# R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

## Syllabus for
## F. Y. B. Sc. Biotechnology Programme
## Semester I and II

## Under Choice Based Credit System (CBCS)
## To be implemented from the Academic Year 2023 - 2024

| | |
|---|---|
| Name of Programme | **B. Sc. Biotechnology** |
| Level | UG |
| No. of Semesters | 06 |
| Year of Implementation | **2023-24** |
| Programme Specific Outcomes (PSO) | At the end of the Programme, Learner will be able -<br>1. To impart hands on skills in preparation of buffers and solutions.<br>2. To impart skills in handling the cultures of micro – organisms.<br>3. To impart the knowledge of molecular biology techniques.<br>4. To impart the skills of Science communication.<br>5. To impart knowledge of society and make students aware about the Problems in society.<br>6. To understand basic principles of research methodology and identify a research problem.<br>7. To gain critical thinking and analytical skills to understand new diagnostic methods.<br>8. To design strategies for successful implementation of ideas. |
| Relevance of PSOs to the local, regional, national, and global developmental needs | Biotechnology is important at Global, National, Regional and local level. The significance of Biotechnology identified at all these levels and it is relevant to everyday life. The curriculum design of B. Sc. Biotechnology programme helps in understanding various concepts in detail. This programme includes new emerging technologies and their applications. This also involves the actual working and mechanism required in industries. The application part is taken care of so that the learner shall be able to connect the phenomena around him with the curriculum. This programme also imparts the research values among the learners. The hard and softs skills acquired during the completion of this programme shall make him employable. |

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40 % marks in the first part and by conducting the Semester End Examinations of 60 % marks in the second part.

**Standard of Passing**

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i. e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i. e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

**Performance Grading:**

**Letter Grades and Grade Points**

| **Semester GPA/ Program CGPA Semester/Program** | **% of Marks** | **Alpha-Sign / Letter Grade Result** |
|---|---|---|
| 9.00-10.00 | 90.0 -100 | 0 (Outstanding) |
| 8.00 ≤ 9.00 | 80.0 ≤ 90.0 | A+ (Excellent) |
| 7.00 ≤ 8.00 | 70.0 ≤ 80.0 | A (Very Good) |
| 6.00 ≤ 7.00 | 60.0 ≤ 70.0 | B+ (Good) |
| 5.50 ≤ 6.00 | 55.0 ≤ 60.0 | B (Above Average) |
| 5.00 ≤ 5.50 | 50.0 ≤ 55.0 | C (Average) |
| 4.00 ≤ 5.00 | 40.0 ≤ 50.0 | P (Pass) |
| Below 4.00 | Below 40 | F (Fail) |
| Ab (Absent) | - | Absent |

Bachelor of Science (B.Sc.) in Biotechnology Programme

*Under Choice Based Credit System (CBCS)*

*Course Structure*

F. Y. Biotechnology

*(To be implemented from Academic Year 2023-24)*

| Course Code | Semester I | Credits | Course Code | Semester II | Credits |
|---|---|---|---|---|---|
| | ***Discipline Specific Course (DSC)*** | | | ***Discipline Specific Course (DSC)*** | |
| | ***Major*** | | | ***Major*** | |
| USBT101 | Fundamentals of Biotechnology | **02** | USBT201 | Cell Biology and Microbiology | **02** |
| USBT102 | Introduction to Microbiology | **02** | USBT202 | Biochemistry – Concept of Biomolecules | **02** |
| USBT103 | Biotechnology Practical I | **02** | USBT203 | Biotechnology Practical II | **02** |
| | ***Minor*** | | | ***Minor*** | |
| USBT104 | Basic Chemistry – I | **02** | USBT204 | Basic Chemistry - III | **02** |
| USBT105 | Basic Chemistry – II | **1 + 1** | USBT205 | Basic Chemistry - IV | **02** |
| | | **---** | USBT206 | Basic Chemistry Practical | **02** |
| | ***Indian Knowledge System( IKS)*** | | | | |
| USBT106 | Traditional Biotechnology | **02** | | | **---** |
| | ***Skill Enhancement Course (SEC)*** | | | ***Skill Enhancement Course (SEC)*** | |
| USBT107 | Biostatistics | **02** | USBT207 | Bio-analytical Techniques | **1 + 1** |
| | ***Ability Enhancement Course (AEC)*** | | | ***Ability Enhancement Course (AEC)*** | |
| USBT108 | English: Communication Skills – I | **02** | USBT208 | English: Communication Skills – II | **02** |
| | ***Value Education Course (VEC)*** | | | ***Value Education Course (VEC)*** | |
| USBT109 | Environmental Education - I | **02** | USBT209 | Environmental Education - II | **02** |

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

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|---|---|
| Name of the Course | Fundamentals of Biotechnology |
| Course Code | USBT101 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Major I) |

**Course Outcomes:**

By the end of the course, the student will be able to:

CO1 - Be able to relate to applications and benefits of Biotechnology in the fields of agriculture, livestock, human health and environment.

CO2 - Discuss the basics of fermentation.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Applications of Biotechnology | **Applications of biotechnology**: - **Agriculture**: GM fruits- GM papaya, GM tomato, Insect resistant transgenic plants – Bt cotton, Bt brinjal, Modifications in nutrient quality – starch, oilseed protein, golden rice **Livestock**: Growth, disease resistance, product quality, pharmaceuticals and nutritional supplements, industrial applications **Human welfare**: Cloned genes for production of - Insulin; recombinant vaccine for Hepatitis B virus. Molecular farming, Edible vaccines and their advantages **Environment-** Pollution abatement through GMOs **Bioethics Case study**: Genetically modified microbes | 15 |

| | | | |
|---|---|---|---|
| | | for bioremediation of oil spills in marine environment | |
| II | Fermentation technology | **Introduction to fermentation processes:**<br>Microbial biomass, Microbial enzymes, Microbial metabolites, recombinant products, transformation processes. Development of fermentation Industry<br>**Component parts of fermentation process Screening:**<br>Definition, Primary screening and its methods, Secondary screening and its methods<br>**Fermenter design:**<br>Definition of a fermenter, aerated stirred tank batch fermenter-Typical design, Construction materials used, aeration and agitation<br>**Basic introduction to process parameters:**<br>Temperature control, Foam production and control pH measurement and control, CO2 and O2 control<br>**Fermentation medium:**<br>Basic requirements of industrial media, Criteria for use of raw materials in media, Examples of raw materials used, Growth factors, Water, Carbohydrate sources, Protein sources<br>**Product: A typical process of Ethanol production and Antibiotic production** | 15 |

**Learning Resources recommended:**


1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing.
2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing.
3. Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers.

4. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). Principles of fermentation technology. Elsevier.
5. Casida, L. E. (1968). Industrial microbiology. Industrial microbiology.
6. Okafor, N., & Okeke, B. C. (2017). Modern industrial microbiology and biotechnology. CRC Press.

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

# Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

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|---|---|
| Name of the Course | Introduction of Microbiology |
| Course Code | USBT102 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Major II) |

**Course Outcomes:**

CO1 – To understand the role of sterilization and disinfection in the field of Microbiology.
CO2 – To develop skills towards use of microscopy and staining techniques.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Sterilization and Isolation techniques | **Introduction:** Definition and concept of Sterilization and Disinfection. **Types and Applications:** Dry Heat, Steam under pressure Gases, Radiation and Filtration **Chemical Agents and their Mode of Action**: Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents. **Disinfectant:** Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant **Nutrition, Cultivation and Maintenance of microorganisms:** Nutritional categories of microorganisms, Design and Types of Culture Media, methods of isolation. | 15 |

| | | | |
|---|---|---|---|
| II | Microscopy and stains | **Simple and Compound Microscope**:<br>General principles of optics; various parts and their functions - objectives – numerical aperture, resolving power, depth of focus, working distance, aberrations; oculars; condensers.<br>**Dark Field Microscope; Phase Contrast Microscope and Fluorescent Microscope, TEM, SEM**<br>**Applications of microscopes**<br>**Stains and Staining Solutions-**<br>Definition of Dye and Chromogen; acidic and basic dyes; functions and types of chromophore and auxochrome groups. Theories to explain staining.<br>Definition and function of stain; mordant, intensifiers and fixative.<br>**Natural and Synthetic Dyes.**<br>**Simple Staining, Differential Staining – Gram staining and Acid Fast Staining with specific examples** | 15 |

**Learning Resources recommended:**


1. Prescott, L. M. (2002). Microbiology 5th Edition.
2. Pelczar, Microbiology. (1993). India: McGraw-Hill Education.
3. Ananthanarayan, R., Paniker, C. J. (2006). Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Longman.
4. Salle, A. J., & Salle, A. J. (1954). Fundamental principles of bacteriology McGraw-Hill.
5. Frobisher M. Fundamentals of Microbiology (9th Ed)

## Evaluation Pattern

### A. Internal Evaluation

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

### B. Semester End Evaluation (Paper Pattern)

| Question No. | Unit | Marks |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biotechnology Practical I |
| Course Code | USBT103 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart knowledge and hands on experience of the various practicals related to fundamentals of Biotechnology and introduction to Microbiology.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Analyze a case-study and write a report on any one recent application of Biotechnology (Not older than past 5 years)<br>2. Study of Microscopes – Compound Microscope (Including Handling and storage), Dark Field Microscope, Phase Contrast Microscope, Fluorescent Microscope. (Including ray diagrams)<br>3. Monochrome staining using any suitable material. (Bacteria/Plant/Animal tissue)<br>4. Differential staining – Gram staining, Acid fast staining, Romanowsky staining.<br>5. Special staining – cell wall, capsule.<br>6. Special staining – Spores, negative staining.<br>7. Fungal staining – wet mount (Lactophenol cotton blue/Methylene Blue)<br>8. Preparation of media- Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar<br>9. Sterilization of Laboratory Glassware and Media using Autoclave and Hot air oven<br>10. Isolation techniques: T-streak, polygon method<br>11. Colony Characteristics of Microorganisms.<br>12. Use of Bergey's manual to help identify any one isolate<br>13. Isolation of Yeasts from natural environment. | 60 |

| | | |
|---|---|---|
| | 14. Study of morphology and colony characteristics of yeasts<br>15. Isolation and enumeration of microorganisms – Serial dilution, surface spread method<br>16. Isolation and enumeration of microorganisms – Serial dilution, pour plate method<br>17. Screening of antibiotic producers from soil by Crowded plate method.<br>18. Screening of antibiotic producers from soil by Wilkins Overlay method.<br>19. Study of mitosis from suitable plant material/ Permanent slides/Photographs<br>20. Study of meiosis from suitable plant material/ Permanent slides/Photographs | |

**Learning Resources recommended:**


1. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing.
2. Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers.
3. Okafor, N., & Okeke, B. C. (2017). Modern industrial microbiology and biotechnology. CRC Press.
4. Prescott, L. M. (2002). Microbiology 5th Edition.
5. Pelczar, Microbiology. (1993). India: McGraw-Hill Education.
6. Ananthanarayan, R., Paniker, C. J. (2006). Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Longman


**Evaluation Pattern**

| | No of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Biotechnology Practical I | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M (02 Papers)<br>(02 Major and 02 Minor Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

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|---|---|
| Name of the Course | Basic Chemistry – I |
| Course Code | USBT104 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Minor I) |

**Course Outcomes:**

CO1 – To develop an understanding of chemical bonds.
CO2 - To be able to differentiate between chiral and achiral molecules and different enantiomers.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Nomenclature and chemical bonds | **Classification and Systematic Nomenclature of organic compounds** (few examples)<br>**Chemical Bonds**:<br>Types and transition between the main types of bonding.<br>**Ionic Bond**:<br>Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl.<br>**Covalent Bond**:<br>Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate covalent bonds). Structure of $CH_4$, $NH_3$, $H_2O$, Shapes of $BeCl_2$, $BF_3$.<br>**Hydrogen Bond**:<br>Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides). | 15 |

| | | | |
|---|---|---|---|
| II | Stereochemistry | **Isomerism:**<br>Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality.<br>**Geometric Isomerism and Optical Isomerism**:<br>Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis - Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring)<br>**Conformation**:<br>Conformations of Ethane. Difference between Configuration and Conformation.<br>**Configuration**:<br>Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality Representation of Configuration by ―Flying Wedge Formula<br>**Projection formulae:**<br>Fischer, Newman and Sawhorse. The Interconversion of the Formulae. | 15 |

**Learning Resources recommended:**


1. Bahl, B. S., & Bahl, A. (2017). A textbook of organic chemistry. S. Chand Publishing.
2. Lee, J. D. (2008). Concise inorganic chemistry. John Wiley & Sons.
3. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of analytical chemistry. Cengage learning.
4. Vogel, A. I., & Jeffery, G. H. (1989). Vogel's textbook of quantitative chemical analysis. Wiley.
5. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson).

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Basic Chemistry – II |
| Course Code | USBT105 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Minor II) |

**Course Outcomes:**

CO1 – To develop skills towards use of titrimetric and gravimetric analysis.

CO2 – To impart knowledge and hands on experience of the various practicals related to titrimetric and Gravimetry.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Titrimetric and Gravimetry | **Titrimetric Analysis**:<br>Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples.<br>Types of Titrations – Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration - Strong Acid Vs Strong Base. Theoretical aspects of Titration Curve and End Point Evaluation.<br>Theory of Acid –Base Indicators, Choice and Suitability of Indicators.<br>**Gravimetric Analysis**:<br>Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate.<br>Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate. | 15 |

| | | | |
|---|---|---|---|
| II | Regular Practicals | 1. Preparation of Normal, Molar, Molal, Percent solution<br>2. Determination of strength of HCl in commercial sample<br>3. To standardize commercial sample of NaOH using potassium hydrogen phthalate (KHP).<br>4. To standardize commercial sample of HCl using borax.<br>5. Determination of Acetic acid in Vinegar by Titrimetric Method.<br>6. Determination of the amount of Mg (II) present in the given solution complexometrically.<br>7. Determination of the amount of Fe (II) present in the given solution titrimetrically.<br>8. Determination of amount of $NaHCO_3$ + $Na_2CO_3$ in the given solid mixture titrimetrically.<br>9. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate)<br>10. Determination of the volume strength of hydrogen peroxide solution by titration with standardized potassium permanganate solution<br>11. Determination of amount of K oxalate and oxalic acid in the given solution titrimetrically<br>12. Determination of percent composition of $BaSO_4$ and $NH_4Cl$ in the given mixture Gravimetrically.<br>13. Characterization of organic compounds containing only C, H, O elements (no element test) – compounds belonging to the classes – Carboxylic acid, phenol, aldehyde/ketone, ester, alcohol, hydrocarbon.<br>14. Characterization of organic compounds containing only C, H, O, N, S, Halogen elements (element tests to be done) – Compounds belonging to the classes – Amine, Amide, Nitro compounds, Thiamide, | 45 |

| | | | |
|---|---|---|---|
| | | Haloalkane, Haloarene.<br>15. Qualitative analysis of Inorganic compounds. | |

**Learning Resources recommended:**


1. Bahl, B. S., & Bahl, A. (2017). A textbook of organic chemistry. S. Chand Publishing.
2. Vogel, A. I., & Jeffery, G. H. (1989). Vogel's textbook of quantitative chemical analysis. Wiley.
3. Patel H. N., Turakhia S. P., Puniyani S. R. (2018). F. Y. B. Sc. College Practical Chemistry for Biotechnology, Himalaya Publishing House.


**Evaluation Pattern**

| | No of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Basic Chemistry – II | 2 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M (02 Papers)<br>(20 M each for 2 Experiments; 20 M for Theory based questions - 08 M + 07 M + 05 M) | 40 M<br>(10 M for Assignment, 10 M for Journal, 10 M for Viva, 10 M for Overall Performance) | 100 |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Traditional Biotechnology |
| Course Code | USBT106 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (IKS) |

**Course Outcomes:**

CO1 – To impart the knowledge and history of traditional Biotechnology.
CO2 – To explore the research institutes related to Biotechnology in India.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | History of Biotechnology | **What is Biotechnology?**<br>History and Introduction to Biotechnology; Scope and importance of biotechnology; Role of microorganisms in fermentation<br>**World of Biotechnology**-<br>Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Medical Biotechnology, Environmental Biotechnology.<br>**Potential of Biotechnology**-<br>Achievement of biotechnology; Prevention of misuse of biotechnology. | 15 |
| II | Biotechnology in India | Biotechnology Institutions in India (Public and Private Sector); Public Perception of Biotechnology.<br>**Biotechnology in India** –<br>ICGEB, Needs for future development, Global scenario, Potential and achievements of Biotechnology.<br>Bio-business in India, booming biotech market, success story of biotech market, policy initiatives and global trends; Biotechnology research in India. | 15 |

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|---|---|---|---|
| | | **Case study: Serum Institute of India and its products**<br>**Case study: Any five Biotechnology institutions in India and its products.** | |

**Learning Resources recommended:**

1. A Textbook of Biotechnology by R. C. Dubey, S. Chand Publishing.
2. Advanced Biotechnology by R. C. Dubey, S. Chand Publishing

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Skill Enhancement Course - Biostatistics |
| Course Code | USBT107 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | ~~Core~~/ Elective (SEC) |

**Course Outcomes:**

By the end of the course, the learner will be able to:
CO1 - Gain insights about the use of statistics in the field of Biotechnology.
CO2 – Apply the various statistical tools for analysis of biological data.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Data visualization, sampling strategies and Descriptive statistics | **Introduction to Biostatistics:** Definition and Importance of Statistics in Biology Variables, Types of variables (Quantitative and Qualitative) **Types of Data and data visualization:** Concept of Data, Sources of data, Types of data (Quantitative and Qualitative), Representation of Data and Graphs (Bar Diagrams, Pie Charts and Frequency distribution, Histogram, Polygon and Curve) **Sampling strategies:** Population and Sample, Significance of using samples, Sample size, Random variation, Sampling techniques (Simple random sampling, Systematic sampling, Stratified sampling) **Descriptive statistics:** **Measures of central tendency:** Mean, Mode, Median (Ungrouped & Grouped data) | 15 |

| | | | |
|---|---|---|---|
| | | **Measures of dispersion:**<br>Range, Variance, Standard deviation (Ungrouped & Grouped data), Coefficient of variation<br>**Normal/Gaussian distribution, Standard normal deviate, Sampling variation, Standard error of mean** | |
| II | Parametric and Non – parametric tests | **Theory and Problems based on –** Coefficient of Correlation and Regression analysis; Steps in testing statistical hypothesis<br>**Parametric tests:** Z test, Single mean and two means, t-Test – Single mean, paired and unpaired.<br>**Non-parametric test:** Chi-square test. | 15 |

**Learning Resources recommended:**

1. Khanal, A. B. (2015). Mahajan's Methods in Biostatistics For Medical Students and Research Workers. India: Jaypee Brothers, Medical Publishers Pvt. Limited.
2. Cross, C. L., Daniel, W. W. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences. United Kingdom: Wiley.
3. Arora, P. N., Malhan, P. K. (2009). Biostatistics. India: Himalaya Publishing House.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

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|---|---|
| Name of the Course | Ability Enhancement Course - English: Communication Skills - I |
| Course Code | USBT108 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

By the end of the course, the learner will be able to:

CO1 - Develop an understanding of communication skills required to excel in real work environment andcorporate life.

CO2 - Gain insight into technical and non-technical qualities in career planning.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Academic Skills | **Essentials of Grammar**: Parts of speech, Articles, Modals, Sentences and their types., Punctuation marks<br>**Employment Communication**: Introduction, Resume, Curriculum Vitae, Scannable Resume, Developing an Impressive Resume, Formats of Resume, Job Application or Cover Letter. Email Writing<br>**Professional Presentation**: Nature of Oral Presentation, planning aPresentation, Preparing the Presentation, Delivering the Presentation<br>**Job Interviews**: Introduction, Importance of Resume, Definition of Interview, Background Information, Types of Interviews, Preparatory Steps for Job Interviews, Interview Skill Tips, | 15 |

| | | | |
|---|---|---|---|
| | | Changes in the Interview Process, FAQ During Interviews<br><br>**Group Discussion**: Introduction, Ambience/Seating Arrangement for Group Discussion, Importance of Group Discussions, Difference between Group Discussion, Panel Discussion and Debate, Traits, Types of Group Discussions, topic based and Case based Group Discussion, Individual Traits | |
| II | Soft Skills | Introduction to Soft Skills and Hard Skills<br>**Personality Development**: Knowing Yourself, Positive Thinking, Johari's Window, Communication Skills, Non-verbal Communication, Physical Fitness<br>**Emotional Intelligence**: Meaning and Definition, Need for Emotional Intelligence, Intelligence Quotient versus Emotional Intelligence Quotient, Components of Emotional Intelligence, Competencies of Emotional Intelligence, Skills to Develop EmotionalIntelligence<br>**Etiquette and Mannerism**: Introduction, Professional Etiquette, Technology Etiquette<br>**Communication Today**: Significance of Communication, GSC's 3M Model of Communication, Vitality of the Communication Process, Virtues of Listening, Fundamentals of Good Listening, Nature of Non-Verbal Communication, Need for Intercultural Communication, Communicating Digital World | 15 |

**Learning Resources recommended:**


1. Kumar, Sanjay, and Lata, Pushp. Communication Skills, Second Edition. India, Oxford University Press, 2015.
2. Chauhan, G. S., Sharma, S. (2016). Soft Skills: An Integrated Approach to Maximize Personality. India: Wiley.
3. Mitra, B. K. (2011). Personality development and soft skills (Vol. 156). Oxford University Press.


**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Value Education Course – Environmental Education - I |
| Course Code | USBT109 |
| Class | F. Y. B. Sc. |
| Semester | I |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To develop an understanding of the structure and functioning of the ecosystems.

CO2 – To gain insights about the concept of pollution, climate change and sustainable development.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Ecology and interactions | **Concept of Ecosystems**:<br>Definition and Components- Structure and function of ecosystem aspects of ecosystems<br>Food Chain and Food Web, Ecological Pyramids (Energy, Biomass and Number)<br>Aquatic and Terrestrial Ecosystems, Different Abiotic Factors of ecosystem and adaptations to different abiotic factors<br>**Ecological Interactions:**<br>Commensalism, Mutualism, Predation and Antibiosis, Parasitism, competition<br>**Biodiversity and its conservation:**<br>Introduction – definition: genetic, species, ecosystem diversity, biogeographic classification of India, value of biodiversity, biodiversity at global, national and local levels, India as a mega diversity nation, Hotspots of biodiversity, threats to biodiversity, | 15 |

| | | | |
|---|---|---|---|
| | | conservation of biodiversity | |
| II | Pollution and climate change | **Environmental Pollution:** Definition, Cause, effects and control measures of- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, nuclear hazards. Role of an individual in prevention of pollution. Pollution case studies. **Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.** **Sustainable development**: Concept, basic principles of sustainable development, post-Brundtland world, roots of sustainability, Indicators, paradigm towards new discipline-sustainability science. | 15 |

**Learning Resources recommended:**


1. Verma, V. (2010). Botany. India: Ane Books Pvt Ltd.

2. Bharucha, E. (2005). Textbook of Environmental Studies for Undergraduate Courses. India: Universities Press (India) Pvt. Limited.

3. Verma, P. S. (2004). Cell Biology, Genetics, Molecular Biology: Evolution and Ecology. India: S. Chand Limited.

4. Khoiyangbam, R. S. (2015). Introduction to Environmental Sciences. India: Energy and Resources Institute.

5. Fulekar, M. H. (2010). Environmental Biotechnology. United Kingdom: CRC Press.

6. Scragg, A. H. (2004). Environmental University Press.


**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Cell Biology and Microbiology |
| Course Code | USBT201 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Major I) |

**Course Outcomes:**

CO1 – To discuss the ultrastructure, function and location of organelles in prokaryotic and eukaryotic cells.

CO2 – To gain insight into the basics of virology.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Ultrastructure of prokaryotic and eukaryotic cell | **Ultrastructure of Prokaryotic Cell:**<br>Concept of Cell shape, size and arrangement<br>**Bacterial structures external to cell wall**: Flagella, Pilli, Fimbriae, Capsule, Slime Layer, Sheath<br>**Cell Wall** (Gram Positive and Negative)<br>**Structures internal to cell wall:**<br>Cell Membrane, nucleoid, Cytoplasm and cytoplasmic inclusion bodies and vacuoles, Genetic Material spores and cysts<br>**Ultrastructure of Eukaryotic Cell:**<br>Cell wall; Plasma membrane, Cytoplasmic Matrix, Nucleus –Nuclear Structure, nuclear envelope, nucleoplasm, Nucleolus; cytoplasmic structures – cytoplasmic inclusions, cytoplasmic organelles - Endoplasmic Reticulum; Golgi Apparatus; Mitochondria; Chloroplasts; Ribosomes; Lysosome - Endocytosis, Phagocytosis, Autophagy; Peroxisomes.<br>**External Cell Coverings**:<br>Cilia and Flagella<br>**Comparison of Prokaryotic and Eukaryotic Cells** | 15 |

| | | | |
|---|---|---|---|
| II | Virology | **Introduction to virology:** Historical perspective,<br>**General Characteristics of Viruses:**<br>Host Range<br>Viral Structure - Nucleic Acid, Capsid and Envelope General Morphology- Helical, Polyhedral, Enveloped, Complex.<br>**Taxonomy of Viruses Viral Multiplication:**<br>Multiplication of Bacteriophages and Animal Viruses<br>**Isolation, Cultivation, and Identification of Viruses:**<br>Growing Bacteriophages and animal viruses in the Laboratory, Viral Identification<br>**Case studies**- TMV, Influenza COVID-19 (Self learning) | 15 |

**Learning Resources recommended:**


1. Pelczar, Microbiology. (1993). India: McGraw-Hill Education.
2. Verma, P. S., & Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology. S. Chand Publishing.
3. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing
4. Cooper, G. M., Hausman, R. E., & Hausman, R. E. (2007). The cell: a molecular approach (Vol. 4). Washington, DC: ASM press.
5. Stanier, R. Y. (1987). General Microbiology. Hong Kong: Macmillan.
6. Funke, B. R., Case, C. L., Tortora, G. J. (2013). Microbiology: An Introduction. United Kingdom: Pearson.
7. Woolverton, C. J., Sherwood, L., Willey, J. (2014). Prescott's Microbiology. India: McGraw-Hill Education


**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biochemistry – Concept of Biomolecules |
| Course Code | USBT202 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Major II) |

**Course Outcomes:**

CO1 – To discuss the basics of carbohydrate and lipid biochemistry.
CO2 - To learn about fundamental structures and functions of amino acids and proteins.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Basics of carbohydrate and lipid chemistry | **Classification of carbohydrates:**<br>**Monosaccharides:**<br>Two Families of Monosaccharides. Aldo series and keto series; (Triose - Glyceraldehyde and Dihydroxyacetone, Tetrose- Erythrose and Erythrulose, Pentose- Xylose, Xylulose, Ribose, Ribulose, Hexose- Glucose, Galactose, Mannose, Heptose- sedoheptose and Sedoheptulose (structures to be taught) Concept of Enantiomers, Mutarotation, Anomeric carbon and Epimers of glucose.<br>**Disaccharides:**<br>Maltose, Lactose, Sucrose, Cellobiose (structures to be taught, biological significance, structure and bond type)<br>**Polysaccharides:**<br>Homopolysaccharides and Heteropolysaccharides; Structural and Storage Polysaccharides.<br>E.g., of polysaccharides -: starch (amylose and amylopectin), Glycogen, Peptidoglycan, Cellulose, chitin (structure and bond type)<br>**Industrial applications of carbohydrates:**<br>Fermentation, Pharmaceutical and Food industry.<br>**Classification of Fatty acids:**<br>**Saturated Fatty Acids:**<br>C2- C20 (Examples with trivial name, Biochemical names and Structures) | 15 |

| | | | |
|---|---|---|---|
| | | **Unsaturated Fatty Acids:**<br>Definition of MUFA and PUFA. C16- C20. Palmitic, Oleic, Linoleic, Linolenic, Arachidonic acid (Structures expected)<br>**Storage Lipids:**<br>Acyl Glycerols (Simple and Mixed)<br>Mono, Di and Triacylglycerols. (Structures expected)<br>**Structural lipids:**<br>Phosphatidic acid and Membrane Phospholipids E.g.: Phosphatidylethanolamine, Phosphatidylserine, Phosphatidylcholine, Cardiolipin | |
| II | Proteins and amino acids | **Amino acids:**<br>General introduction, Classification and structures, properties (physical & chemical)<br>Amino Acids as drugs.<br>Titration Curve of Amino Acids.<br>Concept of Isoelectric pH, Zwitterion<br>**Reactions of Amino Acids:**<br>Sorenson‘s Titration, Ninhydrin Test<br>**Proteins:**<br>Introduction, definition and functional classification.<br>**Classification of Proteins:**<br>Simple- Fibrous and Globular Conjugated-<br>Nucleoprotein, Lipoprotein, Glycoprotein,<br>Phosphoprotein, Chromoprotein, Metalloprotein<br>Derived- Primary and Secondary<br>**Peptide bond:**<br>Features Example of Dipeptide, tripeptide, Nonapeptide e.g., Oxytocin, Vasopressin<br>Amino acid composition of Bovine Cytochrome C and Bovine Chymotrypsinogen<br>**Three-dimensional Structure of proteins:**<br>Concept of Monomeric, dimeric and multimeric proteins Primary structure - Peptide linkage, Native<br>Secondary structure - Alpha Pleat and Beta fold; Spatial arrangements of adjacent amino acid residues<br>Tertiary structure - Three-Dimensional arrangement<br>Quaternary structure Di and Multimeric proteins E.g., structure of human Insulin<br>**Properties of proteins:**<br>Solubility, Molecular weight, Shape, Isoelectric pH, Salting out of proteins for purification | 15 |

| | | | |
|---|---|---|---|
| | | **Protein Denaturation and folding:**<br>Denaturing agents and properties of denatured proteins | |

**Learning Resources recommended:**


1. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.
2. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons.
3. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. Mu, P., & Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.
4. Jain, J. L. (2004). Fundamentals of Biochemistry. India: S. Chand Limited.


**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biotechnology Practical II |
| Course Code | USBT203 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart knowledge and hands on experience of the various practicals related to cell biology, microbiology and biochemistry.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| **Regular Practicals** | 1. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination<br>2. Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual)<br>3. Isolation and characterization of food fermenting organism from Idli batter (Using Bergey's Manual)<br>4. Sauerkraut production and to analyze quality parameters during production (odour, color, pH, total acidity)<br>5. Determination of food preservative concentration (salt and sugar) using MIC.<br>6. Detection of Food adulterants in food samples<br>7. Fermentation of Sugarcane juice using yeast.<br>8. Estimation of sugars by Cole's ferricyanide method.<br>9. Estimation of Alcohol by dichromate method<br>10. Study of blood groups ABO in humans<br>11. Study of the structure of important<br>a. Animal viruses (rhabdo, influenza, paramyxo, hepatitis and retroviruses) using electron micrographs/diagrams.<br>b. Plant viruses (caulimo, gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs/diagrams.<br>c. ϕX174, T4,Ȝ) using electron micrographs/diagrams. | 60 |

| | | |
|---|---|---|
| | 12. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.<br>13. Motility by hanging drop method/stab culture<br>14. Study of Growth Curve of *E. coli*<br>15. Sterility testing of Vaccine<br>16. Enumeration by Breed‘s count<br>17. Isolation of chromosomal DNA from *E. coli* and Agarose gel electrophoresis of the chromosomal DNA<br>18. Study of Hill's reaction<br>19. Separation of plant pigments by thin layer chromatography<br>20. Qualitative detection of plant secondary metabolites using standard tests - e. g. Tests for tannins, flavonoids, alkaloids, terpenoids, saponins, steroids. | |

**Learning Resources recommended:**


1. Patel H. N., Turakhia S. P., Puniyani S. R. (2018). F. Y. B. Sc. College Practical Chemistry for Biotechnology, Himalaya Publishing House.
2. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. Mu, P., & Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.
3. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons.


**Evaluation Pattern**

| | No of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Biotechnology Practical II | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M (02 Papers)<br>(02 Major and 02 Minor Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Basic Chemistry – III |
| Course Code | USBT204 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Minor I) |

**Course Outcomes:**

CO1 – To develop an understanding of thermodynamics.
CO2 – To learn about reaction kinetics and order of reaction.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Thermodynamics | **Thermodynamics:**<br>System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.)<br>**Laws of Thermodynamics and its Limitations:**<br>Mathematical expression.<br>Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency.<br>Laws of Thermodynamics as applied to Biochemical Systems.<br>**Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.** | 15 |
| II | Chemical Kinetics | **Reaction Kinetics:**<br>Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order & Molecularity of Reaction, Integrated Rate Equation of First and Second order reactions (with equal initial concentration of | 15 |

| | | | |
|---|---|---|---|
| | | reactants). (Numericals expected)<br>**Determination of Order of Reaction:**<br>a) Integration Method<br>b) Graphical Method<br>c) Ostwald‘s Isolation Method<br>d) Half Time Method. (Numericals expected**)** | |

**Learning Resources recommended:**


1. Rao, C. N. R. (1973). University General Chemistry : An Introduction To Chemical Science. India: Macmillan India Limited.
2. Chang, R. (2000). Physical Chemistry for the Chemical and Biological Sciences. United Kingdom: University Science Books.
3. Lee, J.D., Concise Inorganic Chemistry, 5th ED. (2008). India: Wiley India Pvt. Limited.
4. Bajpai, D. N. (2001). Advanced Physical Chemistry. India: S. Chand, Limited.
5. Singh, A. K., Singh, N. B., Das, S. S. (2009). Physical Chemistry: Volume II. India: New Age International.


**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Basic Chemistry – IV |
| Course Code | USBT205 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Minor II) |

**Course Outcomes:**

CO1 - To gain insight into the details of oxidation - reduction reactions.
CO2 - To develop an understanding of enzymology.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Oxidation reduction reactions | **Principles of Oxidation & Reduction Reactions:** Oxidizing and Reducing Agents Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate. **Balancing Redox Reactions**: Ion Electron Method Oxidation, Reduction, Addition and Substitution & Elimination Reactions. | 15 |
| II | Enzymes | **Introduction to biocatalysis:** Properties of Enzymes, Substrate, Optimum conditions, Co-substrate, Coenzyme, Cofactors **Classification and Nomenclature** (one reaction per class) Mechanism of Enzyme Action, Active Sites, Enzyme Specificity. **Factors affecting enzyme activity** (Effect of pH, Temperature, Substrate Concentration, Enzyme concentration) | 15 |

| | | | |
|---|---|---|---|
| | | **Enzyme Kinetics:**<br>Derivation of Michaelis-Menten Equation, Lineweaver- Burk plot, Concept of km<br>**Types of Enzyme Inhibitions:**<br>Irreversible & Reversible (Competitive, Uncompetitive, Non-Competitive)<br>**Isoenzymes** (LDH, Alkaline Phosphatase, Creatine Phosphokinase)<br>Allosteric Modulators, Co-Factors, Zymogens, Enzyme units<br>Enzymes as Biomarkers and diagnostic tools. (SGPT, SGOT, LDH, CPK)<br>**Industrial Application of Enzymes** | |

**Learning Resources recommended:**


1. Rao, C. N. R. (1973). University General Chemistry : An Introduction to Chemical Science. India: Macmillan India Limited.
2. Chang, R. (2000). Physical Chemistry for the Chemical and Biological Sciences. United Kingdom: University Science Books.
3. Cox, M. M., & Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.
4. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons.
5. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.
6. Jain, J. L. (2004). Fundamentals of Biochemistry. India: S. Chand Limited.


**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Basic Chemistry Practical |
| Course Code | USBT206 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart knowledge and hands on experience of the various practicals related to thermodynamics, chemical kinetics and enzymes.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Preparation of Acetate buffer pH 4.6, Carbonate buffer pH 6.8, Tris buffer pH 8.3<br>2. Qualitative tests for carbohydrates; Molisch test, Benedict's test, Iodine test, Osazone formation<br>3. Estimation of carbohydrates by Lane-Eynon method<br>4. Qualitative tests for lipids.<br>5. Qualitative analysis of amino acids and proteins<br>6. Salowski's test for cholesterol<br>7. To determine enthalpy of dissolution of salt like $KNO_3$<br>8. Determine the rate constant for hydrolysis of ester using HCl as a catalyst<br>9. Determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method<br>10. Study the kinetics of reaction between Thiosulphate ion and HCl<br>11. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction<br>12. Study the reaction between $NaHSO_3$ and $KMnO_4$ and balancing the reaction in acidic, alkaline and neutral medium<br>13. Qualitative Assay of enzyme urease, amylase, dehydrogenase, catalase and protease from Plant/Animal/Microbial source.<br>14. Enzyme Kinetics: Study of the effect of pH on activity of Amylase<br>15. Enzyme Kinetics: Study of the effect of temperature on | 60 |

| | | |
|---|---|---|
| | activity of Amylase<br>16. Study of Effect of Substrate Concentration on amylase enzyme activity and determination of Vmax and Km<br>17. Study of Effect of inhibitors on amylase enzyme activity<br>18. Estimation of Protein by Biuret method<br>19. Estimation of Protein by Folin – Lowry method.<br>20. Quantitative estimation of sugars by DNSA method | |

**Learning Resources recommended:**


1. Rao, C. N. R. (1973). University General Chemistry : An Introduction To Chemical Science. India: Macmillan India Limited.
2. Chang, R. (2000). Physical Chemistry for the Chemical and Biological Sciences. United Kingdom: University Science Books.
3. Lee, J.D., Concise Inorganic Chemistry, 5th ED. (2008). India: Wiley India Pvt. Limited.
4. Bajpai, D. N. (2001). Advanced Physical Chemistry. India: S. Chand, Limited.
5. Singh, A. K., Singh, N. B., Das, S. S. (2009). Physical Chemistry: Volume II. India: New Age International.


**Evaluation Pattern**

| | No of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Basic Chemistry Practical | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M (02 Papers)<br>(02 Major and 02 Minor Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Skill Enhancement Course - Bio-analytical Techniques |
| Course Code | USBT207 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcome:**

CO1 – To develop skills towards the principle, working and applications of different analytical techniques.

CO2 – To impart knowledge and hands on experience of the various practicals related to bio-analytical techniques.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Methods of separation and analytical techniques | **Methods of Separation:**<br>Precipitation, Filtration, Distillation and Solvent Extraction<br>**Analytical Techniques**<br>**Chromatography:**<br>Definition, Principles, Chromatographic performance parameters, Types<br>Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Principle and Applications)<br>**Spectroscopy - Colorimetry:**<br>Properties of electromagnetic radiation, interaction with matter, lasers<br>Colorimetric assays - Principle, Beer - Lambert‘s Law, Measurement of Extinction, Derivation of E = kcl, Limitations of Beer-Lambert's Law, Filter Selection Examples of colorimetric and UV absorption assays<br>**Electrophoresis:**<br>General principles, Factors affecting electrophoresis, Types of support media used, Types | 15 |

| | | | |
|---|---|---|---|
| | | of electrophoresis (Agarose gel electrophoresis, PAGE) | |
| II | Regular and Demonstration Practicals | 1. Determination of absorption maxima of $CuSO_4$/ $K_2Cr_2O_7$<br>2. Verification of Beer – Lambert's law<br>3. Separation of amino acids by Paper Chromatography<br>4. Electrophoresis of proteins by native PAGE<br>5. Electrophoresis of proteins by SDS PAGE<br>6. Paper electrophoresis of amino acids<br>7. Western Blotting – Demonstration<br>8. Separation of components from a mixture using Affinity chromatography (Kit may be used for demonstration)<br>9. Separation of components from a mixture using ion exchange chromatography (Kit may be used for demonstration)<br>10. Separation of components from a mixture using size exclusion chromatography (Kit may be used for demonstration) | 45 |

**Learning Resources recommended:**


1. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R. (2014). Fundamentals of Analytical Chemistry. India: Brooks/Cole, Cengage Learning.
2. Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition, Keith Wilson and John Walker, Cambridge University Press.


**Evaluation Pattern**

| | No of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Bio-analytical Techniques | 2 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M (02 Papers)<br>(20 M each for 2 Experiments; 20 M for Theory based questions - 08 M + 07 M + 05 M) | 40 M<br>(10 M for Assignment, 10 M for Journal, 10 M for Viva, 10 M for Overall Performance) | 100 |

# Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Ability Enhancement Course – English: Communication Skills - II |
| Course Code | USBT208 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

By the end of the course, the learner will be able to:

CO1 - Learn about Leadership, ethical values, capacity building, team building, decision making.
CO2 – Learn about the understanding of stress and management of stress.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Professional Skills | **Creativity at Workplace**: Introduction, Current Workplaces, Creativity, Motivation, Nurturing Hobbies at Work, The Six Thinking Hat Method<br>**Ethical Values**: Ethics and Society, Theories of Ethics, Correlation between Values and behavior, Nurturing Ethics, Importance of Work Ethics, Problems in the Absence of Work Ethics<br>**Capacity Building**: Need and Importance of Capacity Building Elements of Capacity Building Zones of Learning Ideas for Learning Strategies for Capacity Building<br>**Leadership and Team Building**: Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams | 15 |

| | | | |
|---|---|---|---|
| | | **Decision Making and Negotiation**: Introduction to Decision Making, Steps for Decision Making, Decision Making Techniques, Negotiation Fundamentals, Negotiation Styles, Major Negotiation Concept | |
| II | Understanding and Managing stress and conflict in Contemporary society | **Understanding Stress and Conflict**<br><br>Causes of stress and conflict in individuals and society; Agents of socialization and the role played by them in developing the individual; Significance of values, ethics and prejudices in developing the individual; Stereotyping and prejudice as significant factors in causing conflicts in society. Aggression and violence as the public expression of conflict<br><br>**Managing Stress and Conflict in Society**<br>Types of conflicts and use of coping mechanisms for managing individual stress; Maslow's theory of self-actualization; Different methods of responding to conflicts in society; Conflict-resolution and efforts towards building peace and harmony in society | 15 |

**Learning Resources recommended:**


1. Kumar, Sanjay, and Lata, Pushp. Communication Skills, Second Edition. India, Oxford University Press, 2015.
2. Chauhan, G. S., Sharma, S. (2016). Soft Skills: An Integrated Approach to Maximize Personality. India: Wiley.
3. Mitra, B. K. (2011). Personality development and soft skills (Vol. 156). Oxford University Press.

**Evaluation Pattern**

A. **Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

B. **Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Value Education Course – Environmental Education – II |
| Course Code | USBT209 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To understand the relevance of renewable energy sources and conservation of biodiversity.
CO2 – To study the applications of different life forms in environmental remediation.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Renewable sources of energy | **Introduction:**<br>Renewable and Non-renewable resources. The need for a sustainable lifestyle.<br>**Energy resources:**<br>Types of energy<br>Nonrenewable energy - Oil, coal and its environmental impacts.<br>**Renewable energy:**<br>Hydroelectric power, Solar energy, Biomass energy, Biogas, Wind power and Geothermal energy.<br>**Biogas technology:**<br>Biogas plant & types, biodigester. Biogas- composition, production and factors affecting production and uses.<br>**Biofuels**:<br>Ethanol production, Microbial hydrogen production, Biodiesel, Petrocrops. | 15 |
| II | Global environmental problems and issues; Bioremediation | **Green House Effect:**<br>Factors responsible for Green House Effect; Green House gases. | 15 |

| | | | |
|---|---|---|---|
| | | **Global warming:** Ozone depletion; Kyoto protocol; UV radiation; Acid rain<br>Concept of bioremediation.<br>Microorganisms in Bioremediation.<br>Mycoremediation and phytoremediation.<br>Bioremediation technologies.<br>Measuring bioremediation in the field. Bioaugmentation and biostimulation. Monitoring the efficacy of bioremediation. | |

**Learning Resources recommended:**

1. Bharucha, E. (2005). Textbook of Environmental Studies for Undergraduate Courses. India: Universities Press (India) Pvt. Limited.

2. Verma, P. S. (2004). Cell Biology, Genetics, Molecular Biology: Evolution and Ecology. India: S. Chand Limited.

3. Khoiyangbam, R. S. (2015). Introduction to Environmental Sciences. India: Energy and Resources Institute.

4. Fulekar, M. H. (2010). Environmental Biotechnology. United Kingdom: CRC Press.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Basic computer system |
| Course Code | USOE203 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | ~~Core~~/ Elective (Open Elective) |

**Course Outcomes:**

By the end of the course, the student will be able to:
CO1 – To develop an understanding of computer networking and internet.
CO2 – To develop skills to use word processing, spreadsheet, presentation software.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Introduction to computers | Overview and functions of a computer system, Input and output devices, Storage devices. Modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & The Super Computer; Introduction to operating systems: Operating System concept, Windows, Unix/Linux & servers Word Processing: Basic Operations, Creating and Editing documents, Formatting documents. Spreadsheet: Creating and editing workbook, Organizing and formatting worksheets; Data analysis and management; Using formulas and functions; Presentation Graphics: Creating and Editing Presentations, Designing and Enhancing Presentation,Delivering Presentation Advanced Presentation Graphics. | 15 |
| II | Computer networking | Introduction to networking: Various terminologies Associated hardware devices, gadgets (Router, | 15 |

| | | | |
|---|---|---|---|
| | | Switch) tools, services, and resources Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls<br>Computer viruses:<br>An overview of Computer viruses: What is a virus? Virus signs, how do they get transmitted? What are the dangers?<br>General Precautions<br>The Internet and Internet Services: Introduction, History of Internet, Internetworking Protocol, The Internet Architecture, Managing the Internet, Connecting to Internet, Internet Connections: Dial-up Access, Leased Line, Integrated Services Digital Network (ISDN), Digital Subscriber Line (DSL), Cable, Modem Internet Address Internet Services: World Wide Web (WWW), Web Browser, Uniform Resource Locator (URL), Internet Search Engines, WWW Development Languages, Uses of Internet, Electronic Mail: E-mail Address, E-mail Message Format, E -mail Services, How E-mail Works File Transfer Protocol (FTP), How FTP Works, Terminal Network (Telnet), News, Internet Relay Chat (IRC), MS Outlook. | |

**Learning Resources recommended:**


1. Sinha, P. K., Sinha, P. (2004). Computer Fundamentals. India: BPB Publications.
2. Goel, A. (2010). Computer Fundamentals. India: Pearson Education.
3. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley.
4. Tanenbaum, A. S., Wetherall, D. (2014). Computer Networks. United Kingdom: Pearson Education.

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Introduction to Bioinformatics |
| Course Code | USOE206 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | ~~Core~~/ Elective (Open Elective) |

**Course Outcomes:**

By the end of the course, the student will be able to:
CO1 – To develop an understanding of introduction to computers and biological databases.
CO2 – To develop an understanding of BLAST and sequence alignment.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Introduction to computers and Biological databases | **Computer Basics :** Basic Computer Operations: I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating Systems and application softwares.<br>**Biological Databases :**<br>**Classification of Databases -** Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases.<br>**Specialized Databases -** Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP).<br>Genome Information Resources: DNA Sequence Databases Specialized Genomic Resources.<br>Protein Databases based on Composition, Motifs and Patterns.<br>Protein Structure Visualization Software. | 15 |

| | | | |
|---|---|---|---|
| II | BLAST and Sequence alignment | **BLAST and Sequence Alignment:** BLAST and its Types; Retrieving Sequence using BLAST. **Pairwise Alignment:** Identity and Similarity; Global and Local Alignment; Pairwise Database Searching.<br><br>Multiple Sequence Alignment: Goal of Multiple Sequence Alignment; Computational Complexity; Manual Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching; Analysis Packages; MSA. | 15 |

**Learning Resources recommended:**


5. Sinha, P. K., Sinha, P. (2004). Computer Fundamentals. India: BPB Publications.
6. Goel, A. (2010). Computer Fundamentals. India: Pearson Education.
7. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley.
8. Bioinformatics by S. C. Rastogi
9. Bioinformatics by Attawood


**Evaluation Pattern**

**C. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**D. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

## Syllabus for F. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Food Science |
| Course Code | USOE209 |
| Class | F. Y. B. Sc. |
| Semester | II |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ (Open Elective) |

**Course Outcomes:**

CO1 – To develop an understanding of the applications of Biotechnology in the food industry.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Introduction to Food Biotechnology | **Introduction to food biotechnology:** History of microorganisms in food science and key developments, Applications of biotechnology in fermented food products **Introduction to Unit Operations and Processes:** Basic unit operations, food processing & packaging (canning & bottling), Production of cultures | 15 |
| II | Food Fermentations and Preservation | **Fermented food products:** Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics **Food spoilage, food deterioration, food contamination and Food Adulteration** **Methods of food preservation** **Indicators of Food Microbial Quality & Safety:** HACCP, FSSAI & FDA | 15 |

**Learning Resources recommended:**

1. Frazier, W. C., & Westhoff, D. C. (1983). Food microbiology 5th Ed.
2. Lee, B. H. (2014). Fundamentals of food biotechnology. John Wiley & Sons.
3. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). Modern food microbiology. Springer Science & Business Media.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | Both Units | Do as directed. (Any 10) 10 M |
| 2 | I | Long Answer Questions 15 M |
| 3 | II | Long Answer Questions 15 M |
| 4 | Both Units | Short notes (04 out of 06) 20 M |

(Rashmi A. Bhave)
The Chairperson, BoS

# R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

## Syllabus for
## S. Y. B. Sc. Biotechnology Programme
## Semester III and IV

## Under Choice Based Credit System (CBCS)
## To be implemented from the Academic Year
## 2023 - 2024

| | |
|---|---|
| Name of Programme | **B. Sc. Biotechnology** |
| Level | UG |
| No. of Semesters | 06 |
| Year of Implementation | **2023 – 24** |
| Programme Specific Outcomes (PSO) | 1. To impart hands on skills in preparation of buffers and solutions.<br>2. To impart skills in handling the cultures of micro – organisms.<br>3. To impart the knowledge of molecular biology techniques.<br>4. To impart the skills of Science communication.<br>5. To impart knowledge of society and make students aware about the Problems in society.<br>6. To understand basic principles of research methodology and identify a research problem.<br>7. To gain critical thinking and analytical skills to understand new diagnostic methods.<br>8. To write a business plan.<br>9. To design strategies for successful implementation of ideas. |
| Relevance of PSOs to the local, regional, national, and global developmental needs | Biotechnology is important at Global, Regional and local level. The significance of Biotechnology identified at all these levels and it is relevant to everyday life. The curriculum design of B. Sc. Biotechnology programme helps in understanding various concepts in detail. This programme includes hands on skills and knowledge of the different techniques related to molecular biology, tissue culture, basic chemistry and basic microbiology. This also involves the knowledge of problems in society. The application part is taken care of so that the learner shall be able to connect the phenomena around him with the curriculum. This programme also imparts the research values among the learners. The hard and softs skills acquired during the completion of this programme shall make him employable. |

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40 % marks in the first part and by conducting the Semester End Examinations of 60 % marks in the second part.

**Standard of Passing**

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i. e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i. e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

**Performance Grading:**

**Letter Grades and Grade Points**

| **Semester GPA/ Program CGPA Semester/Program** | **% of Marks** | **Alpha-Sign / Letter Grade Result** |
|---|---|---|
| 9.00-10.00 | 90.0 -100 | 0 (Outstanding) |
| 8.00 ≤ 9.00 | 80.0 ≤ 90.0 | A+ (Excellent) |
| 7.00 ≤ 8.00 | 70.0 ≤ 80.0 | A (Very Good) |
| 6.00 ≤ 7.00 | 60.0 ≤ 70.0 | B+ (Good) |
| 5.50 ≤ 6.00 | 55.0 ≤ 60.0 | B (Above Average) |
| 5.00 ≤ 5.50 | 50.0 ≤ 55.0 | C (Average) |
| 4.00 ≤ 5.00 | 40.0 ≤ 50.0 | P (Pass) |
| Below 4.00 | Below 40 | F (Fail) |
| Ab (Absent) | - | Absent |

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biophysics |
| Course Code | USBT 301 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To have a firm foundation in the fundamentals and applications of current biophysical theories related to optics and electromagnetic radiations.

CO2 - To have a firm foundation in the fundamentals and applications of current biophysical theories related to heat, sound, magnetism and fluid dynamics.

CO3 – To provide the skills in electrophoretic techniques.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Optics and Electromagnetic radiations | **Introduction to Optics and Lasers:**<br>***Optics* :**<br>Properties of Light - Reflection, Refraction, Dispersion, Interference.<br>***Lasers* :**<br>Properties of Lasers, Stimulated Emissions, Laser Action; Applications of Laser.<br>**Electromagnetic Radiations:**<br>Introduction to Electromagnetic Radiation.<br>**Spectroscopy :**<br>Types and Properties of Spectra; Basic Laws of Light Absorption.<br>Spectrophotometer:-Principle, Instrumentation and Applications; UV-Vis Spectrophotometer, Single and Dual Beam Spectrophotometer. | 15 |

| | | | |
|---|---|---|---|
| | | **Microscopy:**<br>Types of Microscopy; Electron Optics; Electron Microscopy-Preparation of Specimen, SEM, TEM and Immuno-Electron Microscopy.<br>Fluorescence Microscopy. | |
| II | Heat, Sound, Magnetism and Fluid dynamics | **Heat:**<br>Concept of Temperature; Modes of Heat Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors.<br>**Sound:**<br>Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves; Doppler Effect;<br>Applications of Ultrasonic Waves.<br>**Magnetism:**<br>Magnetic Field; Magnetism of Earth; Paramagnetism, Diamagnetism, Ferromagnetism.<br>Nuclear Magnetism and Biomagnetism.<br>**Fluid Dynamics :**<br>***Viscosity*:**<br>Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity.<br>Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's Viscometer.<br>***Surface Tension*:**<br>Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension.<br>Applications in Biology. | 15 |
| III | Electrophoretic techniques | **Electrophoresis:**<br>Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; | 15 |

| | | | |
|---|---|---|---|
| | | Moving Boundary Electrophoresis; Principle of Electrophoresis; Supporting Matrix; Paper Electrophoresis; AGE; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous); IEF and 2D PAGE. Staining and Detection Methods; Gel-Documentation.<br>Applications in Biology. | |

**Learning Resources recommended:**

1. Brij Lal Subramanium, Chapter 3, 8, 14, 22

2. Concepts of modern Physics, Beiser, Topics 2.1 – 2.2

3. TY College analytical Chemistry, Himalaya Publications

4. Instrumentation: Devices and systems by C. S. Rangan, TMH Publication

5. Biophysical Chemistry – Principles and Techniques, Upadhyay and Nath

**Evaluation Pattern**

**C. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**D. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Applied Chemistry – I |
| Course Code | USBT 302 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To have a firm foundation in the fundamentals of organic chemistry.
CO2 - To impart the knowledge in the synthesis of organic compounds.
CO3 – To explore the fundamentals of green chemistry and synthesis.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Organic Chemistry | **Introduction to Types of Organic Reactions :**<br>Addition, Elimination and Substitution Reactions. Essential and Non-essential Elements in Biological Systems.<br>Role of Metal Ions in Biological Systems.<br>**Metal Coordination in Biological Systems :**<br>Enzymes, Apoenzymes and Coenzymes.<br>Biological Role of Metalloenzymes *wrt* Myoglobins, Haemoglobin.<br>Biological Role of Carboxypeptidases, Catalases and Peroxidases.<br>**Structure and Function :**<br>Dioxygen Binding, Transfer and Utilization; Metal Complexes in Medicines. | 15 |

| | | | |
|---|---|---|---|
| II | Synthesis of organic compounds | **Synthesis of Organic Compounds :** Criteria for Ideal Synthesis; Selectivity and Yield. Linear and Convergent Synthesis and Multicomponent Reactions. Microwave Assisted Organic Synthesis, Ultrasound in Synthesis and Polymer supported Synthesis. Retrosynthesis. | 15 |
| III | Green Chemistry and synthesis | **Green Chemistry and Synthesis:** Introduction to Green Chemistry; Need and Relevance of Green Chemistry; Principles of Green Chemistry. Green Synthesis in Industry: Green Materials, Green Reagents, Green Solvents and Green Catalysts. | 15 |

**Learning Resources recommended:**

1. Advanced organic chemistry, Reinhard Bruckner
2. Biochemistry, Satyanarayan $4^{th}$ edition
3. Textbook of Biochemistry, Lehninger $4^{th}$ edition
4. College organic chemistry for T. Y. B. Sc. (Himalaya Publishing House)
5. Green Chemistry by Ahluwalia

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Immunology |
| Course Code | USBT 303 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To familiarize students with the immune effector mechanisms.
CO2 - To provide the information about cell receptors.
CO3 – To impart the details of various immunotechniques.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Effectors of Immune Response | Haematopoiesis; Cells of the Immune System; Primary and Secondary Lymphoid Organs.<br>Complement System- Classical, Alternate and Lectin; Regulation and Biological Effects of Complement System; Deficiencies of Complement System | 15 |
| II | Cell Receptors | **T-cell Receptor Complex :**<br>Structure and Activation.<br>MHC Classes - General Organization and Inheritance; Structures and Peptide Interactions; Class I and II Diversity and Polymorphism; Antigen Presentation - Endocytic and Exocytic Pathways; MHC Restriction.<br>**B-cell Receptor :**<br>Structure, Maturation and Activation<br>**B-T Cell Interaction (B-T cell Cooperation).** | 15 |

| | | | |
|---|---|---|---|
| III | Immunotechniques | **Precipitation Reactions :** Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis. **Agglutination Reactions :** Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. **Alternatives to Antigen-Antibody Reactions.** | 15 |

**Learning Resources recommended:**

1. Immunology by Janis Kuby, 5$^{th}$ edition
2. Textbook of Microbiology by Ananthnarayan and Paniker, 8$^{th}$ edition
3. Introduction to immunology by C. V. Rao

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Cell Biology and Cytogenetics |
| Course Code | USBT 304 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To have a firm foundation in the fundamentals of cytoskeleton.
CO2 – To acquire the knowledge about cell membrane.
CO3 – To impart the fundamentals of cytogenetics.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Cytoskeleton | **Cytoskeleton :**<br>Overview of the Major Functions of Cytoskeleton.<br>Microtubules: Structure and Composition.<br>MAPs: Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility.<br>Motor Proteins: Kinesins, Dynein; MTOCs.<br>Dynamic Properties of Microtubules.<br>Microtubules in Cilia and Flagella.<br>Microfilaments: Structure, Composition, Assembly and Disassembly.<br>Motor Protein: Myosin.<br>Muscle Contractility: Sliding Filament Model.<br>Actin Binding Proteins : Examples of Non-Muscle Motility.<br>Intermediate Filaments :Structure and Composition; Assembly and Disassembly; Types and Functions. | 15 |

| | | | |
|---|---|---|---|
| II | Cell Membrane | **Cell Membrane :**<br>Uptake of Nutrients by Prokaryotic Cells; Cell Permeability.<br>Principles of Membrane Transport-Transporters and Channels; Active Transport<br>Passive Transport; Types of Transporters; Types of ATP Driven Pumps - Na+ K+ Pump.<br>Cell Junctions; Cell Adhesion and Extracellular Material Microvilli; Tight Junctions, Gap Junctions; Cell Coat and Cell<br>Recognition.<br>Cellular Interactions. | 15 |
| III | Cytogenetics | **Cytogenetics :**<br>Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes.<br>**Variation in Chromosomal Structure and**<br>**Number :**<br>Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy 18 and Trisomy 13.<br>**Sex Determination and Sex Linkage :**<br>Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO)<br>Dosage Compensation and Barr Body.<br>**Genetic Linkage, Crossing Over and Chromosomal Mapping :**<br>Tetrad Analysis; Two-point Cross; Three point Cross; Pedigree Analysis. | 15 |

**Learning Resources recommended:**


1. Microbiology, Prescott Harley, 7th edition
2. Molecular biology of the cell, Bruce Alberts, 4th edition
3. Cell and Molecular biology, De Robertis, 8th edition
4. iGenetics – A molecular approach, Russell, 3rd edition

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Molecular Biology |
| Course Code | USBT 305 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To have an insight into mechanism of gene expression.
CO2 – To provide the knowledge about regulation of gene expression.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Gene Expression – Transcription | **Gene Expression- an Overview.** **Transcription Process in Prokaryotes :** RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain. **Transcription in Eukaryotes :** Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNA's; Transcription of other genes; Spliceosomes; RNA editing. | 15 |
| II | Gene Expression – Translation | **Nature of Genetic Code.** **Wobble Hypothesis.** **Translation :** Process of Protein Synthesis (Initiation, Elongation, Translocation, Termination); **Post Translation Modifications.** **Protein sorting.** | 15 |

| | | | |
|---|---|---|---|
| III | Regulation of Gene Expression | **In Prokaryotes:**<br>***In Bacteria* :**<br>*lac* Operon of *E. coli*; *trp* Operon of *E. coli*.<br>***In Viruses* :**<br>Lytic / Lysogenic Regulation<br>**In Eukaryotes :**<br>Operons in Eukaryotes; Control of Transcriptional Initiation; Gene Silencing and Genomic Imprinting; Post-Transcriptional Control; RNA Interference. | 15 |

**Learning Resources recommended:**

1. iGenetics – A molecular approach, Russell, 3rd edition
2. Molecular biology of the cell, Bruce Alberts, 4th edition

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Bioprocess Technology |
| Course Code | USBT 306 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To understand the basic skills applied in fermentation technology.
CO2 - To build a foundation for more advanced studies in bioprocess technology.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Microorganisms in industrial processes | **Types of Microorganisms used in Industrial Processes :** Bacteria, Actinomycetes, Fungi and Algae. **Screening and Maintenance of Strains:** Primary Screening and Secondary Screening; Cultivation; Preservation of Industrially Important Microbial Strains. | 15 |
| II | Fermentor and Fermentation processes | **Design of a fermentor :** Stirred Tank Fermentor- Basic Design; Parts of a Typical Industrial Fermentor. **Fermentation Media :** Components; Design and Optimization. **Sterilization :** Sterilization of Fermentor and Fermentation Media. **Process Parameters :** *pH*, Temperature, Aeration, Agitation, Foam, etc. | 15 |

| | | | |
|---|---|---|---|
| | | **Types of Fermentation :**<br>Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic.<br>**Product Isolation and Purification.**<br>**Study of Representative Fermentation**<br>**Processes :**<br>Outline of Penicillin and Ethanol Production by Fermentation along with a *flow-diagram*. | |
| III | In vivo and in vitro assay of industrial products | **Assay of Industrial Products:**<br>Chemical and Biological; Types and<br>Subtypes; Kinetics. Advantages and Disadvantages.<br>Half-Life Determination of Pharmacological Products.<br>Bioavailability and Bioequivalence Studies | 15 |

**Learning Resources recommended:**

1. Fermentation by Casida
2. Fermentation by A. H. Patel

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

# Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Research Methodology |
| Course Code | USBT 307 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical~~/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To develop research aptitude, logical thinking and reasoning.
CO2 – To provide skills in interpretation and report writing.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Introduction to Research Methodology and Research Problem | Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Research Process; Criteria of Good Research; Problems Encountered by Researchers in India; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem | 15 |
| II | Research design and Data collection | Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs; Developing a Research Plan- Collection of Primary Data; Observation Method; Interview Method; Collection of Data through Questionnaires; Collection of Data | 15 |

| | | | |
|---|---|---|---|
| | | through Schedules; Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method | |
| III | Interpretation and Report Writing | Meaning of Interpretation, Why Interpretation? Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. | 15 |

**Learning Resources recommended:**

1. Research Methodology by C. R. Kothari, 3rd edition

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USBT301 and USBT302 |
| Course Code | USBTP301 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart knowledge and hands on experience of the various practicals related to biophysics and applied chemistry.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| **Regular Practicals** | 1. Study of Absorption Spectra of Coloured Compounds ($CuSO_4$, $CoCl_2$, $KMnO_4$).<br>2. Verification of Beer-Lambert's Law.<br>3. Extraction of Plasmid DNA and Separation by Agarose Gel Electrophoresis.<br>4. Determination of Purity of Plasmid DNA using UV Spectrophotometry.<br>5. Electrophoresis of Proteins by PAGE and SDS-PAGE.<br>6. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent.<br>9. Organic Estimations: Acetone, Amide, Benzoic Acid.<br>10. Organic Preparations :<br>a) Acetylation of Primary Amine (Preparation of Acetanilide).<br>b) Base Catalyzed Aldol Condensation (Synthesis of Dibenzalpropanone). | 120 |
| **Demonstration Practicals** | 1. Study of the Structure and Function of an Electron Microscope (Visit / Video Demonstration - including Sample Preparation and Staining).<br>2. Demonstration of Structure and Working of a Fluorescence Microscope (Stained Preparation). | |

**Learning Resources recommended:**

1. Advanced organic chemistry, Reinhard Bruckner
2. Biochemistry, Satyanarayan 4th edition
3. Textbook of Biochemistry, Lehninger 4th edition
4. College organic chemistry for T. Y. B. Sc. (Himalaya Publishing House)
5. Green Chemistry by Ahluwalia
6. TY College analytical Chemistry, Himalaya Publications
7. Instrumentation: Devices and systems by C. S. Rangan, TMH Publication
8. Biophysical Chemistry – Principles and Techniques, Upadhyay and Nath

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practicals of USBTP301 | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M<br>(02 Papers)<br>(02 Major and 02 Minor Experiments OR 02 Major Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

# Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USBT303 and USBT304 |
| Course Code | USBTP302 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to immunology.
CO2 - To impart knowledge and hands on experience of the various practicals related to cell biology and cytogenetics.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Complement Fixation Test (CFT).<br>2. Passive Agglutination- RA Factor Test.<br>3. Immunoelectrophoresis.<br>4. ELISA (Kit-based) - HEPALISA.<br>5. DOT-ELISA.<br>6. Study of Chromosomal Aberrations- Deletion, Duplication, Inversion, Translocation and Syndromes- Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter, Turner and Cri-du-Chat.<br>7. Induction of Polyploidy by PDB Treatment using Suitable Plant Material.<br>8. Study of Polytene Chromosomes.<br>9. Mapping based on Tetrad Analysis and Three Point Cross.<br>10. Pedigree Analysis- Autosomal and Sex-Linked. | 120 |
| **Demonstration Practicals** | Western Blotting - Demonstration. | |
| **Visit** | Flow Cytometry - Lab Visit. | |

**Learning Resources recommended:**

1. Microbiology, Prescott Harley, 7th edition
2. Molecular biology of the cell, Bruce Alberts, 4th edition
3. Cell and Molecular biology, De Robertis, 8th edition
4. iGenetics – A molecular approach, Russell, 3rd edition
5. Immunology by Janis Kuby, 5th edition
6. Textbook of Microbiology by Ananthnarayan and Paniker, 8th edition
7. Introduction to immunology by C. V. Rao

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practicals of USBTP302 | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M (02 Papers) (02 Major and 02 Minor Experiments OR 02 Major Experiments) | 40 M (20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

# Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USBT305 and USBT306 |
| Course Code | USBTP303 |
| Class | S. Y. B. Sc. |
| Semester | III |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to molecular biology.
CO2 - To provide knowledge and hands on experience of the various practicals related to bioprocess technology.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| **Regular Practicals** | 1. Study of *E. coli* Diauxic Growth Curve- (Lactose and Glucose).<br>2. Study of lac Gene Expression using Blue-White Selection.<br>3. Expression of β-galactosidase and Measurement of Activity.<br>4. Screening for an Antibiotic Producing Strain of Microorganism.<br>5. Screening for an Alcohol Producing Strain of Microorganism.<br>6. Lab Scale Production of Penicillin (Static and Shaker).<br>7. Purification of Penicillin from Broth Culture of Penicillium spp. by Solvent Extraction.<br>8. Lab Scale Production of Ethanol.<br>9. Purification of Ethanol from Broth Culture of Saccharomyces spp. by Distillation.<br>10. Estimation of Penicillin from Recovered Broth by Chemical (Iodometric) Method.<br>11. Estimation of Penicillin from Recovered Broth by Biological (Bioassay) Method.<br>12. Estimation of Alcohol from Recovered Broth by Dichromate Method. | 120 |

**Learning Resources recommended:**

1. Fermentation by Casida
2. Fermentation by A. H. Patel
3. iGenetics – A molecular approach, Russell, 3rd edition
4. Molecular biology of the cell, Bruce Alberts, 4th edition

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practicals of USBTP303 | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M<br>(02 Papers)<br>(02 Major and 02 Minor Experiments OR 02 Major Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

# Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biochemistry |
| Course Code | USBT401 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To gain an insight into the metabolic processes associated with catabolism of carbohydrates.
CO2 - To gain an insight into the metabolic processes associated with catabolism of amino acids.
CO3 - To gain an insight into the metabolic processes associated with catabolism of lipids and nucleotides.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Carbohydrate metabolism, ETS and Energy rich compounds | **Carbohydrate Metabolism :** Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation; Citric Acid Cycle and its Regulation; Gluconeogenesis; Pentose Phosphate Pathway; Glyoxalate Pathway; Reductive TCA. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) **Electron Transport System :** Electron Transport and Oxidative Phosphorylation. Inhibitors of ETS. **Energy Rich Compounds :** ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc. | 15 |

| | | | |
|---|---|---|---|
| II | Amino acid metabolism | **Amino Acid Breakdown :** Deamination, Transamination, Urea Cycle, Breakdown of Glucogenic and Ketogenic Amino Acids. **Amino Acids as Biosynthetic Precursors :** Biosynthesis of Epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione. (Sequence of Reactions, Regulation and Metabolic Disorders of the above Pathways) | 15 |
| III | Lipid and nucleotide metabolism | **Lipid Metabolism :** Mobilization, Transport of Fatty Acids. Beta, Alpha and Omega Oxidation of Saturated Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids. Energy Yield, Ketone Body Breakdown to Yield Energy. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) **Nucleotide Metabolism :** Degradation of Purines and Pyrimidines. | 15 |

**Learning Resources recommended:**

1. Biochemistry by Satyanarayan and Chakrapani
2. Lehninger Principles of Biochemistry, 4th edition, Nelson and Cox
3. Biochemistry, Voet and Voet, 3rd edition
4. General Microbiology by Stanier

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Applied Chemistry – II |
| Course Code | USBT402 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To have a firm foundation in the fundamentals and applications of current chemical theories for the physical world.
CO2 – To provide the knowledge of sampling and separation techniques.
CO3 – To explore polymers and nanomaterials.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Sampling and separation techniques | **Sampling :**<br>Importance of Sampling and Sampling Techniques<br>Types of Sampling - Random and Non-Random Sampling of Solids, Liquids and Gases.<br>**Separation Techniques :**<br>Types of Separation Techniques - Filtration, Zone Refining, Distillation, Vacuum Distillation.<br>Solvent Extraction – Partition Coefficient and Distribution Ratio, Extraction Efficiency, Separation Factor, Role of Complexing Agents, Chelation, Ion Pair Formation, Solvation, and Soxhlation.<br>Centrifugation - Basic Principles of Sedimentation. | 15 |
| II | Natural product chemistry | **Natural Product Chemistry :**<br>Primary and Secondary Metabolites. | 15 |

| | | | |
|---|---|---|---|
| | | Classification of Natural Products based on Bio-Synthesis.<br>Classification of Natural Products based on Structure- Alkaloids, Phenolics, Essential Oils and Steroids. Structure Determination of Natural Products. Commercial Synthesis of Natural Products.<br>**Chromatographic Separation of Natural Products:**<br>Gas Chromatography and its Applications.<br>Liquid Chromatography: HPLC and its Applications.<br>HPTLC for Separation and Analysis of Natural Products. | |
| III | Polymers and nanomaterials | **Polymers :**<br>Introduction to Polymers.<br>Types of Polymers - Monomer, Polymer, Homopolymer, Copolymer, Thermoplastics and Thermosets, Addition and Condensation Polymers (Examples and Uses) Stereochemistry of Polymers. Biodegradable Polymers.<br>**Nanomaterials :**<br>Introduction to Nanomaterials.<br>Forms of Nanomaterials: Nanoparticles, Nanofilms and Nanotubes Synthesis and Characterization of Nanomaterials. Applications of Nanomaterials. | 15 |

**Learning Resources recommended:**


1. Vogel's Textbook of Quantitative chemical analysis, 6th edition
2. Textbook of organic chemistry for T. Y. B. Sc., Himalaya Publishing House
3. Nanomaterials by B. Viswanathan
4. Polymer Science, V. R. Gowariker, Viswanathan

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Medical Microbiology |
| Course Code | USBT403 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To gain insight into disease factors and processes.
CO2 – To provide the knowledge about diseases caused by microorganisms.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Infectious diseases | **Host Parasite Relationship:** Normal Flora; Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors. **Infection:** Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers. **Diseases:** Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates. | 15 |
| II | Medical Microbiology – Causative organisms – I | **Skin :** *S. aureus, S. pyogenes.* **Respiratory Tract Infections :** *M. tuberculosis, S. pneumoniae* (Characteristics Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). | 15 |

| | | | |
|---|---|---|---|
| | | **Urinary Tract Infections :**<br>*E. coli*: Characteristics, Virulence, Clinical disease, and *E. coli* Infections. *Proteus*. | |
| III | Medical Microbiology – Causative organisms – II | **GI Tract Infections :**<br>*Salmonella and Shigella spps.* *(*Characteristics, Virulence-Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Phage Typing Prophylaxis and Treatment).<br>**Sexually Transmitted Diseases :**<br>Syphilis and Gonorrhoea.<br>**Nosocomial Infections :**<br>*Ps. Aeruginosa* | 15 |

**Learning Resources recommended:**

1. Microbiology: An introduction, Tortora, 9th edition
2. Microbiology by Pelczar and Chan, 5th edition

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

# Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| Name of the Course | Environmental Biotechnology |
| --- | --- |
| Course Code | USBT404 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To gain awareness about different types of environmental pollution.
CO2 – To impart the knowledge of global environmental problems and related issues.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
| --- | --- | --- | --- |
| I | Environmental pollution | **Sources of Pollution.**<br>**Air Pollution :**<br>Types; Sources; Classification of Air Pollutants; Air Pollution Monitoring and Control.<br>**Water Pollution :**<br>Causes, Types and Classification; Eutrophication; Assessment of Water Quality- Pollutant Monitoring and Control;<br>**Soil and Solid Waste Pollution :**<br>Characteristics of Wastes, Impacts of Solid Waste on Health, Occupational Hazards and Control.<br>**Soil Erosion :**<br>Concept, Causes and Effects. | 15 |
| II | Global environmental problems and issues | **Green House Effect :**<br>Factors Responsible for Green House Effect; Green House Gases.<br>Global Warming; Ozone Depletion; Kyoto Protocol; UV Radiation; Acid Rain. | 15 |

| | | | |
|---|---|---|---|
| III | Bioremediation | Concept of Bioremediation. Microorganisms in Bioremediation, Mycoremediation and Phytoremediation. Bioremediation Technologies. Measuring Bioremediation in the Field. Bioaugmentation and Biostimulation. Monitoring the Efficacy of Bioremediation. | 15 |

**Learning Resources recommended:**

1. Environmental Biotechnology by Indu Shekhar Thakur, IK International
2. Environmental Biotechnology by Allan Scragg Oxford University press

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biostatistics and Bioinformatics |
| Course Code | USBT405 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To learn and understand the basic concepts of bioinformatics.
CO2 – To learn and understand the basic concepts and problem solving skills in biostatistics.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Introduction to computers and biological databases | **Computer Basics :** Organization of a Computer; I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating System. **Internet Basics :** Connecting to the Internet, E-mail, FTP, www, Difference between www and Internet. **Biological Databases :** Classification of Databases - Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases. Specialized Databases - Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP). **Genome Information Resources:** DNA Sequence Databases Specialized Genomic Resources. | 15 |

| | | | |
|---|---|---|---|
| | | Protein Databases based on Composition, Motifs and Patterns. **Protein Structure Visualization Software.** | |
| II | BLAST and sequence alignment | **BLAST and Sequence Alignment:** BLAST and its Types; Retrieving Sequence using BLAST. **Pairwise Alignment:** Identity and Similarity; Global and Local Alignment; Pairwise Database Searching. **Multiple Sequence Alignment:** Goal of Multiple Sequence Alignment; Computational Complexity; Manual Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching; Analysis Packages; MSA and Phylogenetic Trees. | 15 |
| III | Biostatistics | Theory and Problems based on-Coefficient of Correlation and Regression Analysis; Steps in Testing Statistical Hypothesis; Parametric Tests:- Z Test – Single Mean and Two Means, t-Test – Single Mean, Paired and Unpaired; Chi-Square Test. | 15 |

**Learning Resources recommended:**

1. Bioinformatics by S. C. Rastogi
2. Bioinformatics by Attawood
3. Methods in Biostatistics by B. K. Mahajan

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

# Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Molecular Diagnostics |
| Course Code | USBT406 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | ~~Core~~/ Elective |

**Course Outcomes:**

CO1 - To learn and understand the molecular techniques and utilizing these techniques in diagnosis.

CO2 – To provide the importance of various nucleic acid amplification methods.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Basics of molecular diagnostics | **Introduction to Molecular Diagnostics:** Overview of Molecular Diagnostics; History of Molecular Diagnostics; Molecular Diagnostics in Post Genomic Era; Areas used in Molecular Diagnostics; Future Prospects - Commercialising Molecular Diagnostics, Personalized Medicine, Theranostics. **Characterisation and analysis of Nucleic – Acids and Proteins:** Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping. **Hybridisation Techniques:** Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications. | 15 |

| | | | |
|---|---|---|---|
| II | Nucleic acid amplification methods | **Target amplification :**<br>PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection.<br>**PCR Types :**<br>Reverse Transcriptase and Real Time PCR.<br>**Probe amplification :**<br>Ligase Chain Reaction | 15 |
| III | Molecular Biology based diagnostics | **DNA Polymorphism and Identification:**<br>RFLP and Parentage Testing;<br>RFLP and Sickle-Cell Anaemia.<br>**Molecular Diagnostics for Infectious Diseases**<br>Molecular Testing for *Neisseria*, Molecular Diagnosis for HIV-1;<br>**Genetic Counselling and Molecular Diagnosis**<br>Genetic Testing- Need and Uses; genetic Counselling.<br>Case Studies- Diagnostic Testing for Cystic Fibrosis; Fragile X Diagnostic and Carrier Testing.<br>**Ethical, Social and Legal Issues to Molecular - Genetic Testing** | 15 |

**Learning Resources recommended:**


1. Molecular Diagnostics by George Patrinos
2. Molecular Diagnostics: Fundamentals, methods and clinical applications, Lela Buckingham and Maribeth Flaws
3. Molecular Diagnostics: For the clinical laboratorian, edited by William B. Coleman, Gregory J. Tsongalis

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Entrepreneurship Development |
| Course Code | USBT407 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | ~~Core~~/ Elective |

**Course Outcomes:**

CO1 - To develop and systematically apply an entrepreneurial way of thinking.
CO2 – To identify and create the business opportunities.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Introduction to Entrepreneurship Development | Concept of Entrepreneur; Entrepreneurship; Need and Importance; Factors Influencing Entrepreneurship; Essentials of a Successful Entrepreneur | 15 |
| II | Setting-up of an Enterprise and Planning | Location of Enterprise; Real Estate and Human Resource Planning, Financial Planning; Role of Government and Financial Institutions in Entrepreneurship Development; Raising Money from Venture Capitalists, Government Grants, Product Selection and Ideas; Project Planning and Formulation; Project Feasibility Assessment; Regulatory Affairs, Corporate Laws,<br>Innovation, IPR generation and Protection, Preparation of a Business Plan, Characteristics and Importance of Planning; | 15 |
| III | Marketing, sales, advertising and | Marketing Plan for an Entrepreneur; Strategic Alliances, Advertising and Sales Promotion; | 15 |

| | | | |
|---|---|---|---|
| | International market research | Market Assessment, Need for International Market Research, Domestic *vs.* International Market Research, Cost and Methodology of Market Research, Desk and Field Research | |

**Learning Resources recommended:**

1. Towards Entrepreneurship by Dr. M. R. Kurup
2. Handbook of Entrepreneurship Development by Basotia and Sharma

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Long Answer Questions 15 M |
| 2 | II | Long Answer Questions 15 M |
| 3 | III | Long Answer Questions 15 M |
| 4 | All Units | Short notes (03 out of 06) 15 M |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals based on USBT401 and USBT402 |
| Course Code | USBTP401 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to biochemistry.
CO2 - To provide the knowledge and hands on experience of the various practicals related to applied chemistry.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum.<br>2. Determination of Total, LDL and HDL Cholesterol in Serum.<br>3. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum).<br>4. Estimation of Uric Acid and Creatinine in Urine.<br>5. Qualitative Detection of Ketone Body in Urine.<br>6. Isolation of Mitochondria and Demonstration of ETC using a Marker Enzyme.<br>7. Separation of Binary (Solid-Solid) Mixture (Min 4 Compounds).<br>8. Identification of Organic Compound of Known Chemical Type (Min 4 Compounds).<br>9. HPLC analysis and Interpretation of any one Secondary Metabolite from Plants<br>10. Analysis of Essential Oils from any Plant Source using GC.<br>11. HPTLC fingerprint analysis of any one Medicinally Important Plant.<br>12. Chemical and Biological Synthesis of Silver Nanoparticles and its Characterisation by UV- VIS Spectrophotometer. | 120 |

**Learning Resources recommended:**

1. Vogel's Textbook of Quantitative chemical analysis, $6^{th}$ edition
2. Textbook of organic chemistry for T. Y. B. Sc., Himalaya Publishing House
3. Nanomaterials by B. Viswanathan
4. Polymer Science, V. R. Gowariker, Viswanathan
5. Biochemistry by Satyanarayan and Chakrapani
6. Lehninger Principles of Biochemistry, $4^{th}$ edition, Nelson and Cox
7. Biochemistry, Voet and Voet, $3^{rd}$ edition
8. General Microbiology by Stanier

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practicals of USBTP401 | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M<br>(02 Papers)<br>(02 Major and 02 Minor Experiments OR 02 Major Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals based on USBT403 and USBT404 |
| Course Code | USBTP402 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to medical microbiology.
CO2 - To impart knowledge and hands on experience of the various practicals related to environmental biotechnology.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Identification of *S. aureus* - Isolation, Catalase, Coagulase Test.<br>2. Identification of *E. coli*- Isolation, Sugar Fermentations, IMViC.<br>3. Identification of Salmonella- Isolation, Sugar Fermentations, TSI Slant.<br>4. Identification of Shigella- Isolation, Sugar Fermentations, TSI Slant.<br>5. Identification of Proteus- Isolation, Sugar Fermentations, IMViC.<br>6. Identification of Pseudomonas - Isolation, Urease test, Oxidase Test, TSI Slant.<br>7. RPR Test (Kit Based).<br>8. Permanent Slide- Mycobacterium.<br>9. Biological Oxygen Demand (BOD).<br>10. Chemical Oxygen Demand (COD).<br>11. Isolation of Bacteria from Air by Gravity Sedimentation Method.<br>12. Most Probable Number (MPN) – Presumptive, Confirmed and Completed Tests.<br>13. Bioremediation of Metal. | 120 |
| **Visit** | Visit to STP / CETP | |

**Learning Resources recommended:**

1. Microbiology: An introduction, Tortora, 9th edition
2. Microbiology by Pelczar and Chan, 5th edition
3. Environmental Biotechnology by Indu Shekhar Thakur, IK International
4. Environmental Biotechnology by Allan Scragg Oxford University press

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practicals of USBTP402 | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M<br>(02 Papers)<br>(02 Major and 02 Minor Experiments OR 02 Major Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

## Syllabus for S. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals based on USBT405 and USBT406 |
| Course Code | USBTP403 |
| Class | S. Y. B. Sc. |
| Semester | IV |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical/ ~~Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to biostatistics and bioinformatics.
CO2 - To impart knowledge and hands on experience of the various practicals related to molecular diagnostics.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases.<br>2. Use of NCBI BLAST Tool.<br>3. Pairwise and Multiple Sequence Alignment and Phylogeny.<br>4. Classification of Proteins using CATH/SCOP.<br>5. Visualization PDB Molecules using Rasmol/Raswin.<br>6. Handling and Calibration of Micropipette.<br>7. Isolation, Quantitative Analysis and AGE of Genomic DNA from Bacteria and Yeast.<br>8. Isolation and Detection of RNA from Bacteria and Yeast.<br>9. Restriction Enzyme Digestion.<br>10. RFLP- Kit Based.<br>11. Primer Designing through Open Online Source NCBI-BLAST.<br>12. DNA Amplification – PCR. | 120 |

**Learning Resources recommended:**

1. Bioinformatics by S. C. Rastogi
2. Bioinformatics by Attawood
3. Methods in Biostatistics by B. K. Mahajan
4. Molecular Diagnostics by George Patrinos
5. Molecular Diagnostics: Fundamentals, methods and clinical applications, Lela Buckingham and Maribeth Flaws
6. Molecular Diagnostics: For the clinical laboratorian, edited by William B. Coleman, Gregory J. Tsongalis

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practicals of USBTP403 | 4 experiments of 1.5 hrs duration<br><br>(02 Papers) | 06 hrs | 60 M<br>(02 Papers)<br>(02 Major and 02 Minor Experiments OR 02 Major Experiments) | 40 M<br>(20 M for Journal, 10 M for viva, 10 M for overall performance) | 100 |

(Rashmi A. Bhave)
The Chairperson, BoS

# R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

## Syllabus for
## T. Y. B. Sc. Biotechnology Programme
## Semester V and VI

## Under Choice Based Credit System (CBCS)
## To be implemented from the Academic Year
## 2023 - 2024

| | |
|---|---|
| Name of Programme | **B. Sc. Biotechnology** |
| Level | UG |
| No. of Semesters | 06 |
| Year of Implementation | **2023 – 24** |
| Programme Specific Outcomes (PSO) | 1. To impart skills in handling the cultures of micro – organisms.<br>2. To impart the knowledge of molecular biology techniques.<br>3. To impart the skills of Science communication.<br>4. To impart knowledge of society and make students aware about the Problems in society.<br>5. To understand basic principles of research methodology and identify a research problem.<br>6. To gain critical thinking and analytical skills to understand new diagnostic methods.<br>7. To write a business plan.<br>8. To design strategies for successful implementation of ideas. |
| Relevance of PSOs to the local, regional, national, and global developmental needs | Biotechnology is important at Global, Regional and local level. The significance of Biotechnology identified at all these levels and it is relevant to everyday life. The curriculum design of B. Sc. Biotechnology programme helps in understanding various concepts in detail. This programme includes hands on skills and knowledge of the different techniques related to molecular biology, tissue culture, basic chemistry and basic microbiology. This also involves the knowledge of problems in society. The application part is taken care of so that the learner shall be able to connect the phenomena around him with the curriculum. This programme also imparts the research values among the learners. The hard and softs skills acquired during the completion of this programme shall make him employable. |

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40 % marks in the first part and by conducting the Semester End Examinations of 60 % marks in the second part.

**Standard of Passing**

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i. e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i. e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

**Performance Grading:**

**Letter Grades and Grade Points**

| **Semester GPA/ Program CGPA Semester/Program** | **% of Marks** | **Alpha-Sign / Letter Grade Result** |
|---|---|---|
| 9.00-10.00 | 90.0 -100 | 0 (Outstanding) |
| 8.00 ≤ 9.00 | 80.0 ≤ 90.0 | A+ (Excellent) |
| 7.00 ≤ 8.00 | 70.0 ≤ 80.0 | A (Very Good) |
| 6.00 ≤ 7.00 | 60.0 ≤ 70.0 | B+ (Good) |
| 5.50 ≤ 6.00 | 55.0 ≤ 60.0 | B (Above Average) |
| 5.00 ≤ 5.50 | 50.0 ≤ 55.0 | C (Average) |
| 4.00 ≤ 5.00 | 40.0 ≤ 50.0 | P (Pass) |
| Below 4.00 | Below 40 | F (Fail) |
| Ab (Absent) | - | Absent |

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Cell Biology |
| Course Code | USBT501 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart the knowledge of cell cycle.
CO2 – To provide the insight of cell signalling.
CO3 – To gain the knowledge of developmental biology.
CO4 – To impart the knowledge of cancer biology.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Cell cycle | Cell cycle Introduction: Prokaryotic and Eukaryotic- **3 Lectures;** The Early Embryonic Cell Cycle and the Role of MPF-**4 Lectures;** Yeasts and the Molecular Genetics of Cell-Cycle Control – **4 Lectures;** Apoptosis, Cell-Division Controls in Multicellular Animals- **4 Lectures** | 15 |
| II | Cell signalling | Cell signalling and signal transduction: Introduction General Principles of Cell Signalling - **3 Lectures;** Signalling via G-Protein-linked Cell-Surface Receptors - **3 Lectures;** Signalling via Enzyme-linked Cell-Surface Receptors - **3 Lectures;** Target-Cell Adaptation, The Logic of Intracellular - **3 Lectures;** Signalling: Lessons from Computer-based "Neural Networks"- **3 Lectures** | 15 |

| | | | |
|---|---|---|---|
| III | Developmental Biology | Overview of how the modern era of developmental biology emerged through multidisciplinary approaches - **5 Lectures;** 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 - **6 Lectures;** Mechanisms of differentiation-cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation--axis specification, positional identification (regional specification), Morphogenetic movements, Model organisms in Developmental biology – **4 Lectures** | 15 |
| IV | Cancer Biology | Cancer: Introduction, Cancer as a Microevolutionary Process - **4 Lectures**; The Molecular Genetics of Cancer - **6 Lectures**; Cancer and Virus Cancer diagnosis and chemotherapy - **5 Lectures** | 15 |

**Learning Resources recommended:**


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

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

# Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Medical Microbiology and Instrumentation |
| Course Code | USBT502 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of medical microbiology.
CO2 – To provide the insight of the various skills and instrumentation.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Virology | Introduction to viruses-Position in biological spectrum; Virus properties **- 2 Lectures**; General structure of viruses Baltimore Classification and Taxonomy (ICTV) **- 2 Lectures**; Cultivation of viruses - **2 Lectures**; Reproduction of ds DNA phages Hepatitis /ss RNA (influenza), animal viruses and plant (TMV) virus – **4 Lectures;** Virus purification and assays - **2 Lectures;** Cytocidal infections and cell damage **- 2 Lectures; Viroids** and Prions – **1 Lecture** | 15 |
| II | Chemotherapeutic drugs | Discovery and Design of antimicrobial agents **-1 Lecture**; Classification of Antibacterial agents, Selective toxicity, MIC, MLC – **2 Lectures** Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: | 15 |

| | | | |
|---|---|---|---|
| | | Vancomycin; Polypeptides: Bacitracin -**2 Lectures**<br>Injury to Plasma membrane: Polymyxin – **1 Lecture**;<br>Inhibition of protein synthesis Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides- Erythromycin- **2 Lectures**;<br>Inhibition of Nucleic acid synthesis:<br>Quinolones, Rifampicin, Metronidazole - **2 lectures**;<br>Antimetabolites: Sulphonamides, Trimethoprim **- 1 lecture**;<br>Drug Resistance: Mechanism, Origin and transmission of drug resistance – **1 lecture**;<br>Use and misuse of antimicrobial agents - **1 lecture**;<br>Antifungal drugs, Antiviral drugs – **2 lectures** | |
| III | Spectroscopy | Principle, instrumentation, working and applications of: Fluorescence Spectroscopy – **3 Lectures**<br>Luminometry **- 3 Lectures**<br>Light scattering spectroscopy **- 3 Lectures**<br>Infrared Spectroscopy **- 3 Lectures**<br>Atomic absorption Spectroscopy – **3 Lectures** | 15 |
| IV | Bioanalytical techniques | Principle, working and applications of: Affinity chromatography **- 2 Lectures**<br>Ion-exchange chromatography **- 2 Lectures**<br>Molecular (size) exclusion chromatography **- 2 Lectures;**<br>HPLC - Method development and validation- **3 Lectures**;<br>Isotopes in Biology: Nature of radioactivity **- 1 Lecture**;<br>Detection Techniques using GM counter, Scintillation counter, autoradiography **- 4 Lectures**; | 15 |

| | | | |
|---|---|---|---|
| | | Applications of Tracer techniques in<br>Biology - **1 Lecture** | |

**Learning Resources recommended:**


1. Principles and techniques in biochemistry and molecular biology (2010), Keith Wilson and John Walker, 7th edition, Cambridge University Press

2. Biophysics (2002) Vasantha Pattabhi and N. Gautham, Kluwer Academic Publishers

3. Physical Biochemistry: principles and applications, 2nd edition (2009), David Sheehan, John Wiley & Sons Ltd

4. HPLC method validation for pharmaceuticals: a review (2013), Harshad V. Paithankar, International Journal of Universal Pharmacy and Bio Sciences 2(4): July-August.

5. Mim's Medical Microbiology 5th edition

6. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill

7. Medical Microbiology Jawetz,E., Brooks,G.E, Melnick,J.L., Butel,J.S Adelberg E. A 18th edition

8. Medical Microbiology by Patrick Murray 5th edition

9. Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown

10. Understanding Viruses by Teri Shors


**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Genomes and Molecular Biology |
| Course Code | USBT503 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of genetic engineering of plants and animals.
CO2 – To provide the skills in molecular biology tools, gene sequencing and editing.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Genetic engineering of plants | Genetic engineering of plants; Methodology. Plant transformation with the Ti plasmid of *A. tumefaciens*, Ti plasmid derived vector system **- 4 Lectures;** Transgenic plants: Physical methods of transferring genes to plants : electroporation, microprojectile bombardment, liposome mediated, protoplast fusion- **5 Lectures;** Vectors for plant cells **- 4 Lectures;** Improvement of seed quality protein **- 2 Lectures** | 15 |
| II | Transgenic animals | Transgenic mice- methodology- retroviral method, DNA microinjection, ES method - **5 Lectures;** genetic manipulation with cre-loxP **- 2 Lectures;** Vectors for animal cells – **2 Lectures;** Transgenic animals recombination system – **2 Lectures;** | 15 |

| | | | |
|---|---|---|---|
| | | Cloning livestock by nuclear transfer – **2 Lectures;** Green Fluorescent Protein **- 1 Lectures;** Transgenic fish – **1 Lectures** | |
| III | Tools in molecular biology | Cloning vectors-Plasmids (pUC series), Cosmids, phagemids M13, shuttle vectors, YAC vectors, expression vectors pET - **4 Lectures;** 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 - **3 Lectures;** Recombinant selection and screening methods: genetic, immunochemical, Southern and Western analysis, nucleic acid hybridization, HART,HRT- **2 Lectures;** Expression of cloned DNA molecules and maximization of expression **- 2 Lectures;** Cloning strategies-genomic DNA libraries, cDNA libraries, chromosome walking and jumping – **4 Lectures** | 15 |
| IV | Gene sequencing and editing | Maxam Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing - **6 Lectures;** Human genome mapping and its implications in health and disease **- 3 Lectures**; RNAi, ZNF(Zinc finger nucleases), TALENS(Transcription Activator Like Effector Nucleases), CRISPER/Cas system(Clustered Regularly Interspersed Repeats) **- 6 Lectures** | 15 |

**Learning Resources recommended:**

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. Genomes 3rd Edition T.A. Brown.

6. Biotechnology B.D. Singh.

7. Gene Cloning and DNA Analysis 6th Edition T.A. Brown.

8. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

# Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Marine Biotechnology |
| Course Code | USBT504 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of marine Biotechnology.

CO2 – To acquire the significance of marine functional foods, nutraceuticals, drugs, enzymes.

CO3 – To gain the role of marine bioresources in cosmetics.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Marine Biotechnology – Introduction and Bioprospecting | Introduction to Marine Biotechnology- **1 lecture;** The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal &deep sea ecosystems. Hydrothermal vents- **4 lectures;** Bioprospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms- **2 lectures;** Methods for Microbial Bioprospecting in Marine Environments **- 2 lectures;** Biotechnological Potential of Marine Microbes **-1 lecture;** Bioactive compounds from other Marine Organisms: fungi, Microalgae, Seaweeds, Actinomycetes, sponges - **5 lectures** | 15 |

| | | | |
|---|---|---|---|
| II | Marine drugs and enzymes | Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents – **4 lectures;** Approved Marine Drugs as Pharmaceuticals **– 2 lecture;** Marine Natural products and its Challenges **– 2 lectures;** Marine Microbial Enzymes- Marine Extremozymes and Their Significance, Current Use of Marine Microbial Enzymes – **7 lectures.** | 15 |
| III | Marine functional foods and nutraceuticals | Marine Functional Foods: Marine Sources as Healthy Foods or Reservoirs of Functional Ingredients -**3 lectures;** Marine-Derived Ingredients with Biological Properties- **3 lectures;** Functional Foods Incorporating Marine-Derived Ingredients **-2 lectures;** Marine Nutraceuticals : Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated Fatty Acids- **3 lectures;** Carotenoids, Soluble Calcium, Fish Collagen and Gelatin, Marine Probiotics **-4 lectures.** | 15 |
| IV | Marine Bioresources and Cosmetics | Marine Bioresources, Marine Secondary Metabolites, Marine Proteins, Marine Lipids- **4 lectures;** Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry, Cosmetics: Definition and Regulations, Cosmeceuticals , Target Organs and Cosmetics Delivery Systems, Components of Cosmetics, Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals , Treatments Based | 15 |

| | | | |
|---|---|---|---|
| | | on Marine Resources , Products Based on Marine Resources **- 11 lectures.** | |

**Learning Resources recommended:**

1. Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.

2. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press_Taylor& Francis (2017)

3. R. S. K. Barnes, R. N. Hughes (auth.)-An Introduction to Marine Ecology, Third Edition Wiley-Blackwell (1999)

4. Blanca Hernández-Ledesma, Miguel Herrero-Bioactive Compounds from Marine Foods-Plant and Animal Sources-Wiley-Blackwell (2013)

5. Fabio Rindi, Anna Soler-Vila, Michael D. Guiry (auth.), Maria Hayes (eds.)-Marine Bioactive Compounds_ Sources, Characterization and Applications-Springer US (2012)

6. W. Evans-Trease and Evans Pharmacognosy 15th ed.-Saunders (2010)

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Applied Component – Biosafety |
| Course Code | USACBT501 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of Biosafety practices.
CO2 – To provide the knowledge about detection and testing of contaminants.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Introduction to biosafety | Introduction - **1 lecture** Biological Risk Assessment, Hazardous Characteristics of an Agent- **2 lectures;** Genetically modified agent hazards – **1 lecture**; Cell cultures - **1 lecture;** Hazardous Characteristics of Laboratory Procedures – **1 lecture;** Potential Hazards Associated with Work Practices – **2 lectures;** Safety Equipment and Facility Safeguards - **2 lectures**; Pathogenic risk and management - **2 lectures** | 15 |
| II | GLP | Concept of GLP**- 1 lectures;** Practicing GLP- **1 lecture**; Guidelines to GLP **- 2 lectures;** Documentation of Laboratory work **- 1 lectures;** Preparation of SOPs - **2 lectures**; Calibration records **- 1 lectures;** Validation of methods **- 1 lectures;** Documentation of results – **1 lecture**; Audits & Audit reports **- 1 lecture.** | 15 |

| | | | |
|---|---|---|---|
| III | Detection and testing of contaminants | Microbial Contamination in food and pharma product - **3 lectures**; Some common microbial contaminants **- 3 lectures;** Microbiological Assays for pharmaceutical products – **4 lectures**; Regulatory Microbiological testing in pharmaceuticals - **3 lectures.** | 15 |
| IV | Biosafety in Biotechnology | Concepts on biosafety in Biotechnology - **2 lectures;** Regulating rDNA technology **-2 lectures;** Regulating food and food ingredients -**3 lectures;** Genetically engineered crops, livestock Bioethics **-3 lectures;** Contemporary issues in Bioethics **- 2 lectures.** | 15 |

**Learning Resources recommended:**

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

**Evaluation Pattern**

A. **Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USBT501 and USBT502 |
| Course Code | USBTP501 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 03 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to cell biology.
CO2 - To impart knowledge and hands on experience of the various practicals related to medical microbiology and instrumentation.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Separation of components from a mixture using Affinity chromatography (Kit may be used)<br>2. Separation of components from a mixture using ion exchange chromatography (Kit may be used)<br>3. Separation of components from a mixture using Size exclusion chromatography (Kit may be used)<br>4. HPLC method validation.<br>5. MIC and MLC of any one antibiotic<br>6. Antibiotic sensitivity test using agar cup method<br>7. Antibiotic sensitivity test using paper disc method<br>8. Antibiotic sensitivity test using ditch method.<br>9. Book review (Emperor of all Maladies) | 72 |
| **Demonstration Practical** | Chick embryo candling and inoculation methods Demonstration experiment | |
| **Visit** | Cancer Biology: (Field visit and 2 page report in the journal) | |

**Learning Resources recommended:**

1. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA

2. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA

3. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA

4. Developmental Biology; Scott Gilbert; 9th Edition

5. Principles and techniques in biochemistry and molecular biology (2010), Keith Wilson and John Walker, 7th edition, Cambridge University Press

6. HPLC method validation for pharmaceuticals: a review (2013), Harshad V. Paithankar, International Journal of Universal Pharmacy and Bio Sciences 2(4): July-August.

7. Mim's Medical Microbiology 5th edition

8. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| TY Practical | 3 experiments of 2 hrs duration | 06 hrs | 60 M (01 Paper) (20 M for 1 Experiment, 25 M for 1 Experiment, 15 M for 1 Experiment,) | 40 M (10 M for Journal, 10 M for Book Review, 10 M for viva, 05 M Identification/ Spotting, 05 M for overall performance) | 100 |

# Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USBT503 and USBT504 |
| Course Code | USBTP502 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 03 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to genomes and molecular biology.
CO2 - To impart knowledge and hands on experience of the various practicals related to marine Biotechnology.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Transformation in *E. coli*.<br>2. Genomic DNA Extraction: Animal cells.<br>3. Restriction enzyme digestion and ligation (Kit may be used).<br>4. Gradient plate technique<br>5. Bacterial gene expression (Kit may be used).<br>6. Study of any 5 marine bacteria and algae (Macro and micro)<br>7. DPPH assay for antioxidant extracted from marine algae<br>8. Extraction of carotenoids from marine algae/Bacteria/Fungi<br>9. Extraction and estimation of Gelatin / Collagen.<br>10. Extraction of alkaloids from marine organisms and their separation by TLC. | 72 |
| **Demonstration Practicals** | 1. Phage titration: Demonstration<br>2. Polymerase chain reaction. Demonstration | |

**Learning Resources recommended:**

1. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.

2. Gene Cloning and DNA Analysis 6th Edition T.A. Brown.

3. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)

4. Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.

5. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press Taylor & Francis (2017)

6. R. S. K. Barnes, R. N. Hughes (auth.)-An Introduction to Marine Ecology, Third Edition Wiley-Blackwell (1999)

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| TY Practical | 3 experiments of 2 hrs duration | 06 hrs | 60 M (01 Paper) (20 M for 1 Experiment, 25 M for 1 Experiment, 15 M for 1 Experiment) | 40 M (10 M for Journal, 10 M for viva, 15 M for Identification/ Spotting, 05 M for overall performance) | 100 |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USACBT501 |
| Course Code | USACBTP503 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to biosafety.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| **Regular Practicals** | 1.Validation of micropipette, measuring cylinders, colorimeters<br>2. Calibration of pH meter and weighing balance<br>3. Vitamin B12 bioassay<br>4. Testing for adulterants in food; ex. Starch in milk<br>5. Making SOP for any 2 major laboratory instruments<br>6. Sterility of injectables | 48 |

**Learning Resources recommended:**


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

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| TY Practical (AC) | 4 experiments of 1.5 hrs duration | 6 hrs | 60 M (20 M each for 2 Experiments, 10 M each for 2 Experiments) | 40 M (10 M for Journal, 10 M for SOP Writing, 10 M for Viva, 05 M for Identification, 05 M for overall performance) | 100 |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biochemistry |
| Course Code | USBT601 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of protein biochemistry and metabolism.
CO2 – To provide the insight of endocrinology and nutrition.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Protein Biochemistry | Protein structure: Protein Tertiary and Quaternary Structures **-2 Lectures;** Protein Denaturation and Folding – **3 Lectures**; Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen Binding Proteins – **2 Lectures;** Complementary Interactions between Proteins and Ligands: Immunoglobulins – **1 Lecture**; Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors **-3 Lectures**; Protein purification – **4 Lectures.** | 15 |
| II | Metabolism | Carbohydrate biosynthesis and its regulation: Peptidoglycan in Bacteria **-2 Lectures;** Starch and sucrose in Plants **-4 Lectures;** Glycogen in Animals - **4 Lectures;** Biosynthesis and regulation of Cholesterol, Atherosclerosis – **5 Lectures.** | 15 |
| III | Endocrinology | Mechanism of action of group I and II hormones- **1 Lecture;** Structure, | 15 |

| | | | |
|---|---|---|---|
| | | storage, release, transport, biochemical functions and disorders associated with hormones secreted by Hypothalamus **-1 Lecture;** Anterior Pituitary gland - GH, stimulating hormones) **-1 Lecture;** Posterior Pituitary gland – oxytocin and vasopressin **-1 Lecture;** Thyroid gland – Thyroxine, calcitonin – **2 Lectures;** Parathyroid gland – PTH **-1 Lecture;** Adrenal medulla – epinephrine and norepinehprine **-1 Lecture;** Adrenal cortex – Glucocortocoids – **1 Lecture;** Pancreas – insulin and glucagon – **2 Lectures;** Female Gonads – estrogen and progesterone - **2 Lectures;** Male gonads – testosterone- **1 Lecture;** Placenta – hCG **- 1 Lecture.** | |
| IV | Nutrition | Minerals and Vitamins; Dietary sources, bioactive form, functions and disorders associated with fat soluble (A D E K) and water soluble vitamins- **7 Lectures;** Minerals - physiological and biochemical functions of principal and trace elements. – **7 Lectures;** Malnutrition – Over nutrition (obesity) and PEM (Kwashiorkor and Marasmus)- **1 Lecture.** | 15 |

**Learning Resources recommended:**


1. Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and Michael Cox W.H. Freeman and Company, New York.

2. Biochemistry, 4th edition (2010), Voet and Voet, John Wiley and sons, USA

3. Harper’s Illustrated Biochemistry, 27th edition, RK Murray, DK Granner, PA Mayes and VW Rodwell, McGraw Hills publication.

4. Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P) Ltd

5. Nutrition Science, 6th edition (2017), Srilakshmi, new age international publishers.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Industrial Microbiology |
| Course Code | USBT602 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of dairy technology.
CO2 – To gain the detailing of fermentation processes.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Dairy technology | Milk: Normal flora, changes in raw milk - **2 lectures;** Enumeration - **1 lecture**; Factors affecting bacteriological quality - **1 lecture**; Dairy technology Preservation methods - **2 lectures**; Pasteurization- **1 lecture**; Starter Cultures - **2 lectures;** Fermented products-Production process and spoilage of Cheese: Swiss and Cheddar - **2 lectures;** Butter - **2 lectures;** Yogurt - **1 lectures** and Buttermilk **- 1 lecture.** | 15 |
| II | Down-stream processing (DSP) | Introduction of DSP **- 2 lectures;** Foam separation - **1 lecture**; Types of Precipitation - **1 lecture**; Filtration **2 lectures**, Centrifugation - **1 lecture;** Chromatography in DSP **- 2 lectures;** Cell disruption-physical and chemical methods - **2 lectures;** Solvent recovery, Membrane processes - **1 lecture;** Drying – **1 lecture**; | 15 |

| | | | |
|---|---|---|---|
| | | Crystallization and Whole broth processing - **2 lectures**. | |
| III | Fermentation process | Introduction to Inoculum development **- 2 lectures;** Bacterial and fungal inoculum development with one example each - **3 lectures**, scale up, scale down - **2 lectures**;<br>Production of: Streptomycin – **1 lecture;** Protease – **1 lecture;** Mushroom - **1 lecture;** Glutamic acid **- 1 lecture;** Lysine – **1 lecture,** ethanol production **1 lecture** Semi-synthetic Penicillin **1 lecture**, Biotransformation **- 1 lecture.** | 15 |
| IV | QA-QC | Concept of GMP- **1 Lectures;** Requirements of GMP implementation - **2 Lectures;** Documentation of GMP practices – **2 Lectures**; Regulatory certification of GMP **- 2 Lectures;** Quality Control (QC**)**: Concept of QC **- 2 Lectures;**<br>Requirements for implementing QC - **2 Lectures;** QA concepts: Concept of QA - **2 Lectures;** Requirements for implementing - **2 Lectures**. | 15 |

**Learning Resources recommended:**


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

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Pharmacology and Neurochemistry |
| Course Code | USBT603 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of general principles of pharmacology.
CO2 – To provide the knowledge of neurochemistry.
CO3 – To gain the knowledge of basic and regulatory toxicology.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | General principles of pharmacology | Mechanism of drug action - **2 Lectures;** drug receptors and biological responses – **2 Lectures;** second-messenger systems, the chemistry of drug–receptor binding – **2 Lectures;** dose–response relationship: therapeutic index - **3 Lectures;** ED, LD, - **2 Lectures;** Potency and Intrinsic Activity – **2 Lectures;** Drug antagonism – **2 Lectures.** | 15 |
| II | Drug absorption and distillation | Absorption of drugs from the alimentary tract - **2 Lectures;** factors affecting rate of gastrointestinal absorption – **2 Lectures;** absorption of drugs from lungs **- 1 Lecture;** skin **- 1 Lecture;** absorption of drugs after parenteral administration factors influencing drug distribution – **2 Lectures;** binding of drugs to plasma proteins – **2 Lectures;** Physiological barriers to drug distribution – **3 Lectures.** | 15 |

| | | | |
|---|---|---|---|
| III | Basic toxicology and regulatory toxicology | Background Definitions - **1 Lectures;** Causation: degrees of certainty Classification - **1 Lectures;** Causes Allergy in response to drugs Effects of prolonged administration: chronic organ toxicity - **2 Lectures;** Adverse effects on reproduction **- 1 Lecture;** Poisons: Deliberate and accidental self-poisoning Principles of treatment Poison-specific measures General measures - **2 Lectures;** Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, - **3 Lectures;** herbicides and pesticides, - **2 Lectures;** biological substances (overdose of medicinal drugs is dealt with under individual agents**)** **- 1 Lecture;** Incapacitating agents: drugs used for torture **- 1 Lecture;** Nonmedical use of drugs – **1 Lecture.** | 15 |
| IV | Neurochemistry | Anatomy and functioning of the brain – **2 Lectures;** Neuronal pathways - **2 Lectures;** Propogation of nerve impulses - **2 Lectures;** Neuronal excitation and inhibition – **3 Lectures;** Synapses and gap junctions **- 3 Lectures;** Action of Neuro toxins and neurotransmitters **- 3 Lectures.** | 15 |

**Learning Resources recommended:**


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

**Evaluation Pattern**

**A. Internal Evaluation**

| Method | Marks |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| Question No. | Unit | Marks |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Environmental Biotechnology |
| Course Code | USBT604 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 2.5 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of renewable sources of energy.
CO2 – To understand the industrial effluent treatment.
CO3 – To gain knowledge about wastewater treatments.
CO4 – To provide the understanding of hazardous waste management.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Renewable sources of energy | Energy sources renewable – solar energy, wind power, geothermal energy and hydropower, biomass energy - **5 Lectures;** Biogas technology- biogas plant & types, biodigester. Biogas- composition, production and factors affecting production, uses – **5 Lectures;** Biofuels – ethanol production. Microbial hydrogen production Biodiesel, Petrocrops **- 5 Lectures** | 15 |
| 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 - **5 Lectures;** Anaerobic biological treatment- contact digesters, packed bed | 15 |

| | | | |
|---|---|---|---|
| | | reactors, anaerobic baffled digesters, UASB - **3 Lectures;** Solid waste treatment **- 2 Lectures;** pollution indicators & biosensors - **2 Lectures;** biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation - **2 Lectures;** Use of immobilized enzymes or microbial cells for treatment - **1 Lecture.** | |
| III | Wastewater treatment | Wastewater treatment-introduction, biological treatment, impact of pollutants on biotreatment, use of packaged organisms and genetically engineered organisms in waste treatment – **5 Lectures;** Heavy metal pollution – sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal – **5 Lectures;** biosorption by bacteria, fungi and algae, factors affecting biosorption limitations of biosorption - **5 Lectures.** | 15 |
| IV | Hazardous waste management | Biodegradation of waste from tanning industry **- 2 Lectures;** petroleum industry **- 2 Lectures;** paper & pulp industry - **2 Lectures;** Dairy – **2 Lectures;** Distillery **- 2 Lectures;** Dye – **1 Lecture;** Antibiotic industry **- 2 Lectures;** Removal of oil spillage & grease deposits – **2 Lectures.** | 15 |

**Learning Resources recommended:**

1. Environmental Biotechnology Allan Scragg Oxford University press

2. Environmental Biotechnology (Basic concepts and applications) Indu Shekar Thakur IK International

3. Environmental Biotechnology (Industrial pollution management) S.N. Jogdand Himalaya Publishing House

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Applied Component – Agribiotechnology |
| Course Code | USACBT601 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 02 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – To impart the knowledge of precision agriculture and agricultural systems.
CO2 – To provide understanding of plant stress biology.
CO3 – To explore the significance of molecular markers in plant breeding.
CO4 – To gain knowledge about the importance of biofertilizers and biopesticides.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Precision agriculture and agricultural systems | Introduction to Agriculture and Agriculture systems- **1 Lecture;** Green-house Technology-- Types of green house, importance, functions and features of green house, Design criteria and calculation **-2 Lectures;** Construction material, covering material and its characteristics, growing media, green house irrigation system. Nutrient management **-3 Lectures;** Greenhouse heating, cooling and shedding and ventilation system, Computer controlled environment – **3 Lectures**;, Phytotrons, fertigation and roof system **-1 Lecture;** Precision Cultivation- tools, sensors for information acquisition **-2 Lectures.** | 15 |
| II | Plant stress biology | Abiotic stress –Physiological and molecular responses of plants to | 15 |

| | | | |
|---|---|---|---|
| | | water stress, salinity stress, temperature stress – heat and cold, Photooxidative stress, stress perception and stress signalling pathways, Ionic and osmotic homeostasis, reactive oxygen species scavenging- **4 Lectures;**<br>Biotic stress - plant interaction with bacterial, viral and fungal pathogens, plant responses to pathogen– biochemical and molecular basis of host-plant resistance , toxins of fungi and bacteria , systemic and induced resistance –pathogen derived resistance, signalling - **8 Lectures.** | |
| III | Molecular markers in plant breeding | Genetic markers in plant breeding--Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP)- **4 Lectures;**<br>Application of Molecular Markers to Plant Breeding [quantitative trait locus (QTL) mapping] **- 4 Lectures;**<br>Plant DNA Barcoding- Barcoding Markers (matK, rbcl, ITS, tmHpsbA), steps, recent advances, Benefits, Limitations - **4 Lectures.** | 15 |
| IV | Biofertilizers and biopesticides | Biofertilizer: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers **-2 Lectures;** Non-symbiotic Nitrogen Fixers Plant Growth Promoting Microorganisms-Phosphate- Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance- **2 Lectures;**<br>Plant Growth Promotion by Fungi--Mycorrhizae Arbuscular Mycorrhizae Ectomycorrhizae **-2 Lectures;** Microbial Inoculants --Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant | 15 |

| | | | |
|---|---|---|---|
| | | Formulations-**3 Lectures;** Biopesticides – types, Bacillus thuringiensis, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application) - **3 Lectures.** | |

**Learning Resources recommended:**


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)

6. Altieri, Miguel A.Farrell, John G-Agroecology- The Science of Sustainable Agriculture, Second Edition-CRC Press (2018)

7. Arie Altman, Paul Michael Hasegawa-Plant Biotechnology and Agriculture_ Prospects for the 21st Century-Academic Press (2011)


**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Class Test/ Online Examination | 20 |
| Assignment | 10 |
| Overall Performance | 10 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USBT601 and USBT602 |
| Course Code | USBTP601 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 03 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart the knowledge and hands on experience of the various practicals related to biochemistry.
CO2 - To impart the knowledge and hands on experience of the various practicals related to industrial microbiology.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| **Regular Practicals** | 1. Estimation of Milk protein-Pynes method<br>2. Microbial analysis of Milk by MBRT and RRT<br>3. Phosphatase test in Milk<br>4. DMC of milk sample<br>5. Isolation of Normal flora from Milk and curd<br>6. Determination of blood glucose levels for detection of diabetes mellitus.<br>7. Determination of serum cholesterol (total, HDL and LDL ratio)<br>8. Estimation vitamin C by DCPIP method from food samples. | 72 |

**Learning Resources recommended:**

1. Harper's Illustrated Biochemistry, 27th edition, RK Murray, DK Granner, PA Mayes and VW Rodwell, McGraw Hills publication.

2. Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P) Ltd

3. Nutrition Science, 6th edition (2017), Srilakshmi, new age international publishers.

4. Applied Dairy Microbiology Elmer H Marth and James L Steele Mercel Dekker Inc New York, 2nd edition

5. Industrial Microbiology Prescott and Dunn CBS publishers

6. Dairy technology by Yadav and Grower

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| TY Practical | 3 experiments of 2 hrs duration | 06 hrs | 60 M (01 Paper) (20 M for 1 Experiment, 25 M for 1 Experiment, 15 M for 1 Experiment) | 40 M (10 M for Journal, 10 M for viva, 15 M for Identification/ Spotting, 05 M for overall performance) | 100 |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USBT603 and USBT604 |
| Course Code | USBTP602 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 03 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to pharmacology, neurochemistry, environmental Biotechnology.
CO2 – To improve skills in writing the research outcomes in the form of thesis dissertation.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. LD 50, ED 50 evaluation using suitable models e.g. daphnia<br>2. Study the effect of heavy metals on the growth of bacteria.<br>3. Determination of Total Solids from an effluent sample.<br>4. Study of physico-chemical (pH, color, turbidity, BOD, COD) parameters of any one industrial effluent sample | 72 |
| **Demonstration** | Estimation of chromium from Effluents (Demonstration) | |
| **Visit** | Visit to ETP/ CET | |

**Learning Resources recommended:**

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

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| TY Practical | 3 experiments of 2 hrs duration | 06 hrs | 60 M (01 Paper)<br>(20 M for 1 Experiment, 25 M for 1 Experiment, 15 M for 1 Experiment) | 40 M<br>(10 M for Journal, 10 M for viva, 15 M for Identification/ Spotting, 05 M for overall performance) | 100 |

## Syllabus for T. Y. B. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practicals of USACBT601 |
| Course Code | USACBTP603 |
| Class | T. Y. B. Sc. |
| Semester | V |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to agribiotechnology.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| **Regular Practicals** | 1. Isolation of Rhizobium<br>2. Isolation of Azotobacter<br>3. Isolation of Phosphate solubilizing bacteria<br>4. Study of effect of abiotic stress on plants.<br>6. Rapid screening tests for abiotic stress tolerance (drought, - PEG, Mannitol & salinity NaCl)<br>7. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Catalase and Peroxidase | 48 |
| **Demonstration** | RAPD analysis demonstration experiment | |
| **Visit** | Visit to green house facility and submission of field visit report. | |

**Learning Resources recommended:**


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)

6. Altieri, Miguel A.Farrell, John G-Agroecology- The Science of Sustainable Agriculture, Second Edition-CRC Press (2018)

7. Arie Altman, Paul Michael Hasegawa-Plant Biotechnology and Agriculture_ Prospects for the 21st Century-Academic Press (2011)

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| TY Practical (AC) | 4 experiments of 1.5 hrs duration | 6 hrs | 60 M (20 M each for 2 Experiments, 10 M each for 2 Experiments) | 40 M (10 M for Journal, 10 M for Viva, 10 M for Identification, 10 M for overall performance) | 100 |

(Rashmi A. Bhave)
The Chairperson, BoS

# R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

## Syllabus for
## M. Sc. Biotechnology Programme
## Semester I and II

## Under Choice Based Credit System (CBCS)
## To be implemented from the Academic Year
## 2023 - 2024

| | |
|---|---|
| Name of Programme | **M. Sc. Biotechnology** |
| Level | PG |
| No. of Semesters | 04 |
| Year of Implementation | **2023-24** |
| Programme Specific Outcomes (PSO) | At the end of the Programme, Learner will be able<br>1. To identify, formulate, review research literature, analyze and design experiments and identify the solutions for complex problems using modern tools.<br><br>2. To apply the knowledge of basic biotechnology to solve complex problems in society.<br><br>3. To design experiments to investigate the problems in varied fields of Biotechnology and allied areas.<br><br>4. To understand and interpret data and derive unique solutions to existing and emerging issue.<br><br>5. To apply reasoning informed by contextual knowledge to assess societal, health, safety and the consequent responsibilities relevant to the professional biotechnology practices.<br><br>6. To recognize the need and have the ability to engage in independent and lifelong learning in technological change.<br><br>7. To function effectively as an individual and as a member or leader in diverse teams and in inter- and multi-disciplinary areas.<br><br>8. To empower with a knowledge base in processes and applications that would impact and influence existing prototypes of green, blue, red and white Biotechnology.<br><br>9. To be skilled and equipped with contemporary knowledge in Biotechnology and would be eligible for jobs in varied industrial sectors. |
| Relevance of PSOs to the local, regional, national, and global developmental needs | Biotechnology is important at Global, National, Regional and local level. The significance of Biotechnology identified at all these levels and it is relevant to everyday life. The curriculum design of M. Sc. Biotechnology programme helps in understanding various concepts in detail. This programme |

| | |
|---|---|
| | includes new emerging technologies and their applications. This also involves the actual working and mechanism required in industries. The application part is taken care of so that the learner shall be able to connect the phenomena around him with the curriculum. This programme also imparts the research values among the learners. The hard and softs skills acquired during the completion of this programme shall make him employable. |

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40 % marks in the first part and by conducting the Semester End Examinations of 60 % marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

C) Practical Examination: 100 Marks

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Journal | 20 |
| 02 | Viva | 10 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

b) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Practical Question 1 | 20 |
| 02 | Practical Question 2 | 20 |
| 03 | Practical Question 3 | 20 |
| Marks in SEE will be converted into 30 marks. | | |

**Standard of Passing**

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i. e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i. e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

**Performance Grading:**

**Letter Grades and Grade Points**

| **Semester GPA/ Program CGPA Semester/Program** | **% of Marks** | **Alpha-Sign / Letter Grade Result** |
|---|---|---|
| 9.00-10.00 | 90.0 -100 | 0 (Outstanding) |
| $8.00 \leq 9.00$ | $80.0 \leq 90.0$ | A+ (Excellent) |
| $7.00 \leq 8.00$ | $70.0 \leq 80.0$ | A (Very Good) |
| $6.00 \leq 7.00$ | $60.0 \leq 70.0$ | B+ (Good) |
| $5.50 \leq 6.00$ | $55.0 \leq 60.0$ | B (Above Average) |
| $5.00 \leq 5.50$ | $50.0 \leq 55.0$ | C (Average) |
| $4.00 \leq 5.00$ | $40.0 \leq 50.0$ | P (Pass) |
| Below 4.00 | Below 40 | F (Fail) |
| Ab (Absent) | - | Absent |

Master of Science (M.Sc.) in Biotechnology Programme

*Under Choice Based Credit System (CBCS)*

*Course Structure*

M.Sc. I Biotechnology

*(To be implemented from Academic Year 2023-24)*

| Course Code | Semester I | Credits | Course Code | Semester II | Credits |
|---|---|---|---|---|---|
| | Major Mandatory | | | Major Mandatory | |
| PSBT101 | Biochemistry | 4 | PSBT201 | Bioinformatics and Biostatistics | 4 |
| PSBT102 | Bioprocess Engineering and Technology | 4 | PSBT202 | Plant and Animal Biotechnology | 4 |
| PSBT103 | Basics in IPR and Patents | 2 | PSBT203 | Patenting in Biotechnology and Bioethics | 2 |
| PSBT104 | Biochemistry Practical PSBT101 | 2 | PSBT204 | Bioinformatics and Biostatistics Practical PSBT201 | 2 |
| PSBT105 | Bioprocess Engineering and Technology Practical PSBT102 | 2 | PSBT205 | Plant and Animal Biotechnology Practical PSBT202 | 2 |
| | Major Electives (Any One) | | | Major Electives (Any One) | |
| PSBT106 | Immunology | 2 | PSBT206 | Bio Entrepreneurship | 3 |
| PSBT107 | Immunology Practical PSBT106 | 2 | PSBT207 | Bio Entrepreneurship Practical PSBT206 | 1 |
| | OR | | | OR | |
| PSBT108 | Molecular Diagnostics | 2 | PSBT208 | Bioanalytical and Biophysical Techniques | 4 |
| PSBT109 | Molecular Diagnostics Practical PSBT108 | 2 | | | |
| PSBT110 | Research Methodology | 4 | PSBT209 | On Job Training/ Field Project | 4 |
| | Total Credits | 22 | | Total Credits | 22 |

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

| Course Code | Semester I | Credits |
| --- | --- | --- |
| | Major: Mandatory | |
| PSBT101 | Biochemistry | 4 |
| PSBT102 | Bioprocess Engineering and Technology | 4 |
| PSBT103 | Basics in IPR and Patents | 2 |
| PSBT104 | Biochemistry Practicals | 2 |
| PSBT105 | Bioprocess Engineering and Technology Practicals | 2 |
| | Major: Elective (Any One from below) | |
| PSBT106 | Immunology | 2 |
| PSBT107 | Immunology Practical PSBT106 | 2 |
| | OR | |
| PSBT108 | Molecular Diagnostics | 2 |
| PSBT109 | Molecular Diagnostics Practical PSBT108 | 2 |
| PSBT110 | Research Methodology | 4 |
| Total Credits | | 22 |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Biochemistry |
| Course Code | PSBT101 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 4 |
| Nature | Theory |
| Type | Major: Mandatory 1 |

# Biochemistry

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Glycobiology and Membrane Biochemistry | 15 |
| 2 | Protein Transport and Membrane Trafficking | 15 |
| 3 | Biochemistry of nucleic acids | 15 |
| 4 | Bioenergetics and regulation of metabolism | 15 |
| | **Total** | **60** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of glycobiology and membrane biochemistry.
CO2 – To provide the insight of protein transport and membrane trafficking.
CO3 – To gain the knowledge of nucleic acids biochemistry.
CO4 – To have a firm foundation in bioenergetics and regulation of metabolism.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Glycobiology and Membrane Biochemistry (15 Lectures) |
| | Glycosylation of Biomolecules - Synthesis N-linked, O-linked, and GPI linked glycoproteins and role of glycosylation.<br>Lipid aggregates: micelles, bilayers, and liposomes- structure, types, preparation, characterization, and therapeutic applications of liposomes.<br>Composition and Architecture of membrane: structural lipids in membranes, membrane bound proteins - structure, properties, and function.<br>Membrane Dynamics: lipid movements, flippase, FRAP, Lipid raft, Membrane fusion.<br>Solubilization of the membrane by using different detergents. |

| | | |
|---|---|---|
| 2 | Protein Transport and Membrane Trafficking | (15 Lectures) |
| | Translocation of Secretory Proteins across the ER Membrane, Insertion, Protein Modifications, Folding, and Quality Control in the ER, Protein sorting and export from Golgi Apparatus.<br>Sorting of Proteins to Mitochondria and Chloroplasts. Molecular Mechanisms of Vesicular Traffic, early and later Stages of the Secretory Pathway, Receptor-Mediated Endocytosis. Protein degradation: Ubiquitin- proteasome pathway and lysosomal proteolysis. | |
| 3 | Biochemistry of nucleic acids | (15 Lectures) |
| | Forces stabilizing nucleic acid structures, triple helix. Super helix topology- linking number, Twist and writhing number, measurement of supercoiling and Topoisomerases.<br>Nucleic acid binding protein – Leucine Zipper, Zinc fingers, OB fold, Beta Barrel, Helix-turn-helix, Helix-loop-helix. Biosynthesis of nucleic acids and inborn errors of nucleic acid Metabolism<br>**Methodologies for detection:** Protein –Protein and DNA –Protein interactions: Gel retardation assay, DNA footprinting, Yeast 2 Hybrid Method advantages and limitations, yeast split-hybrid and reverse two-hybrid systems, Co-Immunoprecipitation (Co-IP) and Far-Western Blot Analysis. | |
| 4 | Bioenergetics and regulation of metabolism | (15 Lectures) |
| | Biosynthesis of Amino acids; phenylalanine, tyrosine, threonine, and methionine. Bioenergetics- coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism. Integration of central metabolism; entry/ exit of various biomolecules from central pathways, principles of metabolic regulation. Strategies of energy Metabolism: organ specialization- Brain, Muscle, Adipose Tissue, Liver, Kidney. Metabolic Homeostasis: Regulation of Appetite, Energy Expenditure and Body Weight. | |

Learning Resources recommended:


1. Stryer, L. (2015). *Biochemistry*. (8th edition) New York: Freeman.
2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th edition). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th edition). Hoboken, NJ: J. Wiley & Sons.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008).
5. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
6. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014).
7. *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
8. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM; Sunderland.
9. Laouini et.al. Preparation, Characterization and Applications of Liposomes: State of the Art. journal of Colloid Science and Biotechnology Vol. 1, 147–168, 2012

10. Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr.No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Bioprocess engineering and technology |
| Course Code | PSBT102 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 4 |
| Nature | Theory |
| Type | Major: Mandatory II |

# Bioprocess Engineering and Technology

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Basic principles of biochemical engineering | 15 |
| 2 | Production of proteins from recombinant microorganisms | 15 |
| 3 | Applications of enzyme technology in food processing | 15 |
| 4 | Applications of microbial technology | 15 |
| | **Total** | **60** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of basic principles of biochemical engineering.
CO2 – To provide the insight of production of proteins from recombinant.
CO3 – To gain the knowledge of applications of enzyme technology in food processing.
CO4 – To have a firm foundation in applications of microbial technology.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Basic principles of biochemical engineering (15 Lectures) |
| | Sources of Microorganisms Used in Biotechnology- Literature search and culture collection supply, Isolation de novo of organisms producing metabolites of economic importance. Strain Improvement- Selection from naturally occurring variants, Manipulation of the genome of industrial organisms in strain improvement Bioreactor design and analysis.<br>Media formulation and optimization methods; sterilization of bioreactors aeration and agitation in bioreactors KLa value (factors affecting and methods of determination). |

| | |
|---|---|
| 2 | Production of proteins from recombinant microorganisms (15 Lectures) |
| | Principles of Microbial Growth: Batch Fermentation, Fed-Batch Fermentation, Continuous Fermentation<br>Maximizing the Efficiency of the Fermentation Process<br>High-Density Cell Cultures, Increasing Plasmid Stability, Quiescent *E. coli* Cells, Protein Secretion and Reducing Acetate<br>Bioreactors: Typical Large-Scale Fermentation Systems<br>Two-Stage Fermentation in Tandem Airlift Reactors,<br>Two-Stage Fermentation in a Single Stirred-Tank Reactor, Batch versus Fed-Batch Fermentation, Harvesting Microbial Cells, Disrupting Microbial Cells, Downstream Processing, Protein Solubilization, Large-Scale Production of plasmid DNA |
| 3 | Applications of enzyme technology in food processing (15 Lectures) |
| | Introduction and scope<br>1. Enzymes sourced from animals and plants used in food manufacturing technology<br>2. Enzyme usage in food applications.<br>Mechanism of enzyme function and reactions in food processes<br>1. Starch-processing and related carbohydrates.<br>2. Lipases for production of food components: interesterified fat<br>3. Enzymes in protein modification: hydrolyzed protein<br>4. Enzymes in bread making - flavor, texture and keeping quality<br>5. Enzymes in dairy product manufacture<br>6. Enzymes in fruit and vegetable processing and juice extraction<br>7. Enzymes in fish and meat processing<br>8. Beer Production using Immobilized Cell Technology |
| 4 | Applications of microbial technology (15 Lectures) |
| | 1. Microbial biomass production: mushrooms, SCP<br>2. Fermented foods from: meat and fish, bread, Vegetables (sauerkraut, cucumber), Legumes and Oil, Seeds soya bean fermentations<br>3. Beverages: a) Stimulant Beverages -coffee, cocoa and tea fermentations b) Alcoholic beverages - Cider production<br>4. Food additives and supplements: a) Lipids, Nucleosides, nucleotides and related compounds- Vitamins<br>b) Natural food preservatives- bacteriocins from lactic acid bacteria – production and applications e. g. Nisin<br>c) Microbial production of colours and flavours.<br>d) Polyhydric alcohols: low-calorie sweetener particularly useful for sweetening food products for diabetics<br>e) Microbial exopolysaccharides - Xanthan gum<br>5. Process Food wastes - for bioconversion to useful products (Compost, biofuels, biomass cheap source of raw material in fermentation etc.) |

Learning Resources recommended:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
4. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
5. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
6. Alexander N. Glazer and Hiroshi Nikaido -Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition
7. Michael Waites and Morgan, Rockney and Highton -Industrial microbiology: An Introduction
8. Robert Whitehurst and Maarten Van Oort - Enzymes in food technology 2nd ed
9. Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield, (2007)

Evaluation Pattern:

A) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Basics in IPR and Patents |
| Course Code | PSBT103 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 2 |
| Nature | Theory |
| Type | Major: Mandatory III |

# Basics in IPR and Patents

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Introduction to IPR | 15 |
| 2 | Basics of Patents | 15 |
| | **Total** | **30** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of the introduction of IPR.
CO2 – To provide the insight of basics of patents.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Introduction to IPR (15 Lectures) |
| | World Intellectual Property Organization (WIPO) – Functions of WIPO – Membership – GATT Agreement – Paris Convention – TRIPS agreement.<br>Types of IP: patents, trademarks, trade secrets, copyright & related rights, industrial design, geographical indications, Biodiversity importance and legislation, plant variety protection and farmers rights act, traditional knowledge. |
| 2 | Basics of Patents (15 Lectures) |
| | Eligibility criteria, concept of novelty, concept of inventive step;<br>Patenting systems- Indian Patent Act and amendments, Process of Patenting, Types of patent applications, Patent Agent,<br>Patent Search, Rights of the patent holder, Assignment and licensing of patents and patent Infringement, case studies. |

Learning Resources Recommended:


1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
2. Karen F. Greif, Jon F. Merz - Current Controversies in the Biological Sciences_ Case Studies of Policy Challenges from New Technologies (Basic Bioethics)-The MIT Press (2007)
3. Padma Nambisan (Auth.) - An Introduction to Ethical, Safety and Intellectual Property Rights
4. Issues in Biotechnology- Academic Press (2017)
5. David Castle - The Role of Intellectual Property Rights in Biotechnology Innovation (2011)
6. Goel, D., & Parashar, S. (2013). IPR, Biosafety and Bioethics. Pearson Education India.
7. Singh, S. S. (2004). The Law of Intellectual Property Rights. Deep and Deep Publications, New Delhi, 96.
8. Talwar Shabana; Intellectual Property Rights in WTO and Developing Countries, Edition 2010, Serials Publications, New Delhi.


Evaluation Pattern:

A) Internal Assessment: 40 % (40 Marks)

| Sr.No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be three questions each of 20 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Immunology |
| Course Code | PSBT106 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 2 |
| Nature | Theory |
| Type | Major: Elective |

# Immunology

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Vaccinology | 15 |
| 2 | Antigen – antibody interactions | 15 |
| | **Total** | **30** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To gain the knowledge of vaccinology.
CO2 – To have a firm foundation in antigen – antibody interactions.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Vaccinology (15 Lectures) |
| | Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine. |
| 2 | Antigen – antibody interactions (15 Lectures) |
| | Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte |

| | |
|---|---|
| | reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs. |

Learning Resources recommended:


1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Immunology. New York: W.H. Freeman.
2. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway’s Immunobiology. New York: Garland Science.
3. An introduction to Immunology C V Rao Narosa Publishing house
4. Immunology essential and fundamental, Second edition S Pathak & U P Parveen Publishing House
5. Text Book of Medical Biochemistry, Praful Godkar. Bahalani Publishers
6. Immunology, An introduction, fourth edition. Ian R Tizard Thomson
7. Immunology, fifth Ed Goldsby, T J. Kindt, Osborne, Janis Kuby Freeman and company.
8. Immunology, sixth Ed Roitt, Brostoff, Male Mosby, An imprint of Elsevier science Ltd
9. Practical immunology, Frank Hay, 4th Edition, Blackwell Science Medical Microbiology, Anantharayan.


Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr.No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be three questions each of 20 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Molecular Diagnostics |
| Course Code | PSBT108 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 2 |
| Nature | Theory |
| Type | Major: Elective |

# Molecular Diagnostics

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Diagnostics Microbiology | 15 |
| 2 | Functional Genomics and Proteomics | 15 |
| | **Total** | **30** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of diagnostic microbiology.
CO2 – To have a firm foundation in functional genomics and proteomics.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Diagnostics Microbiology (15 Lectures) |
| | Techniques: Molecular amplification techniques<br>• Target amplification systems<br>• Probe amplification systems<br>• Signal amplification<br>PCR in molecular diagnostics; viral and bacterial detection; Quantitation of organisms – internal controls, external standards, calibrators, absolute and relative quantification; Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing Detection and identity of microbial diseases Direct detection and identification of pathogenic organisms/ viruses e.g. TB and HIV Clinical utility of molecular diagnostics tests (NAAT) for Hepatitis and AIDS. Molecular identification of fungal pathogens; Pharmacogenetics. |
| 2 | Functional Genomics and Proteomics (15 Lectures) |

| | |
|---|---|
| | Genomics: Gene expression by SAGE and Functional Microarrays- Construction of microarrays – genomics and genomic arrays, cDNA arrays and oligo arrays and Proteomics its applications, NGS platforms, high and low read sequences<br><br>Proteomics: Separation and Identification of Proteins 2D-PAGE, isoelectric focusing, Edmand reaction Protein tryptic digestion and peptide mass fingerprinting mass spectrometry, MALDI-TOF.<br><br>Protein Expression Profiling: Protein Microarrays/ Protein chips: Types and applications, Gel-based quantitative proteomics: DIGE 15 (Difference in Gel Electrophoresis)<br><br>Clinical and biomedical applications of proteomics, Introduction to metabolomics, lipidomics, metagenomics and systems biology. |

Learning Resources recommended:


1. Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure,Dynamics, Function. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). Physical Biology of the Cell. New York: Garland Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
4. Lander, E. (2016). The Heroes of CRISPR. Cell, 164(1-2), 18-28. doi: 10.1016/j. cell.2015.12.041.
5. Ledford, H. (2016). The Unsung Heroes of CRISPR. Nature, 535(7612), 342-344. doi:10.1038/535342a.
6. Molecular Imaging Theranostics, 4(4), 386-398. doi:10.7150/thno.8006 Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
7. Molecular biology of the cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 5th ed. 2008
8. Molecular Microbiology Diagnostic Principles and practice third edition, David H. Persing and Fred C. Tenover Copyright _ 2016 by ASM Press
9. Methods in Molecular Biology, Vol. 204: Molecular Cytogenetics: Protocols and Applications, Edited by: Y. S. Fan © Humana Press Inc., Totowa, NJ 2001
10. Genome 3 TA Brown Molecular Biotechnology – Principles and applications of recombinant technology, Glick 4$^{th}$ edition 2010
11. Human Molecular Genetics. Tom Strachan and Andrew Read, 2004, 3$^{rd}$ Edition, Garland

12. Introduction to human molecular genetics. Jack Pasternak, 2005, 2nd Edition, Wiley publication.

Evaluation Pattern:

A) Internal Assessment: 40 % (40 Marks)

| Sr.No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be three questions each of 20 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Biochemistry Practical PSBT101 |
| Course Code | PSBT104 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 2 |
| Nature | Practical |
| Type | Major: Mandatory |

# *Biochemistry Practical PSBT101*

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to Biochemistry.

Curriculum: (60 Lectures)

| Regular Practicals |
|---|
| 1. To prepare Acetate and Phosphate buffers using the Henderson-Hasselbalch equation.<br>2. Protein purification by ammonium sulphate fractionation, dialysis and separation using PAGE - CBB/silver staining, Glycoprotein staining.<br>3. To determine an unknown protein concentration using Biuret, Folin Lowry and Bradford method.<br>4. Isolation of genomic DNA from plant/animal source.<br>5. Isolation of cholesterol and lecithin from egg yolks.<br>6. Paper chromatography of Amino acids and detection using Ninhydrin. |

Learning Resources Recommended:


1. Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010) Keith Wilson and John Walker, Cambridge university Press.
2. Biochemistry Laboratory (2nd Ed, 2012) Rodney Boyer, Pearson's Publication.
3. Biochemical Methods, Sadasivam and Manikam ($3^{rd}$ Ed, 2008) New age international publishers, 2008.
4. An Introduction to Practical Biochemistry ($3^{rd}$ Edition), David T Plummer, Tata McGraw Hill Publishing Company Limited, 1992.


Evaluation Pattern:

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Journal | 20 |
| 02 | Viva | 10 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

b) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Practical Question 1 | 20 |
| 02 | Practical Question 2 | 20 |
| 03 | Practical Question 3 | 20 |
| Marks in SEE will be converted into 30 marks. | | |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Bioprocess engineering and Technology Practical PSBT102 |
| Course Code | PSBT105 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 2 |
| Nature | Practical |
| Type | Major: Mandatory |

## *Bioprocess Engineering and Technology Practical*
## *PSBT102*

Course Outcomes:

At the end of the Course, the Learner will be able to
CO1 – To impart knowledge and hands on experience of the various practicals related to bioprocess engineering and technology.

Curriculum: (60 Lectures)

| Regular Practicals |
|---|
| 1. Microbial pigment/metabolite:<br>a. Production – Factors affecting – pH, temperature, nutrients, static/ shaker conditions, submerged/surface.<br>b. Extraction – soluble and insoluble pigments - organic solvent extraction and purification.<br>2. Immobilize an organism / enzyme and detect the conversion of substrate to product.<br>3. Methods for measurement of cell mass:<br>a. Direct physical measurement of dry weight, wet weight, or volume of cells after centrifugation.<br>b. Indirect measurement.<br>c. Turbidity measurements employ instruments to determine the amount of light scattered by cell suspension. |
| Demonstration Practicals |
| 1. Demonstration of media optimization by Placket Burman test.<br><br>2. Demonstration of Analytical techniques like HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates. |
| Visit |
| Quality Assurance in a Biotechnology/food/beverage industry – Field visit and report. |
| Report Writing |
| Method validation for any biochemical test (Accuracy, Limit of Detection, Limit of Quantitation, Specificity, Linearity and range, Ruggedness and Robustness) – Report writing. |

Learning Resources Recommended:


1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
4. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
5. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
6. Alexander N. Glazer and Hiroshi Nikaido -Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition
7. Michael Waites and Morgan, Rockney and Highton -Industrial microbiology: An Introduction
8. Robert Whitehurst and Maarten Van Oort - Enzymes in food technology 2nd ed
9. Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield, (2007)


Evaluation Pattern:

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Journal | 20 |
| 02 | Viva | 10 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

b) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Practical Question 1 | 20 |
| 02 | Practical Question 2 | 20 |
| 03 | Practical Question 3 | 20 |
| Marks in SEE will be converted into 30 marks. | | |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Immunology Practical PSBT106 |
| Course Code | PSBT107 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 2 |
| Nature | Practical |
| Type | Major: Elective |

## *Immunology Practical PSBT106*

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to Immunology.

Curriculum: (60 Lectures)

| Regular Practicals |
|---|
| 1. Preparation and sterility testing of heat killed vaccines.<br>2. To perform Dot blot technique.<br>3. Latex bead agglutination / precipitation test for detection of rheumatoid factor (RF).<br>4. Separation of lymphocytes on Ficoll Histopaque and viability count.<br>5. Study of precipitation reactions - Ouchterlony and Mancini methods.<br>6. Widal test - Qualitative and Quantitative.<br>7. RPR (Rapid Plasma Reagin) - Kit based<br>8. Determination of ESR. |
| Demonstration Practical |
| Demonstration of Western blotting. |

Learning Resources Recommended:


1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Immunology. New York: W.H. Freeman.
2. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
3. An introduction to Immunology C V Rao Narosa Publishing house
4. Immunology essential and fundamental, Second edition S Pathak & U P Parveen Publishing House
5. Text Book of Medical Biochemistry, Praful Godkar. Bahalani Publishers
6. Immunology, An introduction, fourth edition. Ian R Tizard Thomson
7. Immunology, fifth Ed Goldsby, T J. Kindt, Osborne, Janis Kuby Freeman and company.
8. Immunology, sixth Ed Roitt, Brostoff, Male Mosby, An imprint of Elsevier science Ltd
9. Practical immunology, Frank Hay, 4th Edition, Blackwell Science
10. Medical Microbiology, Anantharayan.

Evaluation Pattern:

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Journal | 20 |
| 02 | Viva | 10 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

c) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Practical Question 1 | 20 |
| 02 | Practical Question 2 | 20 |
| 03 | Practical Question 3 | 20 |
| Marks in SEE will be converted into 30 marks. | | |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Molecular Diagnostics Practical PSBT108 |
| Course Code | PSBT109 |
| Class | M. Sc. I Biotechnology |
| Semester | I |
| No of Credits | 2 |
| Nature | Practical |
| Type | Major: Elective |

# *Molecular Diagnostics Practical PSBT108*

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to molecular diagnostics.

Curriculum: (60 Lectures)

| Regular Practicals |
|---|
| 1. Sample collection, storage and processing in molecular diagnostic labs.<br>2. Photo album of chromosomal abnormalities in normal and disease condition numerical detected by using different probes – centromeric, locus specific, telomeric Structural - Translocations and fusion genes, Detection of inversions and interstitial deletions by SKY, CGH for a disease or cancer.<br>3. Separation of human serum / plasma proteins / egg white using Native PAGE. |
| Demonstration Practicals |
| 1. Antimicrobial sensitivity test and demonstration of drug resistance.<br>2. Identification of microorganisms using biochemical testing (performing) and 16S rDNA sequencing (demonstration).<br>3. Demonstration/ video of 2D PAGE.<br>4. Demonstration of Affinity chromatography. |
| Visit |
| Visit to molecular diagnostic lab/ cytogenetic lab: Report. |

Learning Resources Recommended:


1. Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010) Keith Wilson and John Walker, Cambridge university Press.
2. Biochemistry Laboratory (2nd Ed, 2012) Rodney Boyer, Pearson's Publication.
3. Biochemical Methods, Sadasivam and Manikam (3rd Ed, 2008) New age international publishers, 2008.
4. An Introduction to Practical Biochemistry (3rd Edition), David T Plummer, Tata McGraw Hill Publishing Company Limited, 1992

Evaluation Pattern:

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Journal | 20 |
| 02 | Viva | 10 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

b) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Practical Question 1 | 20 |
| 02 | Practical Question 2 | 20 |
| 03 | Practical Question 3 | 20 |
| Marks in SEE will be converted into 30 marks. | | |

***Revised Syllabus of Courses of Master of Sciences (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Research Methodology |
| Course Code | PSBT110 |
| Class | M.Sc. I Biotechnology |
| Semester | I |
| No of Credits | 4 |
| Nature | Theory |
| Type | Research Methodology |
| Relevance with Employability/ Entrepreneurship/ Skill development | Learner will gain the knowledge of Research Methodology in biotechnological application. Further, the learner will be benefited in the form of increase in his/her research aptitude, analytical and decision-making skills. Acquisition of the knowledge in the field of research will increase the chances of employability and will offer better prospects in the corporate sector. |

# Research Methodology

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Fundamentals of Research Methods | 15 |
| 2 | Research Design and Measurement Concepts and Literature Searching | 15 |
| 3 | Documentation, scientific writing and Academic Integrity | 15 |
| 4 | Data Collection, Data Processing and Statistical Analysis | 15 |
| | **Total** | **60** |

Course Outcomes:

At the end of the Course, the Learner will be able to -

1. Demonstrate an understanding of the features and importance of research in business, different types of research, the formulation of research problems, research design and the significance of literature review.

2. Apply the knowledge of data collection methods, including primary and secondary data collection techniques, questionnaire designing and factors influencing the choice of data collection methods.

3. Analyze data processing techniques, including editing, coding, classification, tabulation, and graphic presentation, as well as perform statistical analysis.

4. Evaluate different testing methods for hypotheses, including non-parametric tests (ANOVA, factor analysis, path analysis), considering their applicability and significance in research.

5. Create well-structured research reports, following the essentials of research report writing, proper referencing and citation methods and adhering to ethical norms and practices in research.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Fundamentals of Research Methods (15 Lectures) |
| | Definition of research, Role and objectives of research, importance of research, Applications and types of research, Creativity and innovation, Critical thinking, Research process and steps in it, Collecting and reviewing the literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of results and discussion. |
| 2 | Research Design and Measurement Concepts and Literature Searching (15 Lectures) |
| | Selecting and defining a research problem, Need for research design, Features of a good research design, Different research designs, Scales of measurements, Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques.<br><br>Digital: Web sources, E-journals, Journal access, Citation Index, Impact factor, H-index, E-consortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, Scopus. |
| 3 | Documentation, scientific writing and Academic Integrity (15 Lectures) |
| | Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. for illustration, style, publications of scientific work, Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues, Ethics in research, and case studies. |
| 4 | Data Collection, Data Processing and Statistical Analysis (15 Lectures) |
| | Data Collection: Collection of primary data; Observation method; Interview method; Collection of data through Questionnaires; Collection of data through Schedules; Collection of secondary data, Case study method.<br>Data Processing: Significance in Research, Stages in Data Processing: Editing, Coding, Classification, Tabulation, Graphic Presentation. |

| | |
|---|---|
| | Statistical analysis: ANOVA, Factor Analysis and Path analysis.<br>Interpretation of data: significance and Precautions in data interpretation. |

Learning Resources recommended:

**Main References:**


1. Kothari C.R., "Research Methodology, Methods and Techniques" (Second revised edition, New Age International Publication, 2004).

2. Saravanavel P., "Research Methodology" (Kitab Mahal, Sixteenth edition, 2007).

3. Ranjit Kumar, "Research Methodology, a step-by-step guide for beginners" (Pearson education Australia, Second edition 2005).

4. Mark Saunders, Philip Lewis, Adrain Thornhiu, "Research Methods for Business Students" (Pearson Education ltd, Seventh edition, 2016)


**Additional References:**


1. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
2. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press, 1976.
3. The Craft of Scientific Writing by Michael Alley, (Springer).
4. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005
5. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit, 2005, Pearson Education.
6. How to write and publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
7. S. Gupta, (2005). Research Methodology and Statistical techniques, Deep and Deep Publications (P) Ltd. New Delhi, India.
8. R. Kothari, (2008). Research Methodology, New Age International, New Delhi, India.
9. Standard /Reputed Journal authors' instructions.
10. Web resources: www.sciencedirect.com for journal references,
11. www.aip.org and www.aps.org for reference styles.
12. Web resources: www.nature.com, www.sciencemag.org,
13. www.springer.com, www.pnas.org, www.tandf.co.uk,
14. www.opticsinfobase.org for research updates.

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr.No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

| No. of Courses | Semester II | Credits |
|---|---|---|
| | Major: Mandatory | |
| PSBT201 | Bioinformatics and Biostatistics | 4 |
| PSBT202 | Plant and Animal Biotechnology | 4 |
| PSBT203 | Patenting in Biotechnology and Bioethics | 2 |
| PSBT204 | Bioinformatics and Biostatistics Practical PSBT201 | 2 |
| PSBT205 | Plant and Animal Biotechnology Practical PSBT202 | 2 |
| | Major Electives (Any One) | |
| PSBT206 | Bio Entrepreneurship | 3 |
| PSBT207 | Bio Entrepreneurship Practical PSBT206 | 1 |
| | OR | |
| PSBT208 | Bioanalytical and Biophysical Techniques | 4 |
| PSBT209 | On Job Training/ Field Project | 4 |
| | Total Credits | 22 |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Bioinformatics and Biostatistics |
| Course Code | PSBT201 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 4 |
| Nature | Theory |
| Type | Major: Mandatory I |

# Bioinformatics and Biostatistics

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Basics of Bioinformatics and DNA sequence analysis | 15 |
| 2 | Multiple sequence alignments and protein modelling | 15 |
| 3 | Biostatistics | 15 |
| 4 | Biostatistics | 15 |
| | **Total** | **60** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of basics of Bioinformatics and DNA sequence analysis.
CO2 – To provide the insight of multiple sequence alignments and protein modelling.
CO3 – To gain the knowledge of the various concepts of Biostatistics.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Basics of Bioinformatics and DNA sequence analysis (15 Lectures) |
| | Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Biological XML DTD's; databases and search tools: biological background for sequence analysis, NCBI - publicly available tools; resources at EBI; DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases, pairwise alignment techniques: BLAST and FASTA, motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing |

| | |
|---|---|
| 2 | Multiple sequence alignments and protein modelling (15 Lectures) |
| | Multiple sequence alignment: CLUSTALW and CLUSTALX for multiple sequence alignment, submitting DNA protein sequence to databases: where and how to submit, SEQUIN; submitting aligned sets of sequences, updating submitted sequences; methods of phylogenetic analysis.<br><br>Protein modelling: Protein structure and classification databases; Protein structure visualization; Protein structure analysis: Secondary, (Chou Fasman algorithm, GOR algorithm, Tertiary (Homology modelling, Threading, Ab initio) |
| 3 | Biostatistics (15 Lectures) |
| | Introduction and scope of statistics in biological studies and basic concepts. Collection of data, by different sampling methods: Simple random sampling, stratified random sampling and systematic sampling and non - random sampling. Measures of central tendency; Mean, Median and Mode. Measures of Dispersion: Variance/ standard deviation, coefficient of variation and standard error. Confidence limits for mean and proportion. Probability and Basic concepts: Normal and binomial distribution. Correlation and regression analysis for a bivariate data: Scatter diagram |
| 4 | Biostatistics (15 Lectures) |
| | Test of Hypothesis: Null hypothesis, alternate hypothesis, test statistics, Type I and Type II errors, level of significance and critical region. Z test: for a single sample, two samples, t-test a single sample, two samples and testing the significance of the correlation. Coefficient: t paired test, Chi-square (x2 test): As a goodness of fit and in 2x2 contingency test |

Learning Resources recommended:


1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.

2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.

4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.

5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.

6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

7. S. P. Gupta, Statistical Methods, (45th Revised Edition), Publisher SCHAND

8. William G. Cochran, Sampling Techniques (3th Edition), Wiley and sons

9. Boris V. Gnedenko, Theory of Probability (6th Edition), CRC Press, 13-May-1998

10. Oscar Kempthorne, Klaus Hinkelmann, Design and Analysis of Experiments, Volume1: Introduction to Experimental Design, 2nd Edition, ISBN: 978-0-471-72756-9 December 2007

11. Acheson Johnston Duncan, Quality Control and Industrial Statistics (5th Edition), Irwin; 5 edition January 1, 1986

12. BK Mahajan, Methods in Biostatistics (7th Edition), Published December 1st 2008 by JP Medical Ltd

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Plant and Animal Biotechnology |
| Course Code | PSBT202 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 4 |
| Nature | Theory |
| Type | Major: Mandatory II |

# Plant and Animal Biotechnology

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Plant tissue culture | 15 |
| 2 | Plant genetic manipulations | 15 |
| 3 | Animal cell culture and Animal reproductive Biotechnology | 15 |
| 4 | Molecular mapping and marker assisted selection | 15 |
| | **Total** | **60** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of plant tissue culture.
CO2 – To provide the insight of plant genetic manipulations.
CO3 – To gain the knowledge of animal cell culture and animal reproductive Biotechnology.
CO4 – To have a firm foundation in molecular mapping and marker assisted selection.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Plant tissue culture (15 Lectures) |
| | Historical perspective; totipotency; culture and organogenesis; Somatic embryogenesis; establishment of Animal cell cultures – callus culture, cell suspension culture, media culture preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - |

| | |
|---|---|
| | methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production. |
| 2 | Plant genetic manipulations (15 Lectures) |
| | Genetic engineering: Agrobacterium-plant interaction; Genetic virulence; Ti and Ri plasmids; opines and their manipulations significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming -concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds. |
| 3 | Animal cell culture and Animal reproductive Biotechnology (15 Lectures) |
| | Brief history of animal cell culture; ATC media: serum, serum free and plant based serum alternatives and chemically defined media. Application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Novel strategies and advancement in mammalian cell line development, large scale production of animal cells, advances in tissue engineering, use of genetic engineering tools for therapy.<br><br>Animal reproductive biotechnology: structure of sperms reproductive and ovum; cryopreservation of sperms and ova of biotechnology livestock; artificial insemination; super ovulation, and embryo recovery and in vitro fertilization; culture of Vaccinology embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species |
| 4 | Molecular mapping and marker assisted selection (15 Lectures) |
| | Molecular markers - hybridization and PCR based mapping and markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; marker DNA fingerprinting-principles and applications; assisted introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods. |

Learning Resources recommended:


1. Biology of plant metabolomics, Robert Hall, Annual Plant Reviews, 43, Chichester, West Sussex; Ames, Iowa: Wiley-Blackwell, 2011
2. Plant Biotechnology. Umesha, S. (2013).
3. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
4. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Publishers.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
7. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
8. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.
9. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Human a Press.
10. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
11. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
12. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: n Introduction to Genetic Engineering. Oxford: Oxford University Press.
13. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants, Wiley 2002.


Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Patenting in Biotechnology and Bioethics |
| Course Code | PSBT203 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 2 |
| Nature | Theory |
| Type | Major: Mandatory III |

# Patenting in Biotechnology and Bioethics

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Patenting | 15 |
| 2 | Bioethics | 15 |
| | **Total** | **30** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of patenting.
CO2 – To provide the insight of bioethics.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Patenting (15 Lectures) |
| | Patentability of Statutory Provisions Regarding Biotechnological; Biotechnology Inventions Under the Current Patent Act 1970 (as Inventions Amended 2005). Interpreting TRIPS in the Light of Biotechnology, Territorial Nature of Patents: From Territorial to Global Patent Regime, Inventions, Feasibility of a Uniform Global Patent, System, Merits and Demerits of Uniform Patent Law, Relevance of the Existing International Patent, Tentative Harmonization Efforts, Implications of Setting up a Uniform World Patent System. |
| 2 | Bioethics (15 Lectures) |
| | Introduction, bioethics in health care- euthanasia, Bioethics artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, organ transplantation. Ethics of clinical research, Bioethics in research – cloning and stem cell research, Human and animal experimentation, Agricultural biotechnology - |

| | |
|---|---|
| | Genetically engineered food, environmental risk, labeling and public opinion. Bioterrorism. |

Learning Resources recommended:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
2. Karen F. Greif, Jon F. Merz - Current Controversies in the Biological Sciences_ Case Studies of Policy Challenges from New Technologies (Basic Bioethics)-The MIT Press (2007)
3. V. Sreekrishna - Bioethics and Biosafety in Biotechnology-to New Age International Pvt Ltd. Publishers (2007)
4. Padma Nambisan (Auth.) - An Introduction to Ethical, Safety and Intellectual Property Rights
5. Issues in Biotechnology- Academic Press (2017)
6. Kshitij Kumar Singh (auth.) - Biotechnology and Intellectual Property Rights_ Legal and Social Implications-Springer India (2015)
7. Talwar Shabana; Intellectual Property Rights in WTO and Developing Countries, Edition 2010, Serials Publications, New Delhi.

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr.No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) | | |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Bio Entrepreneurship |
| Course Code | PSBT206 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 3 |
| Nature | Theory |
| Type | Major: Elective |

# Bio Entrepreneurship

## *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Innovation and Entrepreneurship | 15 |
| 2 | Business strategies | 15 |
| 3 | Finance and Accounting | 15 |
| | **Total** | **45** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To gain the knowledge of innovation and entrepreneurship.
CO2 – To have a firm foundation in business strategies.
CO3 – To provide the insight of finance and accounting.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Innovation and Entrepreneurship (15 Lectures) |
| | Innovation and entrepreneurship in bio-business Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms; Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging biofirms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies. |
| 2 | Business strategies (15 Lectures) |

| | |
|---|---|
| | Bio markets: business strategy and marketing Negotiating the road from lab to the market (strategies and processes of negotiation with financers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills. |
| 3 | Finance and Accounting (15 Lectures) |
| | Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology. |

Learning Resources recommended:

1. Adams, D. J., & Sparrow, J. C. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences Scion
2. Shimasaki, C. D. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies Academic Press Latest Edition
3. Onetti, A., & Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge Routledge Latest Edition
4. Jordan, J. F. Innovation, Commercialization, and Start-Ups in Life Sciences CRC Press Latest Edition.

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities | 10 |
| Question Paper Pattern for Periodical Class Test/ Online Examination | | |

Maximum Marks: 30
Duration: 60 Minutes
Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)

B) Semester End Examination: 60 % (60 Marks)

Duration: The examination shall be of 2 hours’ duration.
Question Paper Pattern
1. There shall be four questions each of 15 marks.
2. All questions shall be compulsory with internal options.
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Bioanalytical and Biophysical Techniques |
| Course Code | PSBT208 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 4 |
| Nature | Theory |
| Type | Major: Elective |

## Bioanalytical and Biophysical Techniques

### *Units at a Glance*

| Sr. No. | Units | No. of Lectures |
|---|---|---|
| 1 | Microscopic Techniques | 15 |
| 2 | Chromatography | 15 |
| 3 | HPTLC Principles and Instrumentation | 15 |
| 4 | Spectroscopy | 15 |
| | **Total** | **60** |

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of microscopic techniques.
CO2 – To provide the insight of chromatography.
CO3 – To gain the knowledge of HPTLC principles and instrumentation.
CO4 – To have a firm foundation in spectroscopy.

Curriculum:

| Sr. No. | Units |
|---|---|
| 1 | Microscopic Techniques (15 Lectures) |
| | Confocal microscopy, Scanning Probe microscope, AFM, cryotomy scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy, single cell imaging. Environmental SEM and its advantages, Immunoelectron microscopy. |
| 2 | Chromatography (15 Lectures) |

| | |
|---|---|
| | HPLC and GC: Specialized columns & detectors in HPLC, Ultra Performance Liquid Chromatography (UPLC), Fast protein liquid chromatography (FPLC), 2D-HPLC and preparative HPLC, Universal and specific Detectors in GC (FID, TCD, ECD, FPD and NPD), Derivatization for GC and Applications. |
| 3 | HPTLC Principles and Instrumentation (15 Lectures) |
| | HPTLC vs TLC, Densitometry & quantitation in HPTLC, HPTLC in fingerprinting & QC, Troubleshooting, Applications of HPTLC, Method Development and validation, Preparative HPTLC |
| 4 | Spectroscopy (15 Lectures) |
| | Introduction and principle of: fluorescence spectroscopy, Light scattering spectroscopy, Luminometry, circular dichroism, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction, X ray crystallography and NMR, Molecular analysis using light scattering, IR, Atomic absorption Spectroscopy. |

Learning Resources recommended:


1. Douglas A. Skoog, Principles of Instrumental Analysis, Saunders College Publishing
2. Chung Chow Chan, Y. C. Lee, Analytical Method Validation and Instrumental Performance Verification, Wiley Interscience o Raymond P. W. Scott,
3. Chromatographic Detectors Design Function Function and Operation, Marcel Dekker Inc
4. D. J. David, Gas Chromatographic Detectors, John Wiley & Sons
5. G. Subramanian, Preparative and Process Scale Liquid Chromatography, Ellis Horwood
6. W. M. A. Niessen, Liquid Chromatography Mass Spectrometry 2nd Ed., Marcel Dekker Inc.
7. Dr. P. D. Sethi, HPTLC High Performance Thin Layer Chromatography


Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester | 30 |
| 02 | Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation | 10 |

| | | |
|---|---|---|
| | and exhibit of leadership qualities in organizing related academic activities | |

| |
|---|
| Question Paper Pattern for Periodical Class Test/ Online Examination<br>Maximum Marks: 30<br>Duration: 60 Minutes<br>Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each) |

B) Semester End Examination: 60 % (60 Marks)

| |
|---|
| Duration: The examination shall be of 2 hours' duration.<br>Question Paper Pattern<br>1. There shall be four questions each of 15 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Bioinformatics and Biostatistics Practical PSBT201 |
| Course Code | PSBT204 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 2 |
| Nature | Practical |
| Type | Major: Mandatory |

# Bioinformatics and Biostatistics Practical PSBT201

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to Bioinformatics and Biostatistics.

Curriculum: (60 Lectures)

| Regular Practicals |
|---|
| 1. Using NCBI and Uniprot web resources.<br>2. Introduction and use of various genome databases.<br>3. Sequence information resources: Using NCBI, EMBL, GenBank, Entrez, Swissprot/ TrEMBL, UniProt.<br>4. Similarity searches using tools like BLAST and interpretation of results.<br>5. Multiple sequence alignment using ClustalW.<br>6. Phylogenetic analysis of protein and nucleotide sequences.<br>7. Homology modeling.<br>8. Use of various primer designing and restriction site prediction tools.<br>9. Use of different protein structure prediction databases (PDB, SCOP, CATH).<br>10. Measures of central tendency: Mean, median and mode for grouped and ungrouped data.<br>11. Measures of dispersion: Standard deviation for grouped and ungrouped data: standard value for the mean and proportion.<br>12. Confidence limits for the mean and proportion.<br>13. Probability: Normal distribution and Binomial distribution use of normal tables.<br>14. Correlation and Regression: Estimation of correlation coefficient, to fit regression equations from bivariate data.<br>15. Test of hypothesis: a) Z-test b) t-test c) x2 test |
| Demonstration Practical |
| Use of gene prediction methods (GRAIL, Genscan, Glimmer). |

Learning Resources Recommended:


1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.

5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
7. S. P. Gupta, Statistical Methods, (45th Revised Edition), Publisher SCHAND
8. William G. Cochran, Sampling Techniques (3th Edition), Wiley and sons
9. Boris V. Gnedenko, Theory of Probability (6th Edition), CRC Press, 13-May-1998
10. Oscar Kempthorne, Klaus Hinkelmann, Design and Analysis of Experiments, Volume1: Introduction to Experimental Design, 2nd Edition, ISBN: 978-0-471-72756-9 December 2007
11. Acheson Johnston Duncan, Quality Control and Industrial Statistics (5th Edition), Irwin; 5 edition January 1, 1986
12. BK Mahajan, Methods in Biostatistics (7th Edition), Published December 1st 2008 by JP Medical Ltd

Evaluation Pattern:

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Journal | 20 |
| 02 | Viva | 10 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

b) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Practical Question 1 | 20 |
| 02 | Practical Question 2 | 20 |
| 03 | Practical Question 3 | 20 |
| Marks in SEE will be converted into 30 marks. | | |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Plant and Animal Biotechnology Practical PSBT202 |
| Course Code | PSBT205 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 2 |
| Nature | Practical |
| Type | Major: Mandatory |

# Plant and Animal Biotechnology Practical PSBT202

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to plant and animal Biotechnology.

Curriculum: (60 Lectures)

| Regular Practicals |
|---|
| Plant tissue culture -<br>1. Prepare culture media with various supplements for plant tissue culture.<br>2. Prepare explants from suitable plants for inoculation under aseptic conditions.<br>3. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG.<br>4. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.<br>5. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometric methods.<br>Animal cell culture -<br>6. Count cells of an animal tissue and check their viability.<br>7. Prepare culture media with various supplements for plant and animal tissue culture.<br>8. Prepare single cell suspension from spleen and thymus.<br>9. Isolate DNA from animal tissue by SDS method.<br>10. Attempt animal cell fusion using PEG. |

Learning Resources Recommended:


1. Biology of plant metabolomics, Robert Hall, Annual Plant Reviews, 43, Chichester, West Sussex;Ames, Iowa: Wiley-Blackwell, 2011
2. Plant Biotechnology. Umesha, S. (2013).
3. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
4. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Publishers.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics.Malden, MA: Blackwell Pub.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
7. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
8. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.

9. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: HumanaPress.
10. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
11. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
12. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: n Introduction to Genetic Engineering. Oxford: Oxford University Press.
13. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants, Wiley 2002.

Evaluation Pattern:

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Journal | 20 |
| 02 | Viva | 10 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

b) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Practical Question 1 | 20 |
| 02 | Practical Question 2 | 20 |
| 03 | Practical Question 3 | 20 |
| Marks in SEE will be converted into 30 marks. | | |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | Bio Entrepreneurship Practical PSBT206 |
| Course Code | PSBT207 |
| Class | M. Sc. I Biotechnology |
| Semester | II |
| No of Credits | 1 |
| Nature | Practical |
| Type | Major: Elective |

# Bio Entrepreneurship Practical PSBT206

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to bio entrepreneurship.

Curriculum: (30 Lectures)

| Case Study |
|---|
| Case study - Successful Entrepreneurship in Biotechnology/Pharma industry – Presentation. |
| Project and Report Writing |
| Project submission on startup ideas and validation, presentation and report writing. |
| MOOC |
| Any MOOC related to Biotechnology. |

Learning Resources Recommended:

1. Coursera
2. Swayam https://swayam.gov.in
3. NPTEL https://nptel.ac.in/noc/
4. Udemy

Evaluation Pattern:

a) Internal Assessment: 40 % (40 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | MOOC Report | 15 |
| 02 | Case Study Report | 15 |
| 03 | Overall performance | 10 |
| Marks in Internal Assessment will be converted into 20 marks. | | |

b) Semester End Examination: 60 % (60 Marks)

| Sr. No. | Particulars | Marks |
|---|---|---|
| 01 | Project work | 20 |
| 02 | Project Report | 20 |
| 03 | Project Presentation | 20 |
| Marks in SEE will be converted into 30 marks. | | |

***Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024***

| | |
|---|---|
| Name of the Course | On Job Training/ Field Project |
| Course Code | PSBT209 |
| Class | M.Sc. I Biotechnology |
| Semester | II |
| No of Credits | 4 |
| Nature | Practical |
| Type | On Job Training/ Field Project |
| Relevance with Employability/ Entrepreneurship/ Skill development | The learners will be able to think critically, organize ana analyze scientific data; to develop advanced scientific writing skills to write research articles, reviews, thesis and proposals and to make oral, poster or Powerpoint presentations; to understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism. |

# Guidelines and Evaluation pattern for On Job Training/ Field Project (100 Marks)

**Introduction:**

Inclusion of On Job Training/ Field Project in the course curriculum of the M.Sc. in Biotechnology programme is one of the ambitious aspects in the programme structure. The main objective of inclusion of On Job Training/ Field Project is to inculcate ability to interpret particular aspect of the study in his/ her own words.

## Guidelines for On Job Training

On-the-Job Training/Field Project: Students will be required to undertake a designated project or tasks in an organization or industry relevant to their field of study. The course aims to provide students with practical exposure and hands-on experience in a professional work environment related to their field of study.

**Course Objectives:**

By the end of the course, students should be able to -

1. Gain exposure to real-world insights and apply theoretical knowledge to practical situations
2. Enhance his/her skills regarding problem-solving, decision-making, and communication skills.
3. Understand organizational dynamics and work culture.
4. Build industry connections and networking opportunities.

**Course Duration:**

Minimum 20 days / 120 hours of On Job Training with an Organization/ NGO/ Charitable Organization/ Private firm.

- The theme of the internship should be based on any study area of the Major course.
- Project Report should be of minimum 50 pages.
- Experience Certificate is Mandatory.

**Report Structure:**

The students will be required to submit a comprehensive report at the end of the On-the-Job Training/Field Project. A project report has to be brief in content and must include the following aspects:

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution and the period of training.

b) **Certificate of Completion:**

A certificate issued by the organization or supervisor confirming the successful completion of the training.

c) **Declaration:**

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) **Acknowledgment:**

Recognizing individuals or organizations that provided support, guidance or resources during the training.

e) **Table of Contents:**

Providing a clear outline of the report's sections and page numbers.

f) **Executive Summary:**

A bird's eye view of your entire presentation has to be precisely offered under this Category.

g) **Introduction on the Company:**

A Concise representation of company/ organization defining its scope, products/services, etc.

h) **Your Role in the Organization during the On Job Training:**

The key aspects handled, the department under which you were deployed and brief Summary report duly acknowledged by the reporting head.

i) **Challenges**:

The challenges confronted while churning out theoretical knowledge into practical world.

j) **Conclusion:**

A brief overview of your experience and suggestions to bridge the gap between theory and practice.

**Course Outcomes:**

1. Apply theoretical knowledge and concepts acquired during the academic program to real-world work scenarios.
2. Develop practical skills and competencies necessary for successful professional engagement.
3. Demonstrate effective problem-solving, decision-making and critical thinking abilities in a work environment.
4. Adapt to and navigate organizational dynamics and work culture in the chosen industry/ institute.
5. Prepare a comprehensive report documenting the training/project experience, findings and recommendations.

## Guidelines for Field Project

The Field Project for Master of Science in Biotechnology is designed to provide students with hands-on learning experiences in understanding different methods and techniques. The project aims to expose students to development-related issues in both rural and urban settings. It offers opportunities for students to observe and study actual field situations related to Biotechnology and programmes that guide the development process. Additionally, students will explore innovative practices to address complex problems in the society.

**Course Objectives:**
By the end of the course, students should be able to -
1. Think critically, organize and analyze scientific data.
2. Develop advanced scientific writing skills to write research articles, reviews, thesis and proposals and to make oral, poster or Powerpoint presentations.
3. Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism.

**Course Duration**: One Semester Minimum 20 days / 120 hours of field project work.

**Course Outline:**

1. **Introduction to Field Project (10 Hours)**
   Understanding the significance of field-based learning in societal development. Identifying the objectives and expected outcomes of the field project.
   Selecting suitable rural and urban settings for the project.

2. **Field Visits and Observations (30 Hours)**
   Organizing field visits to selected rural and urban areas. Observing and documenting the societal conditions, challenges and opportunities in the community.
   Engaging with local stakeholders and understanding their perspectives.

3. **Research and Data Collection (20 Hours)**
   Designing research methodologies and data collection tools. Collecting primary and secondary data related to development issues. Analyzing and interpreting the data to identify key challenges and potential solutions.

4. **Understanding Policies and Programmes (20 Hours)**
   Exploring government policies and programmes related to societal development. Studying the role of various organizations in implementing development initiatives.

5. **Identifying Innovative Solutions (20 Hours)**
   Brainstorming and ideating innovative practices to address identified societal problems. Developing action plans for implementing proposed solutions.
6. **Preparing Project Report and Presentations (20 Hours)**
   Preparing a detailed project report as per the format and making presentations for the same. Developing Report writing and presentation skills among the learner.

**Rubrics for Field Project Report Evaluation:**

1. **Content (40 Marks):**

| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Unsatisfactory (1) |
|---|---|---|---|---|---|
| Introduction and Objectives | Clear and well-defined | Clearly stated | Adequately stated | Vaguely stated | Not stated or unclear |
| Literature Review | Comprehensive and relevant | Relevant and adequate | Limited relevance | Inadequate or missing | Not included |

| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Unsatisfactory (1) |
|---|---|---|---|---|---|
| Field Visits and Observations | Thorough and detailed | Adequate information | Limited data collection | Incomplete or lacking detail | No field observations made |
| Data Analysis | In-depth analysis | Analyzed effectively | Some analysis performed | Superficial or incomplete | No data analysis conducted |
| Understanding of Policies and Programmes | Strong understanding | Adequate understanding | Limited understanding | Inadequate or inaccurate | No understanding displayed |
| Identified Socio-Economic Problems | Comprehensive and clear | Clearly identified | Some problems identified | Inadequate or vague | No problems identified |
| Conclusion | Concise and conclusive | Clear and summarized | Somewhat conclusive | Unclear or missing | No conclusion provided |
| Recommendations | Well-developed and feasible | Feasible and relevant | Partially feasible | Infeasible or lacking detail | No recommendations given |

**2. Presentation (20 Marks):**

| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Unsatisfactory (1) |
|---|---|---|---|---|---|
| Structure and Organization | Well-structured and logical | Clear organization | Adequate organization | Lacks structure | Disorganized and unclear |

| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Unsatisfactory (1) |
|---|---|---|---|---|---|
| Language and Clarity | Clear, concise, and fluent | Fluent language | Some clarity issues | Difficult to understand | Incoherent and unclear |
| Visual Presentation | Professional and engaging | Neat and presentable | Some visual aids used | Minimal use of visuals | No visuals used |
| Grammar and Spelling | No errors in grammar/spelling | Minor errors | Some errors | Frequent errors | Numerous errors |

**3. Research Methodology (10 Marks):**

| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Unsatisfactory (1) |
|---|---|---|---|---|---|
| Appropriate Method Selection | Highly appropriate | Mostly appropriate | Adequate method choice | Inappropriate methods | No clear method used |
| Data Collection and Analysis | Thorough data collection | Adequate data analysis | Limited analysis | Incomplete or weak analysis | No data analysis done |

**4. Creativity and Innovation (20 Marks):**

| Criteria | Excellent (10) | Good (8) | Satisfactory (6) | Needs Improvement (4) | Unsatisfactory (2) |
|---|---|---|---|---|---|
| Innovation in Problem Solving | Highly innovative | Innovative solutions | Some creativity shown | Lacks creativity | No innovative solutions |

**5. Overall Impression (10 Marks):**

| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Unsatisfactory (1) |
|---|---|---|---|---|---|
| Overall Quality | Exceptional quality | High quality | Acceptable quality | Below acceptable | Poor quality |
| Contribution and Learning | Outstanding contribution | Significant contribution | Some contribution | Limited or no learning | No contribution or learning |

**Conclusion:**

The Field Project for Master of Science in Biotechnology provides students with invaluable experiences in understanding societal contexts and development-related issues. Through field visits, research and innovative thinking, students gain practical insights into addressing complex challenges and contributing to the societal development of communities. The rubrics for evaluation ensure a comprehensive assessment of students' learning and contributions during the project.

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution and the period of training/project.

**b) Certificate of Completion:**

A certificate issued by the organization or guide confirming the successful completion of the project.

**c) Declaration:**

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

**d) Acknowledgment:**

Recognizing individuals or organizations that provided support, guidance or resources during the project.

**e) Table of Contents:**

Providing a clear outline of the report's sections and page numbers.

**f) Executive Summary:**

A bird's eye view of your entire presentation has to be precisely offered under this Category. A brief overview of the project, its objectives, and key findings should be mentioned.

**g) Introduction:**

Background information about the field project and its significance. Objectives and scope of the project.

**h) Literature Review:**

Overview of relevant literature and studies related to the chosen field and development issues.

**i) Methodology:**

Description of the research methods used for data collection, such as interviews, surveys, or observations. Explanation of the data analysis techniques employed.

**j) Field Visits and Observations:**

Detailed accounts of the field visits including locations, dates and observations made during the visits. Photographs or visual aids to support the observations.

**k) Data Analysis:**

Presentation and interpretation of the data collected during the field visits. Charts, graphs, or tables to illustrate the findings.

i) **Understanding Policies and Programmes:**

Explanation of relevant government policies and programmes related to the identified development issues. Assessment of how these policies will be implemented in the field context.

ii) **Identified Societal Problems:**

Detailed description of the complex societal problems observed in the community. Analysis of the root causes and implications of these problems.

**l) Innovative Solutions:**

Presentation of innovative practices proposed to address the identified problems.
Description of the action plans to implement these solutions.

**m) Conclusion & Recommendations:**

Summary of the key findings and outcomes of the field project. Reflections on the overall experience and learning during the project. Specific recommendations for policymakers, organizations, or stakeholders to address the identified issues.

**n) References & Appendices:**

List of all sources cited in the project report. Additional supporting materials, such as interview transcripts, survey questionnaires, or field visit notes can be attached as appendices.

**The project report based on 'On Job Training/ Field Project' shall be prepared as per the broad guidelines given below:**

- Font type: Times New Roman
- Font size: 12-For content, 14-for Title
- Line Space: 1.5-for content and 1-for in table work
- Paper Size: A4
- Margin: in Left-1.5, Up-Down-Right-1
- The Project Report shall be bounded.

Format

1st page (Main Page)

Title of the problem of the Project

A Project Submitted

to

**R. P. Gogate college of Arts & Science and**

**R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)**

under

**University of Mumbai**

for partial completion of the degree

of

**Master in Science**

**in special Group Biotechnology**

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

**R. P. Gogate college of Arts & Science and**

**R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)**

Near District Court

Month and Year

On separate page

Index

On separate page

**Declaration by learner**

I the undersigned Miss/Mr. ________________________________ [Name of the learner] here by, declare that work embodied in this project work titled ________________ forms my own contribution to the research work carried out under the guidance of [Name of the guiding teacher] __________________________________ is a result of my own research work and has not been previously submitted to any other University for any other Degree/ Diploma to this or any other University.

Wherever reference has been made to previous works of others, it has been clearly indicated as such and included in the bibliography.

I, here by further declare that all information of this document has been obtained and presented in accordance with academic rules and ethical conduct.

Name and Signature of the learner

Certified by

Name and signature of the Guiding Teacher

On separate page

**Acknowledgment**

(Model structure of the acknowledgement)

To list who all have helped me is difficult because they are so numerous and the depth is so enormous.

I would like to acknowledge the following as being idealistic channels and fresh dimensions in the completion of this project.

I thank the **R. P. Gogate college of Arts & Science and R. V. Jogalekar College of Commerce, Ratnagiri (Autonomous) & University of Mumbai** for giving me opportunity to do this project.

I would like to thank my Principal, ___________for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our Head ________________, for his moral support and guidance.

I would also like to express my sincere gratitude towards my project guide ______________ whose guidance and care made the project successful.

I would like to thank my College Library, for having provided various reference books and magazines related to my project.

Lastly, I would like to thank each and every person who directly or indirectly helped me in the completion of the project especially my Parents and Peers who supported me throughout my project.

(Rashmi A. Bhave)
The Chairperson, BoS

# R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

## Syllabus for
## M. Sc. Biotechnology Programme
## Semester III and IV

## Under Choice Based Credit System (CBCS)
## To be implemented from the Academic Year
## 2023 - 2024

| | |
|---|---|
| Name of Programme | **M. Sc. Biotechnology** |
| Level | PG |
| No of Semesters | 04 |
| Year of Implementation | **2023-24** |
| Programme Specific Outcomes (PSO) | At the end of the Programme, Learner will be able<br><br>1. To identify, formulate, review research literature, analyze and design experiments and identify the solutions for complex problems using modern tools.<br><br>2. To apply the knowledge of basic biotechnology to solve complex problems in society.<br>3. To design experiments to investigate the problems in varied fields of Biotechnology and allied areas.<br>4. To understand and interpret data and derive unique solutions to existing and emerging issue.<br>5. To apply reasoning informed by contextual knowledge to assess societal, health, safety and the consequent responsibilities relevant to the professional biotechnology practices.<br><br>6. To recognize the need and have the ability to engage in independent and lifelong learning in technological change.<br><br>7. To function effectively as an individual and as a member or leader in diverse teams and in inter- and multi-disciplinary areas.<br><br>8. To empower with a knowledge base in processes and applications that would impact and influence existing prototypes of green, blue, red and white Biotechnology.<br><br>9. To be skilled and equipped with contemporary knowledge in Biotechnology and would be eligible for jobs in varied industrial sectors. |
| Relevance of PSOs to the local, regional, national, and global developmental needs | Biotechnology is important at Global, National, Regional and local level. The significance of Biotechnology identified at all these levels and it is relevant to everyday life. The curriculum design of M. Sc. Biotechnology programme helps in understanding various concepts in detail. This programme includes new emerging technologies and their applications. This |

| | |
|---|---|
| | also involves the actual working and mechanism required in industries. The application part is taken care of so that the learner shall be able to connect the phenomena around him with the curriculum. This programme also imparts the research values among the learners. The hard and softs skills acquired during the completion of this programme shall make him employable. |

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40 % marks in the first part and by conducting the Semester End Examinations of 60 % marks in the second part.

**Standard of Passing**

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i. e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i. e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

**Performance Grading:**

**Letter Grades and Grade Points**

| **Semester GPA/ Program CGPA Semester/Program** | **% of Marks** | **Alpha-Sign / Letter Grade Result** |
|---|---|---|
| 9.00-10.00 | 90.0 -100 | 0 (Outstanding) |
| 8.00 ≤ 9.00 | 80.0 ≤ 90.0 | A+ (Excellent) |
| 7.00 ≤ 8.00 | 70.0 ≤ 80.0 | A (Very Good) |
| 6.00 ≤ 7.00 | 60.0 ≤ 70.0 | B+ (Good) |
| 5.50 ≤ 6.00 | 55.0 ≤ 60.0 | B (Above Average) |
| 5.00 ≤ 5.50 | 50.0 ≤ 55.0 | C (Average) |
| 4.00 ≤ 5.00 | 40.0 ≤ 50.0 | P (Pass) |
| Below 4.00 | Below 40 | F (Fail) |
| Ab (Absent) | - | Absent |

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Applied Virology and Microbiology |
| Course Code | PSBT 301 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 – Students will understand epidemiological principles in prevention, control and management of pandemic disease. They will acquire understanding of antimicrobial resistance for management of drug resistance in population.
CO2 - Students will understand the different aspects of biofilm and their management. They will also get insights into latest development of diagnostics & therapeutics for such diseases.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Pandemic diseases, pathogenesis, diagnosis and treatment | Introduction to Pandemic diseases and causative agent like H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus.<br><br>Structure of these viruse-coat and envelope protein, genome composition Pathogenesis (Mechanism of infection) and Acute Clinical manifestations (Signs and<br><br>symptoms) of H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, | 15 |

| | | | |
|---|---|---|---|
| | | Ebola virus Diagnosis, and Treatment for H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus Economic and Social loss due to t Viruses | |
| II | Epidemiology of infectious diseases | Concept of Host, Reservoir, Source of infection, Carrier, Epidemic, Endemic, Pandemic, Outbreak History, Definition scope, importance of epidemiology<br><br>Epidemiology, Health & Public Health Epidemiological principles in prevention & control of disease Measures of disease frequency – Concept of incidence, prevalence, Incidence rate, cumulative incidence, case fatality Epidemiological studies Organizations in disease control & Research – WHO, CDC, UNICEF, NACO, ICMR, NARI, NIV & NGOs | 15 |
| III | Medical Microbiology | Emerging Pathogens / Infections: Diseases caused by Bacteria / parasites/ viruses Name of causative agent, Name of disease caused, History, Antigenic structure, virulence factors, source of infection,<br><br>Transmission, Pathogenesis, Clinical manifestations, Laboratory diagnosis, Treatment, Prophylaxis, vaccines , Current research and developments Bacteria as emerging pathogens / Diseases caused by bacteria: MOTT, Legionella, Conditions caused by *Helicobacter pylori* Viruses as emerging | 15 |

| | | | |
|---|---|---|---|
| | | pathogens / Diseases caused by viruses : HIV (AIDS), Chikungunya, Dengue, Parasites as emerging pathogens / Diseases caused by parasites : Malaria , *Entamoeba histolytica* (Amoebic dysentery) | |
| IV | Biofilms and Antimicrobial activity | Structure of Biofilm – Extracellular polymeric substances, Biofilm architecture. Stages in formation of Biofilm. Microbial interactions in Biofilms (Quorum sensing)<br><br>Need for formation of Biofilms by microorganisms<br><br>Microorganisms commonly associated with biofilms on indwelling medical devices<br><br>Response of biofilms to host defense mechanisms & antimicrobial agents<br><br>Recent advances in biofilm management.<br><br>Conventional methods of drug susceptibility testing (Kirby-Bauer disc diffusion, Stoke's method, E test)<br><br>Advanced methods- Macro & Micro broth dilution methods, Time kill curves, serum killing curves, checker-board assays. Detection of drug resistance in Staphylococci, Streptococci, Enterococci. Automated methods of sensitivity testing. Concept of CLSI standards | 15 |

**Learning Resources recommended:**


1. Microbiology An introduction 10th edition Gerald Tortora, Burdell Funke, Christine Case, pearson Education Inc. Publication 2010

2. Basic Epidemiology R. Bonita, Bealglehole, T. Kjellstrom, 2nd Edition, 2006, WHO

3. Principles of Epidemiology in Public Health Practice, Third edition, US Department of Health & Human Services, CDC, 2012

4. Martin Rusnák, Viera Rusnáková, Georges Kamtoh, RELATIONS BETWEEN EPIDEMIOLOGY AND PUBLIC HEALTH, 2018 https://www.researchgate.net/publication/323964710

5. Evaluation and use of Epidemiological evidence for environmental health risk assessment guideline document World Health Organization 2000 eur/00/5020369

6. Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10$^{th}$ ed Universities Press; Tenth edition, 2017

7. Koneman's Colour Atlas & Textbook of Diagnostic microbiology, 7th edition, 2017, Lippincott, Williams & Wilkins.

8. Mackie & McCartney Medical Microbiology, J. G. Collee, J. P.Duguid, A. G. Fraser, B. P. Marmion, Thirteenth edition, Churchill Liviingston

9. Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12th ed, Moshby


**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Assignment/ Powerpoint presentation/ Class Test | 30 |
| Active participation in routine class instructional deliveries | 05 |
| Overall performance | 05 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Environmental Biotechnology |
| Course Code | PSBT 302 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - At the end of the course, students will be able to understand various concepts of environmental biotechnology, latest development in the area and use of microbiological, molecular and analytical methods in environmental biotechnology.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Air | Air pollution & air Quality Monitoring, Sampling, Source Apportionment. Air Pollution Management in Urban Settlement & Rural Areas, Integrated Air Pollution Management, Green Belt. Biofilters/ Bioscrubber. Catalytic Systems. Green Technology. Ozone Layer Depletion Atmospheric Brown Cloud, Impact on Flora and Fauna Impact on Crop Yield, concept of carbon credit, footprint. | 15 |

| | | | |
|---|---|---|---|
| II | Soil | Causes of soil salinity; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Soil pollution and air quality; Bioleaching of metals, bioaugmentation & biomagnification for soil remediation.<br><br>Phytostabilization – Contaminant removal, Soil cover, Rhizosphere modification, Geotextile capping solid waste; Industrial solid waste; Domestic solid waste; Agricultural solid waste; Municipal solid waste; Major sources of solid wastes; Effects of solid waste generation on quality of air, water and public health; solid waste management, Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes. | 15 |
| III | Water | Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms. Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial, microplastics); Biological indicators (Marine microbes, algae and crustaceans) and accumulators: Biotechnological application of hazardous waste management of water; Use of microbial systems, Phytoremediation strategies in constructed wetlands, Designing constructed wetlands, Substrate, Hydraulic loading rate, Hydraulic | 15 |

| | | | |
|---|---|---|---|
| | | retention time, The selection of plant species, Surface area of wetland, Mechanisms to remove pollutants from constructed wetlands | |
| IV | Biodiversity and Environmental Monitoring | Introducing biodiversity informatics, Global patterns of distribution of biodiversity, biomes, Composition and distribution of biodiversity in India, Taxonomic Database Working Group (TDWG) standards, compatibility and interoperatability, taxonomically intelligent systems, Global biodiversity information system-Overview of the UNEP/GEF biodiversity data management project (BDM), Biosensors in Environmental Monitoring – Working & its application for monitoring environment pollutants,<br><br>Application of protein biomarkers; Biosensors and biochips. IOT for water quality monitoring – General working, Application, water Parameters | 15 |

**Learning Resources recommended:**

1. Chandrappa, R., & Kulshrestha, U. C. (2015). Sustainable air pollution management: theory and practice. Springer.

2. Karl B. Schnelle & Charles A. Brown, (2002) Air pollution control technology Handbook. CRC Press

3. Singh, R. L. (Ed.). (2017). Principles and applications of environmental biotechnology for a sustainable future. Springer Singapore.

4. Enger, E. D., Smith, B. F., & Bockarie, A. T. (2000). Environmental science: A study of interrelationships (p. 434). Boston, MA: McGraw-Hill.

5. Rittmann, B. E., & McCarty, P. L. (2012). Environmental biotechnology: principles and applications. Tata McGraw-Hill Education.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Assignment/ Powerpoint presentation/ Class Test | 30 |
| Active participation in routine class instructional deliveries | 05 |
| Overall performance | 05 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Biologics and Regulatory Affairs |
| Course Code | PSBT 303 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - At the end of the course, the learner will be: Familiar with the basic concepts and significance of Biologics/Biosimilar in addition to having knowledge about its therapeutic applications.
CO2 - Knowledgeable in the steps involved in the production of Biologics/Biosimilars. Aware of the protocols/techniques required for characterization of the Biosimilar relative to the Reference Biologic Acquainted with the regulatory aspects of approval of a Biosimilars.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Introduction to Biologics and Biosimilars | Definition: Drugs, Small molecules, Large molecules/Biologics Categories of Biologics: protein-based hormones, enzymes, monoclonal antibodies, vaccines, blood products, and gene/ cellular therapies. Similarities and Differences: Small molecules versus generics, Biologics versus Biosimilars. | 15 |

| | | | |
|---|---|---|---|
| | | USFDA Approved Small Molecules and USFDA Approved Generics USFDA Approved Biologics and USFDA Approved Biosimilars Indian Regulatory Scenario in relation to Small Molecules and Biologics<br><br>Therapeutic uses of some of the Biologics/Biosimilars Acceptable quality differences between approved Biosimilar and innovator's product | |
| II | Production of Biologics and Biosimilars | Reference Biologic and its significance, Choice of expression system/s and stability of cell lines<br><br>Development of upstream and downstream processes and scale up to manufacturing, Major factors contributing to the maintenance of product quality: raw materials and manufacturing conditions, virus filtration, mycoplasma removal, ultrafiltration<br><br>Example: Production of Monoclonal antibody, downstream processing of Mab<br><br>Introduction to the concept of Biobetters Vs Biosimilars | 15 |
| III | Characterization of Biologics and Biosimilars | Appearance, particulates, pH, osmolality, particle size, Molecular Weight, Protein Sequence and/or amino acid composition Glycosylation, Sialylation, Phosphorylation, Acetylation, and Myristoylation, if any Sulfhydryl | 15 |

| | | | |
|---|---|---|---|
| | | groups(s) and di-sulphide bridges. Size and Purity on HPLC/ MALDI Isoform pattern. Gel electrophoresis (IEF, SDS PAGE and Native PAGE), Western blot Fluorescence spectrum FTIR spectrum and NMR spectrum Bioassays, characterization using Monoclonal Antibody as an example | |
| IV | Quality assurance and regulatory affairs of Biologics and Biosimilars | Introduction to Regulatory Affairs and approvals of Biosimilars, Products approved under the FD&C .PHS/BCPI Act 2009: Innovator Biologics Approval, Biosimilar Pathway, Totality of Evidence, Information required to demonstrate biosimilarity, Interchangeability, Product Switching, Product Naming<br><br>Global regulatory framework | 15 |

**Learning Resources recommended:**


1. Biosimilars: Regulatory, Clinical and Biopharmaceutical Development, Editors: Hiten J. Gutka • Harry Yang • Shefali Kakar, AAPS Advances in the Pharmaceutical, Sciences Series, Volume 34.

2. https://www.fda.gov/drugs/drug-approvals-and-databases/approved-drug-products-therapeutic-equivalence-evaluations-orange-book.

3. https://www.fda.gov/drugs/therapeutic-biologics-applications-bla/purple-book-lists-licensed-biological-products-reference-product-exclusivity-and-biosimilarity.

4. http://nib.gov.in/ NIB-DBT2016.pdf.

5. Biosimilars of Monoclonal Antibodies, A Practical Guide to Manufacturing, Preclinical, and Clinical Development. Edited by Cheng Liu, Ph.D.,K. John Morrow, Jr., Ph.D., Copyright c 2017 by John Wiley & Sons, Inc. All rights reserved. Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

6. Introduction to Biologic and Biosimilar Product Development and Analysis, Karen M. Nagel, AAPS Introductions in the Pharmaceutical Sciences, Editor-in-Chief: Robin M. Zavod, Midwestern University, Downers Grove, IL, USA.

7. Regulatory Requirements of 'Similar Biologics' for Marketing Authorization in India. Review Article. Sharmila et al., International Journal of Drug Regualtory Affairs; 2017, 5(1), 20-24.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Assignment/ Powerpoint presentation/ Class Test | 30 |
| Active participation in routine class instructional deliveries | 05 |
| Overall performance | 05 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Molecular Enzymology and Enzyme Technology |
| Course Code | PSBT 304 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - Enzyme deficiencies and use of enzymes as therapeutics.
At the end of the course the student will be aware of the enzyme kinetics, the catalytic power of an enzyme, changes in the active site, and the importance of the transition state. The importance of obtaining enzymes in their pure form and the ways it can be achieved.
CO2 - The need for and methods for enzyme engineering to enhance its activity or half - life. The significance of enzymes as diagnostic tools, in therapy, industrial application and as biosensors; and the outcome of enzyme deficiencies.

**Curriculum:**

| **Unit** | **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|---|
| I | Basic concepts | Brief history and introduction; chemical nature and properties of enzymes; **how enzymes work** mechanism of action; **catalytic power** and specificity of enzymes; types of catalysis; **active site**; **transition state** and evidence for enzyme transition state complementarity; enzyme kinetics – | 15 |

| | | | |
|---|---|---|---|
| | | **factors affecting enzyme activity**; enzyme inhibition; enzyme specificity; **regulatory enzymes**, regulation of enzyme activity; **allosteric enzymes** and their kinetic<br><br>properties; units of enzymes; non protein enzymes; coenzymes and cofactors; isoenzymes; enzyme pattern in diseases. | |
| II | Techniques of enzyme purification and studies/enzyme engineering | Based on molecular size (Dialysis/ ultrafiltration, density gradient centrifugation, size exclusion chromatography); based on solubility of proteins (Isoelectric precipitation, salting out); based on electric charge (Ion exchange chromatography, Electrophoresis capillary electrophoresis, 2D electrophoresis); based on adsorption properties (Adsorption and Affinity chromatography). Other techniques: Immobilized metal ion affinity chromatography, Hydrophobic interaction chromatography, Reversed phase chromatography and Chromatofocusing.<br><br>Enzyme engineering – Introduction,<br><br>Objectives, Principles, Examples and Steps involved in enzymes engineering. Random mutagenesis and molecular breeding of DNA.<br><br>Recent advances in Rational approaches for Enzyme engineering.<br><br>Applications of enzyme engineering. | 15 |

| | | | |
|---|---|---|---|
| III | Industrial and medical application of enzymes | Textile Industry, Detergent Industry, Pulp and Paper Industry, Animal Feed Industry: Enzyme Technology for Detoxification of Mycotoxins in Animal Feed, Phytases for Feed Applications and Leather Industry. Enzyme Applications for Human and Animal Nutrition. Biosensors – Introduction, instrumentation, Types and examples. Enzymes based sensors as diagnostic tools- Biosensors for Blood Glucose, Biosensors for Urea in Blood and Urine, Biosensors for Uric Acid, Biosensors for Arginine, Biosensors for Asparagine, Biosensors for Creatinine, Biosensors for Cholesterol, Allosteric enzyme based biosensors. | 15 |
| IV | Enzyme deficiencies/diagnostic enzymes/therapeutics | Disorders of amino acid metabolism- Phenylketonuria, Alkaptonuria, Homocystinuria. Disorders of carbohydrate metabolism – Galactosemia, Hereditary fructose intolerance, Hereditary lactose intolerance. Disorder of lipid metabolism - Gaucher disease, Fabry disease. Disorders of purine and pyrimidine metabolism- HGPRT deficiency, Adenosine deaminase deficiency, Orotic aciduria. Enzymes in diagnosis of diseases- Liver disorders, Cancer, Cardiac disorders. | 15 |

| | | | |
|---|---|---|---|
| | | Role of Other enzymes- Lysozyme, Butyrylcholinesterase and Lipases. Therapeutic uses of enzymes - enzymes in replacement therapy, enzymes in cancer treatment, enzymes for fibrinolysis, enzymes used for various treatments and enzyme gene therapy. | |

**Learning Resources recommended:**


1. Lehninger Principles of Biochemistry (4th Ed. Nelson, D., and Cox, M.; W.H. Freeman and Company, New York, 2005.

2. Satyanarayan and Chakrapani, Biochemistry. New Delhi, Elsevier Health Sciences APAC, 2013.

3. Berg JM, Tymoczko JL, Stryer L (2002): Biochemistry, 5th ed., Freeman WH and Co., New York.

4. https://shodhganga.inflibnet.ac.in/ bitstream/10603/100595/7/07_chapter%201.pdf General Introduction to enzymes.

5. https://iopscience.iop.org/ book/978-0-7503-1302-5/chapter/bk978-0-7503-1302-5ch1 Introduction to enzymes and their applications.

6. Biochemistry by Lehninger, 2nd Ed, Kalyani publication 2008.

7. Understanding enzymes (3rd edition). Edited by Trevor Palmer, Ellis Horwood, Chichester, 1991.

8. Protein purification principles, High Resolution Methods, and Applications, 3rd Edition, Jan-Christer Janson, John Wiley & Sons, Inc., Hoboken, New Jersey.

9. https://www.biotecharticles.com/ Applications-Article/Methods-of-Purification-of-Enzymes-583.html

10. https://www.creative-enzymes.com/service/enzyme-purification_307.html Enzyme purification.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Assignment/ Powerpoint presentation/ Class Test | 30 |
| Active participation in routine class instructional deliveries | 05 |
| Overall performance | 05 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practical I |
| Course Code | PSBTP301 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to applied virology and microbiology.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| Regular Practicals | 1. Viral Titering – Plaque Assay, Tissue Culture Infectious Dose (TCID), Chicken Embryo Infectious Dose (CEID)<br>2. Immunoassays: For detection of the virus antigens by ELISA / RIA<br>3. Detection techniques for COVID like RT- PCR and various RAPID tests<br>4. Diagnosis of dengue (kit method)<br>5. Diagnosis of Chikungunya (kit method)<br>6. Antibiotics susceptibility testing by broth Macro dilution method & Micro broth dilution method | 60 |

| | | |
|---|---|---|
| | 7. Study of microbial biofilm formation on various surfaces & Biofilm visualization by staining | |
| Demonstration Practicals | Demonstration of minimum biofilm inhibition concentration of antibiotics/ disinfectants. | |

**Learning Resources recommended:**

1. Microbiology An introduction 10th edition Gerald Tortora, Burdell Funke, Christine Case, pearson Education Inc. Publication 2010

2. Basic Epidemiology R. Bonita, Bealglehole, T. Kjellstrom, 2nd Edition, 2006, WHO

3. Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, $10^{th}$ ed Universities Press; Tenth edition, 2017

4. Koneman's Colour Atlas & Textbook of Diagnostic microbiology, 7th edition, 2017, Lippincott, Williams & Wilkins.

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practical I | 4 experiments of 1.5 hrs duration | 6 hrs | 60 M (01 Paper)<br>(2 Major Experiments, 2 Minor Experiments) | 40 M<br>(20 M for Journal, 10 M for Viva, 10 M for overall performance) | 100 |
| Practical I examination marks will be converted into 50 marks. | | | | | |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practical II |
| Course Code | PSBTP302 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to environmental Biotechnology.

**Curriculum:**

| **Title** | **Learning Points** | **No of Lectures** |
|---|---|---|
| Regular Practicals | 1. Soil and water quality assessment (temp, pH, salinity, water holding capacity of soil etc.)<br>2. Study of metal tolerance of microorganisms isolated from soil/water<br>3. Soil ecosystem analysis/ analysis of microorganisms of soil<br>4. Analysis of compost<br>5. Detection of heavy metals concentration in soil/ water<br>6. Study and comparison of different air samplers<br>7. Growth curve of metal tolerant organism isolated from soil/ water. | 60 |

**Learning Resources recommended:**


1. Chandrappa, R., & Kulshrestha, U. C. (2015). Sustainable air pollution management: theory and practice. Springer.

2. Karl B. Schnelle & Charles A. Brown, (2002) Air pollution control technology Handbook. CRC Press

3. Singh, R. L. (Ed.). (2017). Principles and applications of environmental biotechnology for a sustainable future. Springer Singapore.

4. Enger, E. D., Smith, B. F., & Bockarie, A. T. (2000). Environmental science: A study of interrelationships (p. 434). Boston, MA: McGraw-Hill.

5. Rittmann, B. E., & McCarty, P. L. (2012). Environmental biotechnology: principles and applications. Tata McGraw-Hill Education.


**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practical II | 4 experiments of 1.5 hrs duration | 6 hrs | 60 M (01 Paper)<br><br>(2 Major Experiments, 2 Minor Experiments) | 40 M<br><br>(20 M for Journal, 10 M for Viva, 10 M for overall performance) | 100 |
| Practical II examination marks will be converted into 50 marks. | | | | | |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practical III |
| Course Code | PSBTP303 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to biologics and regulatory affairs.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| Regular Practicals | 1) Electrophoresis {PAGE (native, SDS, reducing, non-reducing )} to characterize the protein with regard to its molecular weight, structure/subunits/SS bonds etc., or for detection of impurities in the product<br>2) Concentration of protein with Folin Lowry<br>3) HPLC /FTIR/NMR spectrum based theory questions may be asked for interpretation | 60 |
| Demonstration Practicals | Western blot/dot blot for purity of product demonstration/ dummy sandwich preparation of semi-dry or wet western blot sandwich. | |
| Visit | Visit to a facility manufacturing Biosimilar | |

**Learning Resources recommended:**

1. Biosimilars: Regulatory, Clinical and Biopharmaceutical Development, Editors: Hiten J. Gutka • Harry Yang • Shefali Kakar, AAPS Advances in the Pharmaceutical, Sciences Series, Volume 34.

2. https://www.fda.gov/drugs/drug-approvals-and-databases/approved-drug-products-therapeutic-equivalence-evaluations-orange-book.

3. https://www.fda.gov/drugs/therapeutic-biologics-applications-bla/purple-book-lists-licensed-biological-products-reference-product-exclusivity-and-biosimilarity.

4. http://nib.gov.in/ NIB-DBT2016.pdf.

5. Regulatory Requirements of 'Similar Biologics' for Marketing Authorization in India. Review Article. Sharmila et al., International Journal of Drug Regualtory Affairs; 2017, 5(1), 20-24.

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practical III | 4 experiments of 1.5 hrs duration | 6 hrs | 60 M (01 Paper)<br>(2 Major Experiments, 2 Minor Experiments) | 40 M<br>(20 M for Journal, 10 M for Viva, 10 M for overall performance) | 100 |
| Practical III examination marks will be converted into 50 marks. | | | | | |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practical IV |
| Course Code | PSBTP304 |
| Class | M. Sc. II Biotechnology |
| Semester | III |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to molecular enzymology and enzyme technology.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| Regular Practicals | 1. Microbial Enzyme production:<br>a. Partial purification using ammonium sulphate precipitation.<br>b. Dialysis of the salt-precipitated protein.<br>c. Assessing the enzyme activity and the protein content.<br>2. Effect of inhibitors/ chemicals on enzyme activity.<br>3. Extraction of enzymes from plant sources.<br>4. Measurement of Enzymatic Activity by Using a Colorimetric Assay. | 60 |

| | | |
|---|---|---|
| | 5. Purification of Acid Phosphatase from Wheat Germ.<br><br>6. Enzyme Immunoassays.<br><br>a. Methods for Enzyme Immunoassays.<br><br>b. Non-competitive Solid-phase Enzyme Immunoassay.<br><br>c. Competitive, Solid-phase Enzyme Immunoassay.<br><br>7. Determining of Alkaline Phosphatase (ALP) Concentration in Blood Plasma.<br><br>8. Measuring Lactase Enzymatic Activity.<br><br>9. Screening of new microbial strains for production of enzymes and perform its activity staining (zymogram).<br><br>10. To determine Specific activity of α Amylase from different sources. | |

**Learning Resources recommended:**


1. Satyanarayan and Chakrapani, Biochemistry. New Delhi, Elsevier Health Sciences APAC, 2013.

2. https://shodhganga.inflibnet.ac.in/ bitstream/10603/100595/7/07_chapter%201.pdf General Introduction to enzymes.

3. Understanding enzymes (3rd edition). Edited by Trevor Palmer, Ellis Horwood, Chichester, 1991.

4. Protein purification principles, High Resolution Methods, and Applications, 3rd Edition, Jan-Christer Janson, John Wiley & Sons, Inc., Hoboken, New Jersey.

5. https://www.biotecharticles.com/ Applications-Article/Methods-of-Purification-of-Enzymes-583.html

6. Enzyme purification.

   https://www.creative-enzymes.com/service/enzyme-purification_307.html

**Evaluation Pattern**

<table>
<tr><td></td><td>No. of Experiments</td><td>Duration</td><td>Total Marks</td><td>CIE</td><td>Total</td></tr>
<tr><td>Practical IV</td><td>4 experiments of 1.5 hrs duration</td><td>6 hrs</td><td>60 M (01 Paper)<br><br>(2 Major Experiments, 2 Minor Experiments)</td><td>40 M<br><br>(20 M for Journal, 10 M for Viva, 10 M for overall performance)</td><td>100</td></tr>
<tr><td colspan="6">Practical IV examination marks will be converted into 50 marks.</td></tr>
</table>

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Nanobiotechnology |
| Course Code | PSBT 401 |
| Class | M. Sc. II Biotechnology |
| Semester | IV |
| No of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - Students should be able to understand the basic science behind the properties of nanomaterials and the principles behind advanced experimental techniques for studying nanomaterials.
CO2 - Also understand the different aspects and applications of nanomaterials.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Introduction to nanotechnology and nanomaterials | Introduction: Nanotechnology, Nature's biological pathway, Examples of nanomaterials and nanostructures found in nature. Nanometer-scale materials: Nanometer-Scale Metals Nano Metal Oxides, Nanopolymers, Quantum Dots, Carbon nanostructures. Nanorobotiocs devices of nature ATP synthase, the kinesin, myosin, dynein, flagella modulated motion. | 15 |

| | | | |
|---|---|---|---|
| II | Synthesis of nanomaterials | Synthesis of nanometer-scale materials- Top down and Bottom up approaches. Self-Assembly of nanoparticles and its mechanism.<br><br>Bio-directed synthesis and assembly<br><br>of nanomaterials<br><br>Synthesis and Assembly of Nanoparticles and Nanostructures Using Bio-Derived Templates | 15 |
| III | Nanotechnology in drug delivery | Biological Barriers to Nanocarrier-Mediated Delivery of Therapeutic and Imaging Agents, Nano-Sized Carriers for Drug Delivery, nano enabled drug delivery system, nanorobotics in medicine, Nanomedicine: biopharmaceutics, implantable materials, implantable chemicals, surgical aids | 15 |
| IV | Applications of nanotechnology and Nanotoxicology | Applications of Nanomaterials. Nanotoxicology: Unique Properties, Toxicity of Nanomaterials, Factors Responsible for the Nanomaterial Toxicity, Routes of Exposure, Mechanisms of Nanoparticle Toxicity, In Vitro Testing Methods for Nanomaterials, Ecotoxicity Analyses of Nanomaterials | 15 |

**Learning Resources recommended:**

1. Poinern, Gerrard Eddy Jai. A laboratory course in nanoscience and nanotechnology. CRC Press, 2014.
2. Guozhong, Cao. Nanostructures and nanomaterials: synthesis, properties and applications. World scientific, 2004.

3. Sulabha K. Kulkarni (auth.) - Nanotechnology_ Principles and Practices-Springer International Publishing (2015)

4. Crookes-Goodson, W. J., Slocik, J. M., & Naik, R. R. (2008). Bio-directed synthesis and assembly of nanomaterials. Chemical Society Reviews, 37(11), 2403-2412

5. Chad A. Mirkin, Christof M. Niemeyer - Nanobiotechnology II_ More Concepts and Applications-Wiley-VCH (2007)

6. Christof M. Niemeyer, Chad A. Mirkin (Editors) - Nanobiotechnology_ Concepts, Applications and Perspectives-Wiley-VCH (2004)

7. Chad A. Mirkin, Christof M. Niemeyer - Nanobiotechnology II_ More Concepts and Applications-Wiley-VCH (2007)

8. Oded Shoseyov, Ilan Levy NanoBioTechnology_ BioInspired Devices and Materials of the Future (2008, Humana Press)

9. Textbook of Nanoscience and Nanotechnology by B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday

10. Arun Kumar - Nanomedicine in drug delivery-CRC Press _ Taylor & Francis (2013).

11. Yuliang Zhao, Zhiyong Zhang, and Weiyue Feng - Toxicology of Nanomaterials-Wiley-VCH (2016)

12. Diwan, Parag, and Ashish Bharadwaj, eds. The Nanoscope: Encyclopedia of Nanoscience and Nanotechnology. Pentagon Press, 2005. (Vol 1-6)

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Assignment/ Powerpoint presentation/ Class Test | 30 |
| Active participation in routine class instructional deliveries | 05 |
| Overall performance | 05 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | OMICS and Systems Biology |
| Course Code | PSBT 402 |
| Class | M. Sc. II Biotechnology |
| Semester | IV |
| No. of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - At the end of the course learners will be able to understand how the data is generated by OMICS technologies to contribute to different databases.
CO2 - Understand, compare and contrast the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics; Will be able to apply the different technologies of OMICS to the screening, testing and treatment of human diseases. Understand the structure and dynamics of a systems as a whole. Apply the different approaches to study systems biology by top down and bottom up approach.
CO3 - Introduction to concepts of knowledge discovery process and data mining methods. Understand the application of data mining in genomics, proteomics and development of tools in bioinformatics. Have the knowledge of applications of systems biology in development of personalized medicine, drug development.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | OMICS – the OMICS technology, a broad outlook | Tools of Omics. Introduction to Epigenomics Human genome project- goals, conclusions and application. Structural and functional proteomics protein - protein interaction and identification of | 15 |

| | | | |
|---|---|---|---|
| | | interactions by various methods. Application of Proteomics and Genomics in human diseases, screening, testing and treatment of diseases.<br><br>Metagenomics: concept, strategies, and applications in environmental biotechnology, agriculture and health | |
| II | Transcriptomics, Lipidomics and Metabolomics | Introduction to Transcriptomics, Lipidomics And Metabolomics, Glycomics, Pharmacogenomics Techniques used in Lipidomics- Mass Spectroscopy, TLC, HPLC, GC and Capillary electrophoresis, MALDI. Technique used in Metabolomics- Mass Spectroscopy, Electrophoresis, chromatography-<br><br>GC, LC & NMR. Technique used in Transcriptomics- next generation sequencing, northern blotting, DDRTPCR, microarrays, gel free assays like biolayer interference, SPR.<br><br>Applications of transcriptomics metabolomics and lipidomics in human diseases –screening, testing<br><br>and treatment of diseases.(in clinical applications, personalised medicine, infectious diseases) | 15 |
| III | Introduction to systems biology | Systems biology towards systems level understanding of biological systems, Systems structure, systems dynamics, systems design and control, systems project Models and | 15 |

| | | | |
|---|---|---|---|
| | | Modelling systems in systems biology<br><br>What is a model? Key properties of models, Basic of computational models, networks, data integration, standards, and model organism Perturbation of biological systems and 'Omics' as Quantitative high throughput experimental tools for systems biology<br><br>Standards and formats for systems biology Computational Databases and software tools in systems biology. Biological networks: metabolic networks, gene regulatory networks, PPI networks, genetic interaction (GI) networks, and signalling networks | |
| IV | Data mining and application of systems biology | Introduction to Knowledge of discovery in databases (KDD) What is knowledge, need for KDD, KDD process outline, concept and goals.<br><br>Data Mining methods: Statistics – classification, correlation, association analysis, regression, and clustering; Machine learning – Symbolic and statistical approaches.<br><br>Text mining, and Pattern evaluation.<br><br>Data mining in scientific applications<br><br>Application of systems biology: 1. Systems biology to systems medicine. | 15 |

| | | | |
|---|---|---|---|
| | | 2. Application of systems biology in drug discovery and development<br><br>3. Systems biology and synthetic biology | |

**Learning Resources recommended:**

1. Bioinformatics and functional genomics (2003), Jonathan Pevsner, John Wiley and sons Publications

2. Omic technologies: genomics, transcriptomics, proteomics and metabolomics, Richard P. Horgan and Louise C. Kenny, Scientific advisory committee (sac), the obstetrician and gynaecologist.

3. Systems Biology a textbook, second edition, Edda Klipp, Wolfram Liebermeister, Christoph Wierling AAxel Kowald, Wiley wch publications

4. Analysisof biological networks (2008), Bjorn Junker, Falk Schreiber, Wiley Interscience

5. Introduction to biological networks, Alpan Ravaland, Animesh Ray, CRC Press (2013).

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Assignment/ Powerpoint presentation/ Class Test | 30 |
| Active participation in routine class instructional deliveries | 05 |
| Overall performance | 05 |

## B. Semester End Evaluation (Paper Pattern)

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Drug Discovery and Clinical Study |
| Course Code | PSBT 403 |
| Class | M. Sc. II Biotechnology |
| Semester | IV |
| No. of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

By the end of the course the student will:
CO1 - Able to learn about drug discovery-design pathway using some in-silico tools.
CO2 - Able to understand the clinical trial design set up as well as they will gain information on rules-regulation and responsibilities in clinical studies.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Clinical research informatics in drug discovery | Introduction to the drug discovery & development<br>• Source of drugs<br>• Structural effects on drug action<br>• Drugs derived from natural products<br>• General principles of pharmacology<br>• Drug development and testing | 15 |

| | | | |
|---|---|---|---|
| | | process<br><br>**Approaches to new drug discovery**<br><br>• Computer-aided drug design<br><br>• Identification of novel drug candidates and drug targets<br><br>• Construction the signalling network of a drug using integer linear programming<br><br>• Identification for druggable targets of a disease | |
| II | Clinical trial design and Indian regulations | **Clinical Trial Design**<br><br>• Basic framework of clinical trial<br><br>• Randomized clinical trials and different phases<br><br>• Adaptive randomization methods<br><br>• Seamless design<br><br>• Internal pilot design<br><br>• Design selection factors<br><br>**Regulations**<br><br>• The national regulatory body<br><br>• Key documents in clinical research<br><br>• Regulatory requirements for the conduct of clinical trials in India<br><br>**The Roles and Responsibilities of** | 15 |

| | | | |
|---|---|---|---|
| | | **Stakeholders in the Sharing of Clinical Trial Data**<br>• Participants in clinical trials<br>• Investigators,<br>• Research institutions and universities<br>• Journals and Professional societies | |
| III | Pharmacovigilance | Scope and purposes of pharmacovigilance<br>• Adverse Drug Reactions (ADR)<br>• ADR classification<br>• Nature and mechanism of ADR<br>• Concept of safety<br>• Phases and types of DATA<br>**The process of Pharmacovigilance**<br>• Signal detection, evaluation and investigation,<br>• Communication<br>**Methods of evaluating effectiveness of action International regulatory collaboration**<br>• WHO, CIOMS, ICH, ISoP, ISPE | 15 |
| IV | Clinical data science | Data management in clinical research: An overview | 15 |

| | | | |
|---|---|---|---|
| | | • Data Sources and Data Types<br><br>• Standards in Healthcare Data<br><br>• Research Data Stewardship for Healthcare Professionals<br><br>• Preparing Data for Prediction Model Development<br><br>• Prediction Modelling Methodology<br><br>• Clinical Decision Support System | |

**Learning Resources recommended:**


1. Fundamentals of Clinical Data Science, Pieter Kubben, Michel Dumonier, Andre Dekker, ISBN 978-3-319-99712-4 ISBN 978-3-319-99713-1 (eBook).
2. Experimental designs for small randomized clinical trials: an algorithm for choice, Orphanet J. Rare Dis. 2013; 8: 48, Catherine Cornu et. al.
3. Molecular docking studies, Chapter 5, Shodhganga
4. Basic and clinical pharmacology, 2017, Fourteenth Edition, Section I, Chapter I, Bertram G. Katzung, Editor, ISSN 0891 – 2033.
5. An introduction to Pharmacovigilance, second edition, Patrick Waller and Mira Harrison – Woolrych.

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Powerpoint presentation of a clinical case/trial study report/ Class Test | 30 |
| Active participation in routine class instructional deliveries | 05 |
| Overall performance | 05 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Scientific Writing and Food Biotechnology |
| Course Code | PSBT 404 |
| Class | M. Sc. II Biotechnology |
| Semester | IV |
| No. of Credits | 04 |
| Nature | Theory/ ~~Practical/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

On completion of the course students will be able to:
CO1 - Think critically, organize and analyze scientific data.
CO2 - Develop advanced scientific writing skills to write research articles, reviews, thesis, and proposals and to make oral, poster or power point presentations.
CO3 - Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism.

**Curriculum:**

| Unit | Title | Learning Points | No. of Lectures |
|---|---|---|---|
| I | Basic scientific writing and plagiarism | Introduction to scientific writing.<br><br>Basic scientific writing skills: style and language, spelling, grammar, syntax, jargon and sentence structure. Elements of a scientific paper: abstract, introduction, materials & methods, results, discussion, references and drafting titles. | 15 |

| | | | |
|---|---|---|---|
| | | Scientific writing process: thinking, planning, rough draft, revision of content.<br><br>Processing data & application of statistics, Displaying data: text, table, graph and defining terms and abbreviations.<br><br>Statistical analysis and tools for experimental data.<br><br>Referencing software: Mendeley, Endnote.<br><br>Plagiarism: Definition, Common types of plagiarism, Intentional and Unintentional plagiarism, Detection of plagiarism by antiplagiarism tools (Turnitin, Duplichecker, Viper, Copyleaks), Penalties for plagiarism, Avoiding plagiarism. | |
| II | Advanced scientific writing | Guidelines for Medical writing.<br><br>Scientific writing skills: Writing a research paper for biomedical journal, Writing science research papers and articles, Writing a research proposal, Writing a research report, Writing popular reports, Writing thesis and dissertation, Writing clinical study reports. Presentation skills: Oral presentation, Poster Preparation & presentation, Powerpoint presentations. Research ethics, Scientific misconduct. | 15 |
| III | Food Biotechnology – Nutraceuticals | Nutraceuticals and functional foods Definition, characteristic features, | 15 |

| | | | |
|---|---|---|---|
| | | and classification, phytonutraceuticals, Prebiotics and Probiotics, Sources (with examples e.g. microbes, plants, algae, animals), blue biotechnology, food security, food preservation, Chemopreservation; Food processing (animal and sea food), food packaging | |
| IV | Food Biotechnology in management of health and disease | Applications of nutraceuticals in human health and nutrition- health effects of commonly used nutraceuticals and functional foods (case studies), Safety and Regulatory guidelines Nutraceuitcals in management of health and disease Development of designer foods for specific chronic diseases Nutraceutical adjuvants | 15 |

**Learning Resources recommended:**


1. Thomas, C George. (2019). Research Methodology and Scientific Writing 2nd edition.

2. Kumar, Ranjeet. (2011). Research methodology: a step-by-step guide for beginners 3rd edition.

3. Jennifer Peat, Elizabeth Elliott, Louise Baur, and Victoria Keena. (2002). Scientific Writing (BMJ Books).

4. J.R. Mathews & R.W.Mathews (2008) Successful Scientific Writing, 3rd Ed. Cambridge University Press.

5. https://www.ema.europa.eu/en/documents/scientific-guideline/ich-e-3-structure-content-clinical-study-reports-step-5_en.pdf

6. https://www.emwa.org/documents/about_us/EMWAguidelines.pdf

7. https://www.otago.ac.nz/hedc/otago615367.pdf

8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3510958/

9. http://medind.nic.in/iad/t02/i1/iadt02i1p21.pdf

10. https://intranet.birmingham.ac.uk/as/registry/policy/conduct/plagiarism/interactive-course.aspx

11. https://www.bowdoin.edu/dean-of-students/judicial-board/academic-honesty-and-plagiarism/common-types-of-plagiarism.html

12. https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism?wssl=1

**Evaluation Pattern**

**A. Internal Evaluation**

| **Method** | **Marks** |
|---|---|
| Online Course | 20 |
| Research Proposal | 20 |

**B. Semester End Evaluation (Paper Pattern)**

| **Question No.** | **Unit** | **Marks** |
|---|---|---|
| 1 | I | Unit I questions 12 M |
| 2 | II | Unit II questions 12 M |
| 3 | III | Unit III questions 12 M |
| 4 | IV | Unit IV questions 12 M |
| 5 | All Units | Short notes (03 out of 04) 12 M |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practical I |
| Course Code | PSBTP401 |
| Class | M. Sc. II Biotechnology |
| Semester | IV |
| No. of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to nanobiotechnology.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| Regular Practicals | 1. Biosynthesis and characterization of eco-friendly silver nanoparticles by using plant/leaf extracts/green tea<br>2. Synthesis and characterization of zinc sulfide nanoparticles by A reverse micelle method<br>3. Synthesis and characterization of Fluorescent Carbon Nanoparticles from Candle Soot and its separation of using the Thin-Layer Chromatographic Method<br>4. Synthesis of alginate beads and investigation of citric acid release from a nanoshell coating of polymer<br>5. Antimicrobial activity testing of Nanoparticles/nanocomposites | 60 |

**Learning Resources recommended:**

1. Poinern, Gerrard Eddy Jai. A laboratory course in nanoscience and nanotechnology. CRC Press, 2014.

2. Guozhong, Cao. Nanostructures and nanomaterials: synthesis, properties and applications. World scientific, 2004.

3. Sulabha K. Kulkarni (auth.) - Nanotechnology_ Principles and Practices-Springer International Publishing (2015)

4. Textbook of Nanoscience and Nanotechnology by B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practical I | 4 experiments of 1.5 hrs duration | 6 hrs | 60 M (01 Paper)<br><br>(2 Major Experiments, 2 Minor Experiments) | 40 M<br><br>(20 M for Journal, 10 M for Viva, 10 M for overall performance) | 100 |
| Practical I examination marks will be converted into 50 marks. | | | | | |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practical II |
| Course Code | PSBTP402 |
| Class | M. Sc. II Biotechnology |
| Semester | IV |
| No of Credits | 02 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to OMICS and systems biology.

**Curriculum:**

| Title | Learning Points | No. of Lectures |
|---|---|---|
| Regular Practicals | 1. Gel electrophoresis of lipids (lipoproteins extracted from various sources) to separate and identify the lipid fraction | 60 |
| Demonstration Practicals | 1. Detection assay for gene expression using micro array and qRT –PCR ( demonstration)<br>2. Identification of protein using analytical technique Mass spectroscopy ( demonstration) | |
| Report Writing | 1. Preparation of report based on - Databases and data repositories used in systems Biology | |

**Learning Resources recommended:**

1. Bioinformatics and functional genomics (2003), Jonathan Pevsner, John Wiley and sons Publications

2. Systems Biology a textbook, second edition, Edda Klipp, Wolfram Liebermeister, Christoph Wierling AAxel Kowald, Wiley wch publications

3. Analysis of biological networks (2008), Bjorn Junker, Falk Schreiber, Wiley Interscience

4. Introduction to biological networks, Alpan Ravaland, Animesh Ray, CRC Press (2013).

**Evaluation Pattern**

| | No. of Experiments | Duration | Total Marks | CIE | Total |
|---|---|---|---|---|---|
| Practical II | 4 experiments of 1.5 hrs duration | 6 hrs | 60 M (01 Paper)<br><br>(2 Major Experiments, 2 Minor Experiments) | 40 M<br><br>(20 M for Journal, 10 M for Viva, 10 M for overall performance) | 100 |
| Practical II examination marks will be converted into 50 marks. | | | | | |

## Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

| | |
|---|---|
| Name of the Course | Practical III and Practical IV |
| Course Code | PSBTP403 and PSBTP404 |
| Class | M. Sc. II Biotechnology |
| Semester | IV |
| No. of Credits | 04 |
| Nature | ~~Theory~~/ Practical~~/ Project/ other (please specify)~~ |
| Type | Core/ ~~Elective~~ |

**Course Outcomes:**

CO1 - To impart knowledge and hands on experience of the various practicals related to scientific writing.

**Curriculum:**

| **Title** | **Learning Points** | **No. of Lectures** |
|---|---|---|
| Regular Practicals | 1. A finding of a drug-gene interaction or potentially druggable category using The Drug Gene Interaction Database (DGIdb)<br><br>2. Recognition of binding patterns common to set of protein structures using ProBiS<br><br>3. Recognition of common spatial chemical binding patterns to a Set of Protein Structures using Multiple Alignment of Protein Binding Sites (MultiBind) tool and analysis using RasMol/Jmol<br><br>4. Estimation of total sugars from food products (dairy, fruit juices, bakery) | 60 |

| | | |
|---|---|---|
| | 5. Determination of acid value of natural fats and oils.<br><br>6. Determination of iodine number of fats and oils.<br><br>7. Study of nutraceuticals important plants like Zinziber, Curcuma, Alovera, Asparagus, Ocimum etc.<br><br>8. Estimation of antioxidant property of phytochemical by DPPH.<br><br>9. Qualitative test for tannins, phenols, isoflavones, alkaloids using TLC.<br><br>10. Estimate Cholesterol contents in given sample by Zak's methods.<br><br>11. Estimation of bio-burden by viable counts.<br><br>12. Estimation of gluten from food sample.<br><br>13.To study nutritional components (protein, carbohydrate, secondary metabolites, lipids, vitamin C) of following: Bee honey, Mushrooms, Lentils, Soya, Dairy product, Amla, Papaya, Spinach. | |
| Demonstration Practicals | 1. Computational protein-ligand docking using AutoDock.<br><br>2. Estimation of vitamin B by HPLC.<br><br>3. Estimation of food preservatives/additives (Parabens) from food sample by HPLC. | |
| Online Course | 1. Exploration of various learning platforms in online courses listed below :<br><br>a. Online courses in fundamentals of Neuroscience from Harvard University https://online-<br><br>learning.harvard.edu/course/fundamentals-neuroscience-part-1-electrical-properties-<br><br>neuron?delta=0 | |

| | | |
|---|---|---|
| | b. Molecular Biology from MIT https://ocw.mit.edu/courses/biology/7-28-molecular-biology-spring-2005/<br><br>c. Introduction to Bioethics from Georgetown<br><br>https://bioethicsarchive.georgetown.edu/phlx101-02/course.html#units/introduction<br><br>2. Complete an online course (Minimum 1 week) on the topic related to the biotechnology. Write a comprehensive report on the studied course contents.<br><br>a. Swayam https://swayam.gov.in/<br><br>b. NPTELhttps://nptel.ac.in/noc/<br><br>c. MOOC https://www.it.iitb.ac.in/frg/wiki/images/7/7b/Demo-PPT.pdf<br><br>d. E-learning https://www.bellevuecollege.edu/elearning/start/intro/ | |
| Research Proposal | Write a research proposal on any topic of your interest from the MSc syllabus. For research proposal contents and format refer to NSF guidelines.<br><br>https://www.nsf.gov/pubs/policydocs/pappg19_1/nsf19_1.pdf<br><br>For reference work use Mendeley Desktop.<br><br>https://www.mendeley.com/guides/desktop | |

**Learning Resources recommended:**


1. Fundamentals of Clinical Data Science, Pieter Kubben, Michel Dumonier, Andre Dekker, ISBN 978-3-319-99712-4 ISBN 978-3-319-99713-1 (eBook).
2. Experimental designs for small randomized clinical trials: an algorithm for choice, Orphanet J. Rare Dis. 2013; 8: 48, Catherine Cornu et. al.

3. Molecular docking studies, Chapter 5, Shodhganga
4. Basic and clinical pharmacology, 2017, Fourteenth Edition, Section I, Chapter I, Bertram G. Katzung, Editor, ISSN 0891 – 2033.
5. An introduction to Pharmacovigilance, second edition, Patrick Waller and Mira Harrison – Woolrych.
6. Thomas, C George. (2019). Research Methodology and Scientific Writing 2nd edition.
7. Kumar, Ranjeet. (2011). Research methodology: a step-by-step guide for beginners 3rd edition.
8. Jennifer Peat, Elizabeth Elliott, Louise Baur, and Victoria Keena. (2002). Scientific Writing (BMJ Books).
9. https://www.bowdoin.edu/dean-of-students/judicial-board/academic-honesty-and-plagiarism/common-types-of-plagiarism.html

**Evaluation Pattern**

Project Dissertation – 100 M

For semester IV it is mandatory for students to undergo Hands-on Project training in an established research laboratory or college laboratory for 4-6 months; this should involve one or more relevant instrumentation techniques. Thesis on the same to be evaluated by the guide alternatively by an internal examiner for 40 M based on the student’s performance, written matter and experimentation. A certificate must be appended with the thesis. Another examiner will assess for 60 M as a Presentation during practical exams.

(Rashmi A. Bhave)
The Chairperson, BoS