



**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 - 1. To impart hands on skills in preparation of buffers and solutions. 2. To impart skills in handling the cultures of micro – organisms. 3. To impart the knowledge of molecular biology techniques. 4. To impart the skills of Science communication. 5. To impart knowledge of society and make students aware about the Problems in society. 6. To understand basic principles of research methodology and identify a research problem. 7. To gain critical thinking and analytical skills to understand new diagnostic methods. 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. 8 out of 20) in the Internal Assessment and 40 % marks in Semester End Examination (i. e. 12 out of 30) 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	O (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

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
<i>Discipline Specific Course (DSC)</i>			<i>Discipline Specific Course (DSC)</i>		
<i>Major</i>			<i>Major</i>		
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
<i>Minor</i>			<i>Minor</i>		
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
<i>Indian Knowledge System(IKS)</i>			<i>Indian Knowledge System(IKS)</i>		
USBT106	Traditional Biotechnology	02			---
<i>Skill Enhancement Course (SEC)</i>			<i>Skill Enhancement Course (SEC)</i>		
USBT107	Biostatistics	02	USBT207	Bio-analytical Techniques	1 + 1
<i>Ability Enhancement Course (AEC)</i>			<i>Ability Enhancement Course (AEC)</i>		
USBT108	English: Communication Skills – I	02	USBT208	English: Communication Skills – II	02
<i>Value Education Course (VEC)</i>			<i>Value Education Course (VEC)</i>		
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

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	<p>Applications of biotechnology: -</p> <p>Agriculture: GM fruits- GM papaya, GM tomato, Insect resistant transgenic plants – Bt cotton, Bt brinjal, Modifications in nutrient quality – starch, oilseed protein, golden rice</p> <p>Livestock: Growth, disease resistance, product quality, pharmaceuticals and nutritional supplements, industrial applications</p> <p>Human welfare: Cloned genes for production of - Insulin; recombinant vaccine for Hepatitis B virus. Molecular farming, Edible vaccines and their advantages</p> <p>Environment- Pollution abatement through GMOs</p> <p>Bioethics Case study: Genetically modified microbes</p>	15

		for bioremediation of oil spills in marine environment	
II	Fermentation technology	<p>Introduction to fermentation processes: Microbial biomass, Microbial enzymes, Microbial metabolites, recombinant products, transformation processes. Development of fermentation Industry</p> <p>Component parts of fermentation process Screening: Definition, Primary screening and its methods, Secondary screening and its methods</p> <p>Fermenter design: Definition of a fermenter, aerated stirred tank batch fermenter-Typical design, Construction materials used, aeration and agitation</p> <p>Basic introduction to process parameters: Temperature control, Foam production and control pH measurement and control, CO₂ and O₂ control</p> <p>Fermentation medium: 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</p> <p>Product: A typical process of Ethanol production and Antibiotic production</p>	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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 M

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

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	<p>Introduction: Definition and concept of Sterilization and Disinfection.</p> <p>Types and Applications: Dry Heat, Steam under pressure Gases, Radiation and Filtration</p> <p>Chemical Agents and their Mode of Action: Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents.</p> <p>Disinfectant: Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant</p> <p>Nutrition, Cultivation and Maintenance of microorganisms: Nutritional categories of microorganisms, Design and Types of Culture Media, methods of isolation.</p>	15

II	Microscopy and stains	<p>Simple and Compound Microscope: General principles of optics; various parts and their functions - objectives – numerical aperture, resolving power, depth of focus, working distance, aberrations; oculars; condensers.</p> <p>Dark Field Microscope; Phase Contrast Microscope and Fluorescent Microscope, TEM, SEM</p> <p>Applications of microscopes</p> <p>Stains and Staining Solutions- Definition of Dye and Chromogen; acidic and basic dyes; functions and types of chromophore and auxochrome groups. Theories to explain staining. Definition and function of stain; mordant, intensifiers and fixative.</p> <p>Natural and Synthetic Dyes. Simple Staining, Differential Staining – Gram staining and Acid Fast Staining with specific examples</p>	15
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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 Practical	<ol style="list-style-type: none"> 1. Analyze a case-study and write a report on any one recent application of Biotechnology (Not older than past 5 years) 2. Study of Microscopes – Compound Microscope (Including Handling and storage), Dark Field Microscope, Phase Contrast Microscope, Fluorescent Microscope. (Including ray diagrams) 3. Monochrome staining using any suitable material. (Bacteria/Plant/Animal tissue) 4. Differential staining – Gram staining, Acid fast staining, Romanowsky staining. 5. Special staining – cell wall, capsule. 6. Special staining – Spores, negative staining. 7. Fungal staining – wet mount (Lactophenol cotton blue/Methylene Blue) 8. Preparation of media- Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar 9. Sterilization of Laboratory Glassware and Media using Autoclave and Hot air oven 10. Isolation techniques: T-streak, polygon method 11. Colony Characteristics of Microorganisms. 12. Use of Bergey's manual to help identify any one isolate 13. Isolation of Yeasts from natural environment. 	60

	14. Study of morphology and colony characteristics of yeasts 15. Isolation and enumeration of microorganisms – Serial dilution, surface spread method 16. Isolation and enumeration of microorganisms – Serial dilution, pour plate method 17. Screening of antibiotic producers from soil by Crowded plate method. 18. Screening of antibiotic producers from soil by Wilkins Overlay method. 19. Study of mitosis from suitable plant material/ Permanent slides/Photographs 20. Study of meiosis from suitable plant material/ Permanent slides/Photographs	
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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	2 experiments of 1.5 hrs duration (01 Paper)	03 hrs	30 M (01 Paper) (01 Major and 01 Minor Experiment)	20 M (05 M for Journal, 10 M for viva, 05 M for overall performance)	50

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

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) Chemical Bonds: Types and transition between the main types of bonding. Ionic Bond: Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl. Covalent Bond: Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate covalent bonds). Structure of CH ₄ , NH ₃ , H ₂ O, Shapes of BeCl ₂ , BF ₃ . Hydrogen Bond: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).	15

II	Stereochemistry	<p>Isomerism: Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality. Geometric Isomerism and Optical Isomerism: 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) Conformation: Conformations of Ethane. Difference between Configuration and Conformation. Configuration: Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality Representation of Configuration by —Flying Wedge Formula Projection formulae: Fischer, Newman and Sawhorse. The Interconversion of the Formulae.</p>	15
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<p>Titrimetric Analysis: Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples. 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. Theory of Acid –Base Indicators, Choice and Suitability of Indicators.</p> <p>Gravimetric Analysis: Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate. Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate.</p>	15

II	Regular Practicals	<ol style="list-style-type: none"> 1. Preparation of Normal, Molar, Molal, Percent solution 2. Determination of strength of HCl in commercial sample 3. To standardize commercial sample of NaOH using potassium hydrogen phthalate (KHP). 4. To standardize commercial sample of HCl using borax. 5. Determination of Acetic acid in Vinegar by Titrimetric Method. 6. Determination of the amount of Mg (II) present in the given solution complexometrically. 7. Determination of the amount of Fe (II) present in the given solution titrimetrically. 8. Determination of amount of $\text{NaHCO}_3 + \text{Na}_2\text{CO}_3$ in the given solid mixture titrimetrically. 9. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate) 10. Determination of the volume strength of hydrogen peroxide solution by titration with standardized potassium permanganate solution 11. Determination of amount of K oxalate and oxalic acid in the given solution titrimetrically 12. Determination of percent composition of BaSO_4 and NH_4Cl in the given mixture Gravimetrically. 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. 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
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		Haloalkane, Haloarene. 15. Qualitative analysis of Inorganic compounds.	
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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 (01 Paper)	03 hrs	30 M (01 Paper) (02 Major Experiments)	20 M (15 M for Class Test, 05 M for Journal)	50

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	<p>What is Biotechnology? History and Introduction to Biotechnology; Scope and importance of biotechnology; Role of microorganisms in fermentation</p> <p>World of Biotechnology- Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Medical Biotechnology, Environmental Biotechnology.</p> <p>Potential of Biotechnology- Achievement of biotechnology; Prevention of misuse of biotechnology.</p>	15
II	Biotechnology in India	<p>Biotechnology Institutions in India (Public and Private Sector); Public Perception of Biotechnology.</p> <p>Biotechnology in India – ICGEB, Needs for future development, Global scenario, Potential and achievements of Biotechnology. Bio-business in India, booming biotech market, success story of biotech market, policy initiatives and global trends; Biotechnology research in India.</p>	15

		Case study: Serum Institute of India and its products Case study: Any five Biotechnology institutions in India and its products.	
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<p>Introduction to Biostatistics: Definition and Importance of Statistics in Biology Variables, Types of variables (Quantitative and Qualitative)</p> <p>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)</p> <p>Sampling strategies: Population and Sample, Significance of using samples, Sample size, Random variation, Sampling techniques (Simple random sampling, Systematic sampling, Stratified sampling)</p> <p>Descriptive statistics: Measures of central tendency: Mean, Mode, Median (Ungrouped & Grouped data)</p>	15

		Measures of dispersion: Range, Variance, Standard deviation (Ungrouped & Grouped data), Coefficient of variation 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 Parametric tests: Z test, Single mean and two means, t-Test – Single mean, paired and unpaired. 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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 M

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

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 and corporate life.

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

Curriculum:

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

		<p>Changes in the Interview Process, FAQ During Interviews</p> <p>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</p>	
II	Soft Skills	<p>Introduction to Soft Skills and Hard Skills</p> <p>Personality Development: Knowing Yourself, Positive Thinking, Johari's Window, Communication Skills, Non-verbal Communication, Physical Fitness</p> <p>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 Emotional Intelligence</p> <p>Etiquette and Mannerism: Introduction, Professional Etiquette, Technology Etiquette</p> <p>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</p>	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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<p>Concept of Ecosystems: Definition and Components- Structure and function of ecosystem aspects of ecosystems Food Chain and Food Web, Ecological Pyramids (Energy, Biomass and Number) Aquatic and Terrestrial Ecosystems, Different Abiotic Factors of ecosystem and adaptations to different abiotic factors</p> <p>Ecological Interactions: Commensalism, Mutualism, Predation and Antibiosis, Parasitism, competition</p> <p>Biodiversity and its conservation: 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,</p>	15

		conservation of biodiversity	
II	Pollution and climate change	<p>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.</p> <p>Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.</p> <p>Sustainable development: Concept, basic principles of sustainable development, post-Brundtland world, roots of sustainability, Indicators, paradigm towards new discipline-sustainability science.</p>	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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<p>Ultrastructure of Prokaryotic Cell: Concept of Cell shape, size and arrangement Bacterial structures external to cell wall: Flagella, Pili, Fimbriae, Capsule, Slime Layer, Sheath Cell Wall (Gram Positive and Negative) Structures internal to cell wall: Cell Membrane, nucleoid, Cytoplasm and cytoplasmic inclusion bodies and vacuoles, Genetic Material spores and cysts</p> <p>Ultrastructure of Eukaryotic Cell: 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.</p> <p>External Cell Coverings: Cilia and Flagella</p> <p>Comparison of Prokaryotic and Eukaryotic Cells</p>	15

II	Virology	<p>Introduction to virology: Historical perspective, General Characteristics of Viruses: Host Range Viral Structure - Nucleic Acid, Capsid and Envelope General Morphology- Helical, Polyhedral, Enveloped, Complex. Taxonomy of Viruses Viral Multiplication: Multiplication of Bacteriophages and Animal Viruses Isolation, Cultivation, and Identification of Viruses: Growing Bacteriophages and animal viruses in the Laboratory, Viral Identification Case studies- TMV, Influenza COVID-19 (Self learning)</p>	15
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<p>Classification of carbohydrates:</p> <p>Monosaccharides: 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.</p> <p>Disaccharides: Maltose, Lactose, Sucrose, Cellobiose (structures to be taught, biological significance, structure and bond type)</p> <p>Polysaccharides: Homopolysaccharides and Heteropolysaccharides; Structural and Storage Polysaccharides. E.g., of polysaccharides -: starch (amylose and amylopectin), Glycogen, Peptidoglycan, Cellulose, chitin (structure and bond type)</p> <p>Industrial applications of carbohydrates: Fermentation, Pharmaceutical and Food industry.</p> <p>Classification of Fatty acids:</p> <p>Saturated Fatty Acids: C2- C20 (Examples with trivial name, Biochemical names and Structures)</p>	15

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

		Protein Denaturation and folding: Denaturing agents and properties of denatured proteins	
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<ol style="list-style-type: none"> 1. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination 2. Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual) 3. Isolation and characterization of food fermenting organism from Idli batter (Using Bergey's Manual) 4. Sauerkraut production and to analyze quality parameters during production (odour, color, pH, total acidity) 5. Determination of food preservative concentration (salt and sugar) using MIC. 6. Detection of Food adulterants in food samples 7. Fermentation of Sugarcane juice using yeast. 8. Estimation of sugars by Cole's ferricyanide method. 9. Estimation of Alcohol by dichromate method 10. Study of blood groups ABO in humans 11. Study of the structure of important <ol style="list-style-type: none"> a. Animal viruses (rhabdo, influenza, paramyxo, hepatitis and retroviruses) using electron micrographs/diagrams. b. Plant viruses (caulimo, gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs/diagrams. c. ϕX174, T4,3) using electron micrographs/diagrams. 	60

	12. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique. 13. Motility by hanging drop method/stab culture 14. Study of Growth Curve of <i>E. coli</i> 15. Sterility testing of Vaccine 16. Enumeration by Breed's count 17. Isolation of chromosomal DNA from <i>E. coli</i> and Agarose gel electrophoresis of the chromosomal DNA 18. Study of Hill's reaction 19. Separation of plant pigments by thin layer chromatography 20. Qualitative detection of plant secondary metabolites using standard tests - e. g. Tests for tannins, flavonoids, alkaloids, terpenoids, saponins, steroids.	
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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	2 experiments of 1.5 hrs duration (01 Paper)	03 hrs	30 M (01 Paper) (01 Major and 01 Minor Experiment)	20 M (05 M for Journal, 10 M for viva, 05 M for overall performance)	50

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: System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected.) Laws of Thermodynamics and its Limitations: Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency. Laws of Thermodynamics as applied to Biochemical Systems. Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.	15
II	Chemical Kinetics	Reaction Kinetics: 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) Determination of Order of Reaction: a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numericals expected)	
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<p>Principles of Oxidation & Reduction Reactions: Oxidizing and Reducing Agents Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate.</p> <p>Balancing Redox Reactions: Ion Electron Method Oxidation, Reduction, Addition and Substitution & Elimination Reactions.</p>	15
II	Enzymes	<p>Introduction to biocatalysis: Properties of Enzymes, Substrate, Optimum conditions, Co-substrate, Coenzyme, Cofactors</p> <p>Classification and Nomenclature (one reaction per class) Mechanism of Enzyme Action, Active Sites, Enzyme Specificity.</p> <p>Factors affecting enzyme activity (Effect of pH, Temperature, Substrate Concentration, Enzyme concentration)</p>	15

		<p>Enzyme Kinetics: Derivation of Michaelis-Menten Equation, Lineweaver- Burk plot, Concept of k_m</p> <p>Types of Enzyme Inhibitions: Irreversible & Reversible (Competitive, Uncompetitive, Non-Competitive)</p> <p>Isoenzymes (LDH, Alkaline Phosphatase, Creatine Phosphokinase)</p> <p>Allosteric Modulators, Co-Factors, Zymogens, Enzyme units</p> <p>Enzymes as Biomarkers and diagnostic tools. (SGPT, SGOT, LDH, CPK)</p> <p>Industrial Application of Enzymes</p>	
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<ol style="list-style-type: none"> 1. Preparation of Acetate buffer pH 4.6, Carbonate buffer pH 6.8, Tris buffer pH 8.3 2. Qualitative tests for carbohydrates; Molisch test, Benedict's test, Iodine test, Osazone formation 3. Estimation of carbohydrates by Lane-Eynon method 4. Qualitative tests for lipids. 5. Qualitative analysis of amino acids and proteins 6. Salowski's test for cholesterol 7. To determine enthalpy of dissolution of salt like KNO_3 8. Determine the rate constant for hydrolysis of ester using HCl as a catalyst 9. Determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method 10. Study the kinetics of reaction between Thiosulphate ion and HCl 11. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction 12. Study the reaction between $NaHSO_3$ and $KMnO_4$ and balancing the reaction in acidic, alkaline and neutral medium 13. Qualitative Assay of enzyme urease, amylase, dehydrogenase, catalase and protease from Plant/Animal/Microbial source. 14. Enzyme Kinetics: Study of the effect of pH on activity of Amylase 15. Enzyme Kinetics: Study of the effect of temperature on 	60

	activity of Amylase 16. Study of Effect of Substrate Concentration on amylase enzyme activity and determination of V_{max} and K_m 17. Study of Effect of inhibitors on amylase enzyme activity 18. Estimation of Protein by Biuret method 19. Estimation of Protein by Folin – Lowry method. 20. Quantitative estimation of sugars by DNSA method	
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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	2 experiments of 1.5 hrs duration (01 Paper)	03 hrs	30 M (01 Paper) (01 Major and 01 Minor Experiment)	20 M (10 M for Journal, 05 M for viva, 05 M for overall performance)	50

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	<p>Methods of Separation: Precipitation, Filtration, Distillation and Solvent Extraction</p> <p>Analytical Techniques</p> <p>Chromatography: Definition, Principles, Chromatographic performance parameters, Types Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Principle and Applications)</p> <p>Spectroscopy - Colorimetry: Properties of electromagnetic radiation, interaction with matter, lasers 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</p> <p>Electrophoresis: General principles, Factors affecting electrophoresis, Types of support media used, Types</p>	15

		of electrophoresis (Agarose gel electrophoresis, PAGE)	
II	Regular and Demonstration Practicals	1. Determination of absorption maxima of $\text{CuSO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ 2. Verification of Beer – Lambert’s law 3. Separation of amino acids by Paper Chromatography 4. Electrophoresis of proteins by native PAGE 5. Electrophoresis of proteins by SDS PAGE 6. Paper electrophoresis of amino acids 7. Western Blotting – Demonstration 8. Separation of components from a mixture using Affinity chromatography (Kit may be used for demonstration) 9. Separation of components from a mixture using ion exchange chromatography (Kit may be used for demonstration) 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 (01 Paper)	03 hrs	30 M (01 Paper) (02 Major Experiments)	20 M (15 M for Class Test, 05 M for Journal)	50

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	<p>Creativity at Workplace: Introduction, Current Workplaces, Creativity, Motivation, Nurturing Hobbies at Work, The Six Thinking Hat Method</p> <p>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</p> <p>Capacity Building: Need and Importance of Capacity Building Elements of Capacity Building Zones of Learning Ideas for Learning Strategies for Capacity Building</p> <p>Leadership and Team Building: Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams</p>	15

		<p>Decision Making and Negotiation: Introduction to Decision Making, Steps for Decision Making, Decision Making Techniques, Negotiation Fundamentals, Negotiation Styles, Major Negotiation Concept</p>	
II	Understanding and Managing stress and conflict in Contemporary society	<p>Understanding Stress and Conflict</p> <p>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</p> <p>Managing Stress and Conflict in Society</p> <p>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</p>	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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 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	<p>Introduction: Renewable and Non-renewable resources. The need for a sustainable lifestyle.</p> <p>Energy resources: Types of energy Nonrenewable energy - Oil, coal and its environmental impacts.</p> <p>Renewable energy: Hydroelectric power, Solar energy, Biomass energy, Biogas, Wind power and Geothermal energy.</p> <p>Biogas technology: Biogas plant & types, biodigester. Biogas- composition, production and factors affecting production and uses.</p> <p>Biofuels: Ethanol production, Microbial hydrogen production, Biodiesel, Petrocrops.</p>	15
II	Global environmental problems and issues; Bioremediation	<p>Green House Effect: Factors responsible for Green House Effect; Green House gases.</p>	15

		<p>Global warming: Ozone depletion; Kyoto protocol; UV radiation; Acid rain</p> <p>Concept of bioremediation.</p> <p>Microorganisms in Bioremediation.</p> <p>Mycoremediation and phytoremediation.</p> <p>Bioremediation technologies.</p> <p>Measuring bioremediation in the field. Bioaugmentation and biostimulation. Monitoring the efficacy of bioremediation.</p>	
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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	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 M

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

Name of the Course	Introduction to Bioinformatics
Course Code	USOEBT202
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	<p>Computer Basics : Basic Computer Operations: I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating Systems and application softwares.</p> <p>Biological Databases :</p> <p>Classification of Databases - Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases.</p> <p>Specialized Databases - Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP).</p> <p>Genome Information Resources: DNA Sequence Databases Specialized Genomic Resources. Protein Databases based on Composition, Motifs and Patterns. Protein Structure Visualization Software.</p>	15

II	BLAST and Sequence alignment	<p>BLAST and Sequence Alignment: BLAST and its Types; Retrieving Sequence using BLAST. Pairwise Alignment: Identity and Similarity; Global and Local Alignment; Pairwise Database Searching.</p> <p>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.</p>	15
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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. Bioinformatics by S. C. Rastogi
5. Bioinformatics by Attawood

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class Test	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 M

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

Name of the Course	Introduction to Food Science
Course Code	USOEBT102
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	<p>Introduction to food biotechnology: History of microorganisms in food science and key developments, Applications of biotechnology in fermented food products</p> <p>Introduction to Unit Operations and Processes: Basic unit operations, food processing & packaging (canning & bottling), Production of cultures</p>	15
II	Food Fermentations and Preservation	<p>Fermented food products: Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics</p> <p>Food spoilage, food deterioration, food contamination and Food Adulteration</p> <p>Methods of food preservation</p> <p>Indicators of Food Microbial Quality & Safety: HACCP, FSSAI & FDA</p>	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.

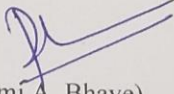
Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class Test	15
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
2	II	A) Long Answer Question. (Any 01) 06 M B) Do as directed. (Any 04) 04 M
3	Both Units	Short Notes (Any 02) 10 M


(Rashmi A. Bhave)
The Chairperson, BoS