bioprocess Technology

Module 1
1. Introduction to Bioprocess Technology – Scaling up of a Bioprocess, Upstream Processing, Downstream Processing,
2. Fermentation- Types of Fermentation, Its significance in Industry, Submerged Fermentation and Solid state fermentation, batch fermentation and continuous fermentation, Chemo stat Fermentation.

Module 2
3. Upstream Processing – Sterilization, Media Components, Cell cultures, its isolation and maintenance, strain improvements –methods of strain improvements, inoculation of microorganisms
4. Upstream Processing – Importance of downstream processing and methods of downstream processing, centrifugation, filtration, precipitation, dialysis, Chromatographic techniques- gel filtration, ion exchange chromatography and affinity chromatography, electrophoresis, capillary electrophoresis, Quality assurance techniques and its importance in marketing.

Module 3
5. Bioreactors - types of bioreactors, factors affecting the design of bioreactors
6. Industrial microorganisms and cultivation of microorganisms in bioreactors, Kinetics
of microbial growth.

7. Culture media sterilization for industrial application. Air in Bioreactors, pH maintenance in bioreactors

Module 4

8. Down stream processing and purification of products
9. Industrial bio-production of chemicals - and antibiotics

Module 5

Food and Dairy Biotechnology

10. Introduction to Food Technology - application of biotechnology in food processing use of food modifying enzymes - amylase, proteases, lipases etc.
11. Elementary idea of canning and packing - sterilization and pasteurization of food products

Module 6

12. Introduction to Food microbiology, Dairy microbiology, Microbial processing of milk and milk products. Sterilization and Pasteurization of milk and dairy products, Fermentation of milk, biochemical and physical changes associated with the process-Industrial processing of milk and production of food products - bread, cheese, butter, ghee and other value added products.

References

1. Modern Concepts in Biotechnology HD Kumar Vikas N. Delhi
2. Food Science Potter & Hotchkins CBS N. Delhi
3. Food Microbiology MR Adams and Moss Panima N. Delhi
4. Food Processing- Biotechnological applications Marwah &Arora Asiatic Publ. N. Delhi
5. Biotechnology JE Smith Cambridge UTY Press

Online resources
Authentic Web based resources like NCBI, PubMed, Science direct etc.
- Project work shall be assigned individually.
- It 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 external examiner appointed by the University for Evaluation.
- The work should be presented before the external examiners at the time of general Viva voce examination.

**BT 405  GENERAL VIVA VICE EXAMINATION**

General viva voce on theoretical and practical aspects based on the courses covered from semester I to IV.