# North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

## Structure of syllabus for

# M. Sc. Part I

# Biotechnology

**[2018-19]**

# M. Sc. Part: I Biotechnology

## Prelude

Biotechnology is a multifaceted subject that comprises many specialized area including, biology, chemistry, physics, engineering, technology etc. Now, biotechnology has pervaded in almost every segment of human life and hence, this subject has been included in curricula. The skilled man power in Biotechnology compels the adoption of thorough knowledge of theoretical concepts and experimental aspects of all fields of biotechnology. The study program in Biotechnology as one of the core subjects is designed to cultivate a scientific attitude and an interest towards the modern areas of biotechnology in particular and life science in general along with the collection and interpretation and presentation of scientific data in proper manner. It will help the students to become critical and curious in their outlook. The content of syllabus have been prepared to accommodate the fundamental aspects as well as advanced developments in various disciplines of Biotechnology and to complement the needs of various applied sectors of Biotechnology.

Besides, the students will be equipped with knowledge in the newer areas of microbial physiology, diversity, biomolecules, basic and diagnostic immunology, molecular biology, analytical tools and biostatistics, bioprocess technology, biochemistry, enzymology, and its application in medicine, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. The syllabus is simplified to accommodate the present and future needs of Biotechnology in research field, industrial sector, and environmental area. Hence, more emphasis on Theory and Practical course in new restructured course is bestowed to impart skill-set essentials to further Biotechnology and build interdisciplinary approach.

**Learning Objectives**
**To apprise the students with:**

- How science works and familiarize biotechnology applications in various fields of human life
- Microbial systematic taxonomy, interactions in ecological niche and sustenance in the environment.
- Types, properties structure, classification, functions, kinetics and of biologically important biomolecules
- Principle, working and applications of various bioanalytical tools and methods used in separation, purification, extraction, and characterization of biomolecules.
- Functions and mechanisms of immune system, basis of Ag-Ab interactions and immune response against various pathogens.
- Knowledge of chemical and molecular processes that occurs in living cell.

**Learning outcome:** After completion of this course, students are expected to understand the:

- Basic and poly-phasic approaches microbial systematic, microbial diversity, Microbial-Host interactions, and ecological role in the environment.
- Physical, chemical, biological properties and kinetics of biomolecules.
- Functions and mechanisms of immune system.
- Various methods used in Microbiology, Biochemistry, Enzymology and Immunology
- Replication machinery and enzymes involved in the process, damage and repair system of DNA.
- Operon system and gene regulation in eukaryotes and protein folding and degradation.
- Concepts of pH, pOH and pKa its biological significance, buffers, Henderson-Hasselbalch equation biological buffer systems and their importance.
- Types of routine and modern chromatography, Electrophoresis, spectrophotometry, radiolabeling and safety handling techniques.
- Bioprocess and the kinetic aspects, types of fermenters developed for specialized applications, extraction and purification of fermentation product, concept of quality process and related documentation,

## Course Structure

**Duration:** The duration of M.Sc. (Biotechnology) degree program shall be TWO years.
**Medium of instruction:** The medium of instruction for the course shall be English.

| Subject Code | Title of the Paper | Duration (Hrs./Wk) | Max. Mark | Exam. Time (Hrs.) |
|---|---|---|---|---|
| **SEMESTER-I (Theory courses)** | | | | |
| **BT-101** | Microbial Physiology and Diversity | 04 | 100 | 03 |
| **BT-102** | Biochemistry | 04 | 100 | 03 |

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|---|---|---|---|---|
| **BT-103** | Immunology | 04 | 100 | 03 |
| **SEMESTER-I (Practical)** | | | | |
| **BT-104** | Methods in Microbiology and Biochemistry | 04+04 | 100 | 06 |
| **BT-105** | Methods in Enzymology and Immunology | 04+04 | 100 | 06 |
| **SEMESTER - II (Theory courses)** | | | | |
| **BT-201** | Molecular Biology | 04 | 100 | 03 |
| **BT-202** | Bioanalytical Tools | 04 | 100 | 03 |
| **BT-203** | Bioprocess Technology | 04 | 100 | 03 |
| **SEMESTER - II (Practical)** | | | | |
| **BT-204** | **BT-204** Methods in Molecular Biology and Biochemistry | 04+04 | 100 | 06 |
| **BT-205** | **BT-205** Methods in Industrial Biotechnology | 04+04 | 100 | 06 |

- Each theory and practical course has to complete in 50 lectures, respectively of 60 min duration,
- Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.
- **Theory examination** (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
  - Question 1 (12 marks): 6 sub-questions, each of 3 marks; answerable in brief and based on entire syllabus, attempt any 4 out of 6 questions.
  - Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4.
  - Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.
- **Internal examination** (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of subjective type questions.
- **Practical Examination**: Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on scheduled date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination
- **Equivalence for M.Sc. (Biotechnology) is given below:**

| **Sr.no** | **Old Syllabus (June 2015- 16) Semester I (Pattern 60:40)** | | **New Syllabus (June 2018-19) Semester I (Pattern 60:40)** |
|---|---|---|---|
| 1 | BT 101- Microbial Physiology and Diversity | | BT 101:Microbial Physiology and Diversity |
| 2 | BT 102- Biomolecules | | BT 102:Biochemistry |
| 3 | BT 103- Immunology | | BT 103:Immunology |
| 4 | BT 104- Lab Course- I | | BT 104:Methods in Microbiology and Biochemistry |
| 5 | BT 105- Lab Course- II | | BT 105:Methods in Enzymology and Immunology |
| **Sr.no** | **Old Syllabus (June 2015-16) Semester II (Pattern 60:40)** | | **New Syllabus (June 2018-19) Semester II (Pattern 60:40)** |
| 1 | **BT-201** Molecular Biology | | **BT-201:** Molecular Biology |
| 2 | **BT-202** Bioinstrumentation & Biostatistics | | **BT-202:** Biophysical Chemistry & Biostatistics |
| 3 | **BT-203** Bioprocess Engineering & Technology | | **BT-203:** Bioprocess Technology |
| 4 | **BT-204** Lab Course- III | | **BT-204:**Methods in Molecular Biology and Biochemistry |
| 5 | **BT-205** Lab Course- IV | | **BT-205** Methods in Industrial Biotechnology |

## BT 101: Microbial Physiology and Diversity

| Unit | Topic | Lectures |
|---|---|---|
| I | **Microbial diversity**<br>• Concept, principles of classifications, numerical and molecular taxonomy<br>• Domain and Kingdom concepts in classification of microorganisms<br>• Criteria for classification; Classification of Bacteria as per Bergey's Manual<br>• Molecular methods of classification: Ribotyping, Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis, (TGGE), Amplified rDNA Restriction Analysis, | **10** |
| II | **Microbial physiology**<br>• Ultrastructure of Archaea (*Methanococcus*), Eubacteria (*E. coli*), Unicellular eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumour viruses with example)<br>• Microbial growth: Batch, fed-batch kinetics, continuous and synchronous growth<br>• Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular eukaryotes and the Extremophiles (example from each group) | **10** |
| III | **Host-microbial interactions**<br>• Microbial interaction: predation, competition, parasitism, mutualism, commensalism<br>• Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants, entophytes and their significance<br>• Microbial communication system; Quorum sensing<br>• Microbial fuel cells | **10** |
| IV | **Microbes in the environment**<br>• Role of microorganisms in natural ecosystem and artificial system<br>• Influence of Microbes on the Earth's Environment<br>• Ecological impacts of microbes<br>• Symbiosis (Nitrogen fixation and ruminant symbiosis)<br>• Microbes and Nutrient cycles | **10** |
| V | **Microbial nutrition**<br>• Classification based on nutrition: Autotrophs and chemotrophs, Phototrophs, Lithotrophs, Organotrophs, Photolithotrophic autotrophs<br>• Mechanisms of nutrient transport in bacteria: passive facilitated, active group translocation, Na/K+ ATPase, Ionophores<br>• Pathways of microbial metabolism: ED, PK, $C_3$ and $C_4$ pathway. | **10** |

**Suggested readings:**


1. Pelczar MJ Jr., Chan ECS and Kreig NR, Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury,Massachusetts, 2006.
3. Crueger and A Crueger, Biotechnology: A Textbook of Industrial Microbiology, Sinaeur Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.
6. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T (1994) Bergey‟s Manual of Systemic Bacteriology 9th Edn. William and Wilkins, Baltimore.


## BT 102: Biochemistry

| Unit | Topic | Lectures |
|---|---|---|
| I | **Carbohydrates and lipids**<br>• Carbohydrate metabolism: glycolytic pathway (EMP, HMP, TCA), gluconeogenesis and its regulation,<br>• Lipids: Biosynthesis of fatty acids, cholesterol biosynthesis, ketone body formation, interconversion of phospholipids | **10** |

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|---|---|---|
| | • Oxidation of fatty acids, α, β and ω types, β-oxidation of fatty acid and its regulation and energetics of β oxidation<br>• Biological functions of fat-soluble vitamins: A, D, E and K.<br>• Water soluble vitamins: coenzymes | |
| **II** | **Nucleic acids and proteins**<br>• Biosynthesis: de novo and salvage pathways, catabolism of purines and pyrimidines<br>• Amino acids: deamination, transamination, transdeamination, decarboxylation, urea cycle, ketogenic and glucogenic amino acids<br>• Conformation of proteins: Primary, secondary, tertiary and quaternary structure, stabilizing bonds, Ramachandran plot, principles of amino acid sequencing,<br>• Metabolism of aromatic amino acids, histidine, cysteine and serine<br>• Protein engineering | **10** |
| **III** | **Bioenergetics**<br>• Mitochondrial respiratory chain: organization of carrier, proton gradient, Iron-sulphur protein and cytochrome,<br>• Reverse ETC, respiratory controls<br>• Oxidative phosphorylation, substrate level phosphorylation,<br>• Uncouplers and inhibitors of ETC,<br>• ATP synthase complex, microsomal ETC,<br>• Partial reduction of oxygen and superoxides. | **10** |
| **IV** | **Enzyme catalysis**<br>• Enzyme kinetics: units of enzyme activity, specific activity of enzyme, method of enzyme activity,<br>• Enzyme specificity, turn over number of enzyme,<br>• Mechanism of enzyme catalysis, serine protease<br>• Unisubstrate and multi-substrate enzyme kinetics, Steady state enzyme kinetics: MM hypothesis, Briggs Haldane hypothesis and LB plot, Eddie-Hofstee and Hanes plot<br>• Coenzyme and cofactors (Structure and function of TPP, PLP, FMN) | **10** |
| **V** | **Enzyme inhibition**<br>• Allosteric enzyme: Symmetric and sequential mode of action,<br>• Enzyme inhibition: Competitive, non-Competitive and uncompetitive inhibition, transition state analogues<br>• Enzyme repression, induction and degradation, Feedback inhibition and feed forward induction,<br>• Enzyme immobilization: Principle, technique and applications<br>• Enzyme engineering | **10** |
| **Suggested readings:** | | |
| 1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.<br>2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.<br>3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002. | | |

## BT 103: Immunology

| Unit | Topic | Lectures |
|---|---|---|
| **I** | **Immune system and immunity**<br>• Components of innate and acquired immunity, Phagocytosis, Complement and Inflammatory responses,<br>• Haematopoiesis, Organs and cells of the immune system, primary and secondary lymphoid organs;<br>• Lymphatic system, Lymphocyte circulation, Lymphocyte homing, Mucosal and Cutaneous associated Lymphoid tissue (MALT&CALT), Mucosal Immunity<br>• Antigens: concept and type of immunogens, haptens, Freund's adjuvant | **10** |
| **II** | **Immune responses**<br>• Immunoglobulin: basic structure, classes and subclasses of immunoglobulin,<br>• Antigenic determinants | **10** |

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| | • Multigene organization of immunoglobulin genes<br>• Basis of self-non-self-discrimination<br>• Kinetics of immune response, memory; B cell maturation, activation and differentiation<br>• Generation of antibody diversity, T-cell maturation, activation and differentiation | |
| **III** | **Antigen-antibody interactions**<br>• Precipitation, agglutination and complement mediated immune reactions<br>• Advanced immunological techniques: ELISPOT assay, immunofluorescence, flow cytometry and immune-electron microscopy, Surface Plasmon Resonance | **10** |
| **IV** | **Immunity and infection**<br>• Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group)<br>• Hypersensitivity: Type I-IV<br>• Autoimmunity and types of autoimmune diseases. | **10** |
| **V** | **Vaccine biology**<br>• Active and passive immunization<br>• Live, killed, attenuated, sub unit vaccines<br>• Vaccine technology: Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines<br>• Antibody genes and antibody engineering: chimeric and hybrid monoclonal antibodies, Catalytic antibodies | **10** |

**Suggested readings**


1. Kuby, RA Goldsby, Thomas J. Kindt, and Barbara, A. Osborne, Immunology, 6th Ed, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, and Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications. 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Goding, Monoclonal antibodies, Academic Press. 1985.


## BT 104: Methods in Microbiology and Biochemistry

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|---|---|
| **1** | Isolation of bacteria by streak plate/ spread plate method and subculture for storage of microorganism |
| **2** | Isolation of Cyanobacteria , moulds and yeasts by enrichment technique |
| **3** | Study of Bacterial growth - Growth curve, |
| **4** | Isolation of microorganism from rhizospheric soil/ root nodules |
| **5** | Demonstration of RAPD/ PFGE |
| **6** | Construction of phylogenetic tree using web tools |
| **7** | Quantitative assay of protein by Lowry/ Biuret method |
| **8** | Quantitative assay of sugar by DNSA method |
| **9** | Quantitative estimation of Fats/Lipids |
| **10** | Quantitative estimation of amino acids by Ninhydrin method |
| **11** | Quantitative estimation of DNA by DPA method |
| **12** | Quantitative estimation RNA by Orcinol method |
| **13** | Titration of amino acid: Glycine |

**Suggested readings:**


1. Prakash Singh (2014) Laboratory Protocols in Applied Life Sciences, CRC Press, ISBN 9781466553149
2. K. Wilson and J. Walker. (2005) Practical Biochemistry: Principles and techniques (6th Edition) by Cambridge University Press, Cambridge
3. Plummer D (2005) An Introduction to Practical Biochemistry by. (3rd Edition) Tata MacGraw Hill Publisher.
4. Ulhas K. Patil and Kalyani Muskan, (2009) Essentials of Biotechnology, Ik international, New Delhi
5. Jayaraman J (2011) Laboratory Manual in Biochemistry. New Age International (P) Ltd., Publishers, New Delhi

## BT 105: Methods in Enzymology and Immunology

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| **1** | Detection of antibody/protein in the biological sample using ELISA/Western blotting. |
| **2** | Determination of enzyme activity and specific activity of the enzyme isolated from plant /animal cell |
| **3** | Determination of turn over number and kinetic parameters (Km and Vmax) for enzyme |
| **4** | Effect of pH and temperature on enzyme activity. |
| **5** | Enzyme immobilization by gel entrapment/cross linking/physical adhesion and determination of enzyme activity of immobilized enzyme. |
| **6** | Blood Film Preparation and identification of cells. |
| **7** | Direct agglutination reaction: determination of human blood group antigens. |
| **8** | Radial immunodiffusion: Ouchterlony test. |
| **9** | Purification of IgG from serum. |
| **10** | Diagnosis of typhoid fever using Widal test. |
| **11** | Rocket immunoelectrophoresis. |
| **12** | Isolation and purification of enzyme from plant cell/animal cell |
| **13** | |

**Suggested readings:**


1. Rodney F. Boyer (2000) Modern experimental biochemistry 3rd Edition, Benjamin Cummings. San-Francisco
2. Prakash Singh (2014) Laboratory Protocols in Applied Life Sciences, CRC Press, London
3. Alfred Brown and Heidi Smith (2014) Benson's Microbiological Applications, Laboratory Manual in General Microbiology, MCGraw Hill Publications, New York
4. W. W. C. Topley and Sir Graham S. Wilson (2010) Topley and Wilson′s Microbiology and Microbial Infections, Wiley Publication


## BT 201: Molecular Biology

| Unit | Topic | Lectures |
|---|---|---|
| **I** | **DNA replication tool**<br>• DNA Structure and Replication: DNA replication machinery in Prokaryotes and eukaryotes, Replication fork.<br>• Enzyme of DNA Replication: DNA Polymerase (I,II,III), primases, ligases, helicases, topoisomerases, gyrases and SSBP.<br>• Models of DNA Replication: theta mode of replication, rolling circle model of replication, unidirectional replication, Bidirectional replication, replication of linear<br>• Regulation of DNA replication and inhibitors of DNA replication. | **10** |
| **II** | **DNA damage and repair**<br>• DNA damage: deamination, oxidative damage, alkylation, pyrimidine dimmers, mechanical and chemical damage<br>• DNA mutations: Spontaneous and inducible and mutagenic agents.<br>• DNA repair pathways: Methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination (Specific and Non specific), mismatch, SOS | **10** |
| **III** | **Transcription**<br>• DNA Transcription: DNA binding proteins, RNA polymerase.<br>• Transcription in prokaryotes: Initiation, elongation and termination.<br>• Transcription in Eukaryotes, Control of transcriptional termination: Attenuation and antitermination,<br>• Inhibitors of transcription.<br>• Post-transcriptional Modification: Poly A tailing, 5'Capping 3' tailing<br>• RNA editing, processing of mRNA, splicing with sutable example, mRNA stability, Different modes of mRNA, tRNA, and rRNA splicing, role of various snRNPs | **10** |
| **IV** | **Translation** | **10** |

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| | • Translation in prokaryotes and eukaryotes: Genetic code, Ribosome structure, General structure of tRNA, activation of tRNA, aminoacylation of tRNA, synthetases (Class I and II), formation of initiation complex, initiation factors and their regulation, elongation and elongation factors,<br>• Role of peptidyl transferase termination of translation release factor.<br>• Translational inhibitors.<br>• Post- translational modification of proteins | |
| **V** | **Gene regulation and protein targeting**<br>• Concept of Operon: Structure and regulation of *lac*, *ara*, *his* and tryptophan operons.<br>• Grgulationof lytic and lysogenic pathway in lamda bacteriophage<br>• **Gene regulation in eukaryotes**: DNA rearrangements, Chromatin modification, Cis-acting site, RNA Silencing<br>• Protein targeting to lysosome,plasma membrane, mitochondria<br>• Protein folding, protein degradation with suitable examples. | **10** |

**Suggested readings:**


6. Gerald Karp (2007) Cell and Molecular Biology: Concepts and Experiments, 5th edition Wiley
7. Lewin B. (2013) Gene XI, Pearson Prentice Hall, Pearson Education, Inc., NT, USA
8. Malacinski GM (2003) Essentials of Molecular Biology, 4th edn., Jones and Batiett, London.
9. Watson JD, Baker JA, Bell SP, Gann A, Lewin M, and Losick R (2004) Molecular Biology of the Gene, Benjamin Cummings- CSHL Press, USA.
10. Brown, TA (1995) Essential Molecular Biology, Vol. I, A Practical Approach, IRL Press, Oxford, UK.
11. Nelson DL and Cox MM (2005) Lehninger's Principles of Biochemistry, 4th edn., McMillan Worth Publ. Inc. NY.
12. Russell, PJ (1998) Genetics, 5th edn, Benjamin-Cummings Publ. Co. Inc., NY
13. Molecular Biology, 5th Edition (2011), Weaver R., McGrew Hill Science. USA
14. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press, India
15. Molecular Biology: Genes to proteins, 4th edition (2011), Burton E Tropp, Jones and Bartlett Learning, USA
16. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
17. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002


## BT 202: Biophysical Chemistry and Biostatistics

| Unit | Topic | Lectures |
|---|---|---|
| **I** | **Fundamentals of biophysical chemistry**<br>• pH, pOH, pKa, Isoelectric pH, Henderson-Hasselbalch equation,<br>• Buffer system, colligative properties. | **6** |
| **II** | **Separation techniques**<br>• Chromatography techniques w.r.t. Theory, Principle and application: Paper Chromatography, Thin Layer Chromatography, Gel Filtration Chromatography, Ion Exchange Chromatography.<br>• Modern chromatography techniques: GLC, HPLC and HPTLC.<br>• Electrophoresis techniques w.r.t. Theory, Principle and application: Agarose gel electrophoresis , SDS-PAGE, Capillary electrophoresis, paper electrophoresis.<br>• Isoelectric focusing. | **12** |
| **III** | **Spectrophotometry**<br>• Spectrophotometry w.r.t. Theory, Principle and application: UV-Visible, Fluroscence, IR, NMR and AAS.<br>• Radio labling technique: Commonly used radio isotopes and their properties, detection and measurment of radioactivity.<br>• Radio lableing of macromolucules, tissue and cell.<br>• Safety handling of radio active material. | **12** |

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| **IV** | **Biostatistics-I**<br>• Introduction to Biostatistics, Common terms, notions and applications.<br>• Statistical population and Sampling methods.<br>• Classification and tabulation of data diagrammatic and graphical presentation, Frequency distribution.<br>• Measures of central value, Measures of variability.<br>• Standard deviation, Standard Error, Range, Mean Deviation, Coefficient of variation, Analysis of variance. | **10** |
| **V** | **Biostatistics-II**<br>• Comparison of means: chi square test, students t test, ANOVA with interpretation of data- introduction to MANOVA- statistical tables and their use - significance test and fixing levels of significance-use of statistical software.<br>• Regression: Basic of regression, regression coefficient, regression analysis: Estimation, testing, prediction, checking and residual analysis.<br>• Design of Experiments, randomization, local control, complimentary Randomized, randomized block design. | **10** |

**Suggested readings:**


1. Upadhyay A, Upadhyay K. and Nath, N (2000) Biophysical Chemistry**,** Himalaya Publisher, Nagpur.
2. Friefelder AD (1993) Physical Biochemistry**,** 2nd Edn. W. H. Freeman and Co., USA.
3. Van Holde KE (1985) Physical Biochemistry, 2nd Edn., Prentice Hall Inc. New Jersey.
4. Skoog DA, Hollier FJ and Nieman IA (1998) Principles of Instrumental Analysis, Harcourt Brace College Publishers, Orlando.
5. Wilson K and Walker J (2000) Practical Biochemistry: Principles and techniques,5th Edn. Cambridge University Press, Cambridge.
6. Willard HH and Merrit Jr LL (1986) Instrumental Methods of Chemical Analysis, CBS Publishers, New Delhi
7. Wilson K and Goulding KH Biologists Guide to Principle and Techniques of Practical Biochemistry,ELBS Publications, London.
8. Mikkelsen SR and Corton E (2004) Bioanalytical Chemistry, Wiley Inter science, New York, USA.
9. Sivasankar B (2005) Bioseparations Principles and Techniques, Prentice Hall of India Pvt Ltd., New Delhi.
10. Bengt Nölting (2009) Methods in Modern Biophysics, 3rd Edn., Springer, Berlin


## BT 203: Bioprocess Technology

| Unit | Topic | Lectures |
|---|---|---|
| **I** | **Introduction to Bioprocess Engineering**<br>• Isolation, preservations and maintenance of industrial strains.<br>• Strain improvement of primary and secondary metabolites with examples-protoplast fusion techniques.<br>• Mutagenesis, Genetic Engineering for Strain Improvement.<br>• Production of recombinant molecules in heterologus system, Preservation of cultures. | **8** |
| **II** | **Bioreactors**<br>• Principle, Kinetics, analysis and application, Bioreactor Designing.<br>• Ideal properties of Bioreactor, Body construction, Agitator, Impeller, Baffles: foam separators, sparger, culture vessel, cooling and heating devices, probes for on-line monitoring, computer control of fermentation process, measurement and control of process.<br>• Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types of distribution of gases. | **10** |
| **III** | **Fermentation Process**<br>• Growth of cultures in the fermenter, Importance of media in fermentation, media formulation and modification, Kinetic of microbial growth and death.<br>• Sterilization: Air sterilization, media sterilization, exhaust air.<br>• Types of sterilization: Batch and Continuous sterilization. | **10** |

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| | • Factors affecting sterilization: Del factor, D and Z value.<br>• Inocula development for yeast, bacterial, mycelial processes, Cascade system, | |
| **IV** | **Down stream process**<br>• Biomass harvesting: Precipitation, Filtration and Centrifugation.<br>• Cell Disruption: Physico machanical and chemical methods.<br>• Product Extraction: Solvent extraction,supercritical fluid extraction, Ultrafiltration, Three phase partition.<br>• Product Purification: Chromatography-Adsorption, Size exclusion, ion exchange, Affinity, Reverse phase and HPLC.<br>• Drying and crystallization. | **12** |
| **V** | **Quality practices**<br>• Concept of SOP, GMP, CGMP, GLP and role of FDA.<br>• Biosafety aspects of handling infectious organisms.<br>• Quality Assurance and Documentation.<br>• Economic objectives of fermentation process<br>• Factors affecting fermentation economics. | **10** |

**Suggested readings:**


1. Stanbury, Peter F.; Whitaker, Allan; Hall, Stephen J. (1994) Principles Of Fermentation Technology, II Edn, Butterworth-Heinemann Publishers.
2. Okafor Nduka (2007) Modern Industrial Microbiology and Biotechnology, Science Publishers, USA.
3. Mukhopadhyay, S.N. (2004) Process Biotechnology Fundamentals, 2nd edn., Viva Books, Mumbai, (ISBN: 81-7649-496-8).
4. Shuler M.L.and Kargi F (2008) Bioprocess Engineering-Basic Concepts, 2ndEdn. Prentice-Hall The Indian Environmental Protection Act (EPA), 1986.
5. Food Safety and Standards act (Government of India), 2006.
6. Lodish, MR (2001) Bioseperation Engineering, Wiley Interscience, NY
7. SreeKrishna, V. (2007) Bioethics and Biosafety in Biotechnology, New Age International (P)Ltd., Publ., Mumbai
8. Goodfrey, T. and Reichelt, JR (1997) Industrial Enzymology, 2nd edn., McMillan Publ. Co., London.
9. Modi, HA (2009) Fermentation Technology (Vol-II), Pointer Publication, Jaipur.


## BT 204: Methods in Molecular Biology and Biochemistry

| | |
|---|---|
| **1** | Isolation of genomic DNA from Bacterial/ Animal/ Plant cell. |
| **2** | Restriction digestion/ Slice fractionation of restricted DNA fragment by Agarose Gel Electrophoresis |
| **3** | Isolation of Plasmid DNA by alkaline lysis |
| **4** | Determination of melting temperature (Tm) of nucleic acid. |
| **5** | Isolation RNA by suitable method. |
| **6** | Transformation of *E. coli* |
| **7** | Separation of protein by electrophoresis. |
| **8** | Amino acid separations by paper chromatography |
| **9** | Separation of lipids by thin layer chromatography |
| **10** | Ion Exchange and gel filtration column chromatography |
| **11** | Separation of sub cellular organelles by differential centrifugation |
| **12** | Demonstration of LCMS/ HPLC/ GC/ AAS |

**Suggested readings**


1. Wilson K and Walker J (2000) Practical Biochemistry: Principles and techniques (5 Edition) Cambridge University Press, Cambridge.
2. Plummer DT (2005) An Introduction to Practical Biochemistry (3rd Edition) Tata MacGraw Hill, Publisher.
3. Jayaraman J (1999) Laboratory Manual in Biochemistry, New Age International (P) Ltd., Publishers, New Delhi.

4. Sambrook, J and Russell, D.W. (2001) Molecular Cloning: A Laboratory Manual, Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory.
5. Uppadhyay, A. and Nath (2016) Biophysical Chemistry. Himalaya Publishing Company.

## BT 205: Methods in Industrial Botechnology

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| **1** | Study of Growth kinetics of Yeast by turbidometry or dry weight or cell activity method. |
| **2** | Production of the enzyme in shake flask/ SSF |
| **3** | Purification of enzyme: Salting out/Gel permeation/Ultrfilteration/ ion exchange chromatography |
| **4** | Production of citric acid by fermentation of different carbon sources using *Aspergillus niger* |
| **5** | Production of alcohol using different substrates and its recovery |
| **6** | Determination of Tharmal Death Point (TDP) and Tharmal Death Time (TDT). |
| **7** | Preparation/Development of SOP for antibiotic/ Vitamin assay |
| **8** | Antibiotic production: Inoculum development, recovery and its quantification |
| **9** | Assay of antibiotic using sensitive bacterial strain |
| **10** | Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages) |
| **11** | Chi-square test for goodness of fit |
| **12** | Application of statistical software system (Minitab/ SPSS) for statistical analysis. |
| **13** | Demonstration of construction and working of a typical bioreactor |

**Suggested readings:**

1. Rao DG (2005) Introduction to Biochemical Engineering, McGraw-Hill Pub Co Ltd., New Delhi.
2. Peppler HJ and Perlman D (2001) Microbial Technology: Fermentation Technology (2nd Edition) Vol. I and II Academic Press, NY, USA.
3. Atkinson B (2000) Biochemical Reactors, Pion Ltd, London.
4. Daniel WW (1999) Biostatistics: A Foundation for Analysis in the Health (9edition) Wiley and Sons Inc., New York.
5. Gupta SC (2005) Fundamentals of Statistics, Himalaya Publishing House, New Delhi.
6. Stanton A. Glantz (2012) Primer of Biostatistics (7th Edition) MaGraw Hill, New York
7. Chap Le, Lynn Eberly (2016) Introductory Biostatistics, John Wiley & Sons, Publishers