MODERN EDUCATION SOCIETY'S
NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS)

SYLLABUS

of

F.Y. B.Sc. BIOTECHNOLOGY

(As Par National Education Policy
Implemented from the Academic year 2023-2024)

National Education Policy

A national education policy serves as a complete blueprint for how a country manages its education system. It encompasses different elements such as designing the curriculum, selecting teaching techniques, implementing assessment methods, and developing educational facilities. The policy places great emphasis on fostering inclusivity, embracing diversity, and promoting lifelong learning. It also encourages creativity, flexibility, and the acquisition of skills that align with the evolving job market. Moreover, the policy acknowledges the pivotal role of teachers and supports their continuous professional development. Ultimately, a robust national education policy plays a crucial role in shaping the future of a nation by equipping its citizens with the necessary education and skills for success.

The new curriculum framework will have the following features:

1. Flexibility to move from one discipline of study to another;
2. Opportunity for learners to choose the courses of their interest in all disciplines;
3. Facilitating multiple entry and exit options with UG certificate/ UG diploma/ or degree depending upon the number of credits secured;
4. Flexibility for learners to move from one institution to another to enable them to have multi and/or interdisciplinary learning;
5. Flexibility to switch to alternative modes of learning (offline, ODL, Online learning, and hybrid modes of learning).

Eligibility for the UG Programmes

Higher Secondary Certificate (HSC, 12th Grade) obtained after successful completion of Grade 12 or equivalent stage of education corresponding to Level - 4.

Duration of the Programme

1. The duration of the UG Programme is 4 years or 8 semesters. Students who desire to undergo a 3-year UG Programme will be allowed to exit after completion of the 3rd year. If a student wants to leave after the completion of the first or second year, the student will be given a UG Certificate or UG Diploma, respectively, provided they secure the prescribed number of credits. Students who exit with a UG certificate or UG diploma are permitted to re-enter within three years and complete the degree Programme.
2. Students may be permitted to take a break from the study during the period of study but the total duration for completing the Programme shall not exceed 7 years.

Credit system

1. For the theory course one credit is of 15 hours.
2. For a practical course one credit is of 30 hours.

Multiple Entry and Multiple Exit options

Year	Semesters	Level	Credit requirements		Qualification Title
			Minimum	Maximum	
1st	2	4.5	40	44	UG Certificate
2nd	4	5.0	80	88	UG Diploma
3rd	6	5.5	120	122	Three Year Bachelor's Degree
4th	8	6.0	160	176	Bachelor's Degree-Honours **Or** Bachelor's Degree-Honours with Research

Six different types of courses to be learned across Four Years Degree Programme

Sr. No	Type of course	No. of credits
A	Major (Core) Subject	80 to 88 credits
B	Minor Subject	18-20 Credits
C	Generic/ Open Elective Courses (OE)	10-12 credits
D	Vocational and Skill Enhancement Courses (VSEC)	14-16 credits
E	Ability Enhancement Courses (AEC), Indian Knowledge System (IKS) and Value Education Courses (VEC)	14 Credits
F	OJT: Job Training, Field Projects (FP)/ Internship/ Apprenticeship/ Community Engagement and Service corresponding to the Major (Core) Subject (CEP) Co-curricular Courses (CC) and Research Project	30 Credits

Preamble

The syllabus of the B.Sc. Biotechnology is designed to provide an overview of the fundamental concepts, principles, and practical applications of biotechnology to the students. Biotechnology is a dynamic and interdisciplinary field that merges biology, chemistry, genetics, engineering, and computational sciences to manipulate living organisms, biomolecules, and biological processes to develop innovative solutions for various sectors such as healthcare, agriculture, energy, and the environment.

This syllabus serves as a roadmap for the educational journey in understanding the principles and applications of biotechnology. Throughout this program, students will explore a wide range of topics, including molecular biology, genetic engineering, bioinformatics, Bioprocessing, Microbiology, and Bioethics. You will develop a strong foundation in both theoretical knowledge and practical skills necessary to excel in the field of biotechnology.

The primary objectives of this syllabus are as follows:

- Provide a comprehensive understanding of the principles and techniques used in Biotechnology.
- Foster critical thinking and problem-solving skills through laboratory experiments, case studies, and research projects.
- Familiarize students with the ethical, legal, and social implications of Botechnology.
- Develop your communication and teamwork skills through collaborative projects and presentations.
- Cultivate a strong scientific mindset, encouraging curiosity, innovation, and adaptability in the rapidly evolving field of biotechnology.
- The syllabus consists of a series of core courses that lay the foundation of biotechnology knowledge, along with elective courses that allow you to specialize in specific areas of interest. The curriculum is designed to strike a balance between theoretical concepts and practical applications, ensuring that you acquire hands-on experience with state-of-the-art techniques and instrumentation used in biotechnology laboratories.
- In addition to classroom lectures and laboratory sessions, this syllabus emphasizes the importance of continuous learning and engagement with the latest advancements in the field. You will be encouraged to explore scientific literature, attend conferences, participate in workshops, and engage in research opportunities to broaden your understanding and contribute to the ever-expanding knowledge in biotechnology.
- By the end of this program, students will possess a strong foundation in biotechnology, equipping you with the necessary skills to pursue careers in research and development,

biopharmaceuticals, genetic engineering, diagnostics, agricultural biotechnology, or pursue advanced studies in specialized areas such as synthetic biology, bioinformatics,or biomedical engineering.

- We are excited to embark on this journey with students, and we look forward to witnessing students' growth, passion, and contributions to the field of biotechnology. We expect that the students to be prepared to be inspired, challenged, and empowered as they explore the endless possibilities of this remarkable discipline.

Examination pattern

35 Marks for the semester examination and 15 marks for the continuous evaluation pattern

Passing marks:

Passing marks will be 40 % in each paper of continuous evaluation and end semester exam separately.

Procedure for continuous evaluation

Written test	10 marks
Assignment / Oral	5 Marks
Total	15 Marks

Nature of Question Paper for End Semester Examination

Que. No.	**Type**	**Max marks**
1	Answer the following questions (5 marks) :**5 marks** 1 mark x 5 questions	**5**
2	Answer the following questions (Any 4) **8 Marks** 2 Marks x 5 questions	**8**
3	Attempt any three of the following: **12 Marks** 4 marks x 4 questions	**12**
4	Write short notes on any two of the following 5 Marks x 3 questions:**10 Marks**	**10**
	Total	**35 marks**

Revaluation:

There shall be a revaluation of answer scripts of the semester examination (out of 50 marks) oftheory papers only, as per Ordnance no. 134 A and B

Award of the class

Percentage	Grade	Grade Point
80-100	O: Outstanding	10
70-79	A+: Excellent	9
60-69	A: Very Good	8
55-59	B+: Good	7
50-54	B: Above Average	6
45-49	C: Average	5
40-44	P: Pass	4
0-39	F: Fail	0
-	Ab: Absent	0

Semester I (First Year)

Course Type	Course	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total
Major Mandatory (2+1)	Major Paper 1 (Theory)	**BTMJ111** Fundamentals of Biochemistry	2	2	15	35	50
	Major Paper 2 (Theory)	**BTMJ112** Fundamentals of Microbiology	2	2	15	35	50
	Major Paper 3(Practical)	**BTMJ113** Practicals in Biochemistry and Microbiology	2	2	15	35	50
Major Electives	--	----	---	---	-----	---	---
Minor	-----	----	---	---	-----	---	---
OE (1)	Generic / Open Elective 1	NA (Students will select this subject from Arts/ commerce subjects) Theory ---	2	2	15	35	50
OE (2)	Generic / Open Elective 2	NA (Students will select this subject from Arts/ commerce subjects) Practical	2	2	15	35	50
SEC		**BTSEC114** Analytical Techniques in Biotechnology (Practical)	2	2	15	35	50
VSC	Major Specific Theory	**BTVSC115** Industrial Fermentations (Theory)	2	2	15	35	50
AEC		English	2	2	15	35	50
VEC	---	Environmental Science	2	2	15	35	50
IKS	---	**BTIKS116** Ancient Indian biotechnology	2	2	15	35	50
OJT / FP, CEP, CC, RP	CC I	Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts	6	2	15	35	50
Total			22				

CLA-Continuous Internal Assessment
ESE-End Semester Examination

Semester II (First Year)

Course Type	Course	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total
Major Mandatory (2+1)	Major Paper 4 (Theory)	**BTMJ121** Cell Biology-I	2	2	15	35	50
	Major Paper 5 (Theory)	**BTMJ122** Microbial Biotechnology	2	2	15	35	50
	Major Paper 6(Practical)	**BTMJ123** Practicals in Cell Biology and Microbial Biotechnology	2	2	15	35	50
Major Electives	------	-------	----	----	--	--	----
Minor	Minor Paper 1 (Theory)	Zoology/Botany	2	2	15	35	50
OE (1)	Generic / Open Elective 3	NA (Students will select this subject from Arts/ commerce subjects) Theory ---	2	2	15	35	50
OE (2)	Generic / Open Elective 4	NA (Students will select this subject from Arts/ commerce subjects) Practical	2	2	15	35	50
SEC		**BTSEC124** Practicals in Plant and Animal Sciences	2	2	15	35	50
VSC	Major Specific Theory	**BTVSC125** Fundamentals of plant and animal sciences	2	2	15	35	50
AEC		English	2	2	15	35	50
VEC	---	Environmental Science	2	2	15	35	50
IKS	---	---	---	---	---	---	---
OJT / FP, CEP, CC, RP	CC I	Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts	6	2	15	35	50
Total			22				

CIA- Continuous Internal Assessment
ESE-End Semester Examination

Semester III (Second Year)

Course Type	Course	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total
Major Mandatory (6+ 2)	Major Paper 7 (Theory)	**BTMJ 231** Cell Biology-II	2	2	15	35	50
	Major Paper 8 (Theory)	**BTMJ 232** Molecular Biology-I	2	2	15	35	50
	Major Paper9 (Theory)	**BTMJ 233** Metabolism	2	2	15	35	50
	Major Paper 10 (Practical)	**BTMJ 234** Practicals in Cell Biology, Molecular Biology metabolism	4	2	15	35	50
Major Electives	---	---	---	---	---	---	---
Minor (4)	Minor Paper 3 (Theory) Minor Paper 4 (Practical)	(Students will select this subject from Arts/commerce subjects)	2 4	2 2	15 15	35 35	50 50
OE (2)		(Students will select this subject from Arts/ commerce subjects)	2	2	15	35	50
VSC (2)	Major Specific Theory	**BTVSC235** Genetics (Theory)	2	2	15	35	50
SEC (2)	---	---	---	---	---	---	--
AEC(2),	MIL	Marathi / Hindi (Anyone)	2	2	15	35	50
VEC (2)	---	---	----		---		
IKS (2)	---	---	---	---	---	---	---
FP/CEP (2)	FP –I	**BTFP236** Field Project*	6	2	15	35	50
CC(2)	CC I	Physical Education / Cultural Activities, NSS/NCC/Fine/ Applied/ Visual/ Performing Arts Course	2	2	15	35	50
Total			22				

Semester IV (Second Year)

Course Type	Course	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total
Major Mandatory (6 + 2)	Major Paper 11 (Theory)	**BTMJ 241** Medical Microbiology	2	2	15	35	50
	Major Paper 12 (Theory)	**BTMJ 242** Molecular Biology-II	2	2	15	35	50
	Major Paper13 (Theory)	**BTMJ243** Biodiversity	2	2	15	35	50
	Major Paper 14 (Practical)	**BTMJ 244** Practicals in Medical Microbiology, Molecular biology and Biodiversity	4	2	15	35	50
Major Electives	---	---	---	---	---	---	---
Minor (4)	Minor Paper 3 (Theory) Minor Paper 4 (Practical)	(Students will select this subject from Arts/commerce subjects)	2 4	2 2	15 15	35 35	50 50
OE (2)		(Students will select this subject from Arts/ commerce subjects)	2	2	15	35	50
VSC (2)	---	---	---	---	---	---	---
SEC (2)		**BTSEC245** Pathology	2	2	15	35	50
AEC(2)	MIL	Marathi /Hindi (Anyone)	2	2	15	35	50
VEC (2)	---	---	---		---		
IKS (2)	---	---	---	---	---	---	---
FP/CEP (2)	CEP IV	Community Engagement and Service*	6	2	15	35	50
CC(2)	CC IV	Engagement and Service*	2	2	15	35	50

Community engagement and service: *

This course requires students to participate in field-based learning/projects generally under the supervision of faculty. The curricular component of 'community engagement and service' will involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems. 60 hours of contact along with 30 hours of activities such as preparation for community engagement and service, preparation of reports, etc., and independent reading and study. Thus, the total learner engagedtime would be 90 hours

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	
Bachelor of Science (Hons.) in Biotechnology		
SEMESTER –I Major Paper 1 (Theory)		
Year - First year	**Paper No- BTMJ111**	**Credits 2**
Semester- I	**Name of Paper- Fundamentals ofBiochemistry**	**Hours 30**

Course Outcomes (COs)

On completion of the course, the students will be able to:

1: Learn basic concepts and calculations and the importance of biomolecules.
2: Learn the chemical nature and importance of carbohydrates.
3: Concept of amino acids and proteins and their functions.
4: Learn lipids and their functions.

Sr. No.	COURSE CONTENT / SYLLABUS	Lectures
Unit- 1	**Basic Concepts in Biochemistry**: • Production of biomolecules, Types of bonds, Hydrogen bondingthermodynamics, molecular weight, molecular mass, mole conceptand normality, Molarity, Functions of biomolecules	**7**
Unit- 2	**Carbohydrates Structure, Function, and Properties** • Monosaccharides: Structure and function D and L configuration, ketoses and aldoses, Isomerism, epimers, anomers, chemical and physical properties of glycosidic bond, Reducing and non-reducing sugars, inversion of sugar • Disaccharides: Structure and function • Polysaccharides: Classification based on structure and function • Storage polysaccharides: e.g., starch, glycogen, and inulin	**8**

Unit- 3	**Amino acids & Proteins: Structure & Function**. • Properties ofAmino acids, Essential and non-essential amino acids, • Types of proteins • Classification of proteins • Structure of proteins Primary and secondary • Chemical properties of proteins, Peptide bond formation, • Functions of proteins	**7**
Unit- 4	**Lipids: Structure and Functions** • Classification, of lipids: simple and complex, • nomenclature of physical and chemical properties of fatty acids, essential fatty acids., lipoproteins • Storage and structural lipids: Phospholipids, sphingolipids,glycolipids, cholesterol, • Functions of lipids	8
References	1. Outlines of Biochemistry:5th Edition, (2009), Erice Conn & PaulStumpf; John Wiley and Sons, USA 2. Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet &Judith Voet, John Wiley and Sons, Inc. USA 3. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey,McGraw-Hill College, USA 4. Biochemistry:7th Edition, (2012), Jeremy Berg, Lubert Stryer, W. H. Freeman and Company, NY Lehninger, Principles of Biochemistry. 5th Edition (2008), DavidNelson & Michael Cox, W.H. Freeman and Company, NY.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	
Bachelor of Science (Hons.) in Biotechnology		
SEMESTER – I Major Paper 2 (Theory)		
Year - First year	**Paper No- BTMJ112**	**Credits 2**
Semester-I	**Name of Paper- Fundamentals of Microbiology**	**Hours 30**

Course Outcomes (COs)

On completion of the course, the students will be able to:

1: Explain the structure and different staining techniques.
2: Cultivate bacteria in the laboratory by using various media and techniques.
3: Handling of microbes.
4: Concept of sterilization and disinfection.

Sr. No.	COURSE CONTENT / SYLLABUS	Lectures
Unit.- 1	Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used to include molecular approaches, Microbial phylogeny, and current classification of bacteria. Microbial Diversity: Distribution and characterization of Prokaryotic andEukaryotic cells, Ultrastructure of Bacterial cells, study of major groups of microorganisms e.g., Bacteria, Algae, Fungi, Protozoa, and Unique features of viruses Principles and methods of staining techniques for following: Monochrome, Negative, Differential (Gram, Acid fast), Special staining- Endospore, flagella, cell wall, nucleic acid,capsule	**12**

Unit.- 2	Basic Nutritional and environmental requirements of bacteria Design of media (Bacterial and Fungal): Types of Media and Composition Cultivation and Maintenance of Microorganisms: Isolation of microorganisms and pure culture techniques:Streak, Spread, Serial Dilution, Pour plate, Enrichment, and Anaerobic culture techniques. Nutritional categories of micro-organisms. Preservation and Maintenance methods. Concept of Pure culture, co-culture and Mixed culture,Biofilm formation. Microbial Interactions: Plants and Animals	**6**
Unit.-3	**Microbial growth:** Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth, and factors affecting growth of bacteria.	**6**
Unit--4	**Control of Microorganisms:** By physical and chemical methods Antibiotics agents and mode of action (Concept of MIC andMBC) Handling of microorganisms and Biosafety measures.	**6**
References	1. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd. 2. Pelczar M. J., Chan E. C. S., Krieg N. R. (1993) Microbiology: Concepts and Applications. 6th Edition. McGraw-Hill Education. 3. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology.3rd Edition. Thomson Brooks / Cole. 4. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc. 5. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc. 6. Powar C.B. and H. F. Daginawala (2003). General Microbiology Vol II; Himalaya Publishing House. 7. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	
Bachelor of Science (Hons.) in Biotechnology		
SEMESTER- I Major Practical 3		
Year - First year	**Paper No- BTMJ113**	**Credits 2**
Semester-I	**Name of Paper- Practicals in Biochemistry and Microbiology**	**Hours 60**
Course Outcomes (COs) **On completion of the course, the students will be able to:** 1: How to handle and prevent hazards 2: How to calibrate pipettes and sterilization and wrapping of glassware 3: Concept of normality, molecular weight reagent storage 4: To detect the presence and type of carbohydrates, amino acids, lipids, and estimation 5: Explain the process of different staining techniques 6: Cultivate bacteria in the lab by using various media and techniques		
15 Practicals	**COURSE CONTENT / SYLLABUS**	**Hours 60**
	Practicals in Biochemistry	
1.	Laboratory safety rules, hazards, and First Aid	7 practicals
2.	Glasswares used in biochemistry laboratory	
3.	Reagent preparation and Calculations	
4.	Spot test for Carbohydrates	
5.	Spot test for Proteins	
6.	Spot test for lipids and Estimation of cholesterol	
1.	**Practicals in Microbiology** a) Introduction to Microbiology Laboratory and common microbiology laboratory instruments b) Observation of Microorganisms: c) Monochrome staining d) Gram's staining e) Negative staining f) Motility- Hanging drop technique	8 Practicals

2. 3. 4. 5. 6.	Preparation of Media Bacterial growth media- Nutrient broth, Nutrientagar plates, butts, and slants Fungal growth media- potato dextrose agar plates Isolation and purification of bacteria bySteak plate technique Spread platePour plate Demonstration of microbes from finger tips onnutrient media Visit to Microbiology Industry (Pathology Lab/Culture Collection Centre/ National Centre for Microbial Resource)	
References	1. Cappuccino's. G, Sherman N. Microbiology A Laboratory Manual. Pearson 7th edition 2005. 2. Deshmukh A. M. (1979). Handbook of media, stain and reagents in Microbiology. 3. Aneja K. R. (2003). Experiments in microbiology, Plant pathology and biotechnology 4th edition New Age International Limited New Delhi. 4. Chemical and biological methods for water pollution studies By R.K. Trivedi. 5. S. Sadasivam and A. Manickam, "Biochemical Methods," 2nd Edition, New Age International (P) Limited Publishers, New Delhi, 2004.	

MODERN EDUCATION SOCIETY'S

Nowrosjee Wadia College, Pune (Autonomous)

Bachelor of Science (Hons.) in Biotechnology

SEMESTER-I Skill enhancement course (Practical)

Year- First Year	**Paper No- BTSEC114** **Name of Paper- Practical-Analytical Techniques in Biotechnology I**	**Credits 2**
Semester-I		**Hours 60**

Course Outcomes (COs)

On completion of the course, the students will be able to:

1. Introduce centrifugation -types of centrifugations, Use of differential centrifugationfor isolation of subcellular organelles.
2. Explain the principle of chromatography. Introduce stationary and solvent systems Discuss detection, and identification methods of analytes. Discuss applications of paperchromatography.
3. Outline the concept of electrophoresis. Demonstrate preparation of gel, casting gel ingel assembly, loading sample, staining destaining, and visualizing protein bands under gel documentation system.

15 Practicals	**COURSE CONTENT / SYLLABUS**	**Hours 60**
	1. Biochemical calculations, buffer solutions, measurement of pH, calibration of pipettes, and balance 2. Calibration of pH meter. 3. Quantitative determination of free amino acid content from the biological sample. 4. Preparation of subcellular fractions from rat liver 5. Separation of amino acids by paper chromatography. 6. Determine lambda max of DNA, Protein, andbromophenol blue solutions using a spectrophotometer. 7. Agarose Gel electrophoresis. 8. Native gel electrophoresis. 9. Visualizing Protein bands under the gel documentationsystem 10. Green synthesis of nanoparticles using leaf extract 11. Separation of chlorophyll pigments using paper chromatography. 12. Electron microscopy -SEM and TEM, flow cytometry 13. Protein separation using isoelectric focusing 14. Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction	15 Practical

	system, columns, detectors, reversed phase, and normal phase chromatography. 15. Gas Chromatography: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, and different detectors. Introduction to hyphenated techniques in chromatography, GC-MS, and LC-MS.	
References	1. Jayaram T. 1981. Laboratory manual in Biochemistry, Wiley Eastern Ltd.New Delhi. 2. Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi. 3. Nath RL. 1990. Practical Biochemistry in Clinical Medicine. Academic Pub. 4. Sadasivam S and Manickam A. 1996. Biochemical Methods. 2nd ed. New Age International (P) Ltd. Publisher, New Delhi.	

MODERN EDUCATION SOCIETY'S

Nowrosjee Wadia College, Pune (Autonomous)

Bachelor of Science (Hons.) in Biotechnology

SEMESTER – I Vocational Skill Course (Theory)

Year -First Year	**Paper No - BTVSC115**	**Credits 2**
Semester-I	**Name of Paper- Industrial Fermentation**	**Hours 30**

Course Outcomes (COs)

On completion of the course, the students will be able to:

1 Illustrate the basic design of the fermenter with baffles, sparger, agitation, aeration, andtypes.

2 Explain media formulation using Carbon and Nitrogen sources, use of buffering agents, chelators, and antifoaming agents in media formulation, explainmedia and air sterilization

3 Explain about different methods used for the scale-up and scale-down process.

4 Outline the concept of large-scale manufacturing by explaining optimum conditions, media required, and type of fermentation

Sr. No.	COURSE CONTENT / SYLLABUS	Lectures
Unit- 1 **Unit 2-**	**Introduction to Industrial Fermentation Technology:** • Concept of Fermentation Process- Definition, Historical perspective, • Typical Layout of a typical fermentation unit. • Types of fermentations: Submerged, Surface, Solid State, Dual, Batch, Continuous, Fed-Batch. **Media formulation and sterilization:** • Carbon sources: Cane and Beet molasses, Malt, Corn, Starch, oils, hydrocarbons, and alcohols. • Nitrogen sources: Corn steep liquor, Soybean meal, peanut meal, • Buffering agents, Chelators, Water, Precursors, Inhibitors, Inducers Antifoams. **Media Sterilization**: • Principles, Del factor, Indicator organism for the design of sterilization cycle, • Equipment used in sterilization: Batch and Continuous, **Air sterilization**: Principles, Mechanism of the capture of particles in the air, Fixed(absolute) and non-fixed pore (depth) filter	**15**
	Scale-up and Downstream Processing of fermentatio	

<table>
<tr><td>Unit 3-</td><td>Scale up and Downstream Processing of fermentation product- Methods and equipment’s
Definition: Unit operations and downstream processing, General strategy of product recovery
• Precipitation (Agents used: Salts, Organic solvents, polyelectrolytes, acids and bases)
• Filtration (Plate Frame. Rotary Vacuum, Filter Aids, Flocculating agents)
• Centrifugation (types used in Industry: basket, tubular bowl, disc bowl)
• Cell Disruption (Physical–mechanical and chemical methods).
• Solvent extraction- Liquid extraction
Drying: Drum and spray.

Large Scale Manufacturing Process-
Baker’s yeast, Organic acid (Citric Acid), Vit B12, lysine, alcohol, Enzyme- amylase</td><td>15</td></tr>
<tr><td>References</td><td colspan="2">1. Wulf Cruger and Anneliese Crueger, Biotechnology: A Textbook of Industrial Microbiology, 2nd edition, Panima Publishing Corporation, 2004.
2. Stanbury P., Whitaker A., Stephen H. Principles of Fermentation Technology 3rd Edition Butterworth Heinemann 2017 https://biokamikazi.files.wordpress.com/2013/09/principles_of_fermentation_technol ogy-stanburry_whittaker.pdf
3. Casida Jr, L.E., Industrial Microbiology, 1st edition, New Age International (P) Ltd, 2007.
4. Presscott, Dunn, IndustrialMicrobiology, 1st edition, Agrobios (India), CBS Publication, 2004.
5. A.H. Patel, Industrial Microbiology, 1st edition, MacMillan Publication, 2008.
6. Mathuriya S Abhilasha Industrial BiotechnologyANE books, 2009
7. Prescott SC and Dunn CG Industrial Microbiology Jodhpur Agrobios.2011 http://rims.ruforum.org/B5C1BA5D7194/industri</td></tr>
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	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**24**
Bachelor of Science (Hons.) with research in Biotechnology		
SEMESTER – I Indian Knowledge System (Theory)		
Year – First year	**Paper no. - BTIKS116**	**Credits 2**
Semester- I	**Name of Paper- Ancient Indian Biotechnology**	**Hours 30**

Course Outcomes (COs)

On completion of the course, the students will be able to:

1. Understand the historical context and contributions of ancient India to the field of microbiology and biotechnology.
2. Demonstrate knowledge of various ancient Indian texts and sources
3. Demonstrate knowledge of Indian agriculture practices and techniques
4. Recognize the role of microbes in Ayurveda and understand the use of microbial-based medicinal preparations in ancient Indian medicine.
5. Analyze the role of microbes in traditional brewing and distillation practices in ancient India

Sr. No.	COURSE CONTENT / SYLLABUS	Lectures
Unit 1-	**Introduction to Ancient Indian Biotechnology** Overview of the course objectives and structure Introduction to the historical context of ancient Indian biotechnology Significance of biotechnology in ancient Indian society **Ayurveda and Herbal Medicine** Introduction to Ayurveda, the ancient Indian system of medicine Study of medicinal plants and their applications Exploration of Ayurvedic pharmaceutical formulations **Biotechnology in Agriculture** Study of ancient Indian agricultural practices and techniques Role of biotechnology in enhancing crop productivity and sustainability Exploration of traditional plant breeding methods	**15**

Unit 2-	**Microbes in Ayurveda** Ayurveda and Microbial Concepts Microbial-Based Medicinal Preparations in Ayurveda Ayurvedic Approach to Microbial Infections **Ancient Indian Fermentation Processes** Fermentation Techniques in Ancient India Microbes in Food Fermentation: Yogurt, Idli, and More **Ancient Indian Brewing Techniques** Traditional Alcoholic Beverages Microbial Role in Distillation: Ayurvedic Extracts	**15**
References	1. "Science and Civilization in India" by D.P. Chattopadhyaya 2. "Indian Alchemy: Soma in the Veda" by J.N. Banerjee 3. "Ayurveda: The Science of Self-healing" by Dr. Vasant Lad 4. "The Indian Spices and Recipes: From Ancient Books and Manuscripts" by Nirmala Gupta 5. "Fermented Foods of the World: A Dictionary and Guide" by Geoffrey Campbell-Platt 6. "The Arts of India: From Prehistoric to Modern Times" by Stella Kramrisch 7. "Ancient Indian Agriculture: Genesis, Geography, and Practice" by Dilip K. Chakrabarti 8. "Traditional Indian Textiles" by John Gillow and Nicholas Barnard 9. "Agricultural Techniques in Ancient India: Origins and Practices" by Vidula Jayaswal 10. "Indian Agriculture: Four Decades of Development" by T. Haque 11. "The Ancient Heritage of India: An Introduction" by Upinder Singh 12. "Land and People of Indian States and Union Territories: Volume 19, Tamil Nadu" by S. R. Bakshi 13. "Indian Agricultural Development: Contemporary Issues and Challenges" by S. Mahendra Dev 14. "Biodiversity in Ancient India" by A. G. Balasubramanian and V. K. Gupta 15. "Water Resource Management in Ancient India" by D. K. Taknet and S. K. Bhandari	

Semester II (First Year)

Course Type	Course	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total
Major Mandatory (2+1)	Major Paper 4 (Theory)	**BTMJ121** Cell Biology-I	2	2	15	35	50
	Major Paper 5 (Theory)	**BTMJ122** Microbial Biotechnology	2	2	15	35	50
	Major Paper 6 (Practical)	**BTMJ123** Practicals in Cell Biology and Microbial Biotechnology	2	2	15	35	50
Major Electives	------	-------	----	----	--	--	----
Minor	Minor Paper 1 (Theory)	Zoology/Botany	2	2	15	35	50
OE (1)	Generic / Open Elective 3	NA (Students will select this subject from Arts/ commerce subjects) Theory ---	2	2	15	35	50
OE (2)	Generic / Open Elective 4	NA (Students will select this subject from Arts/ commerce subjects) Practical	2	2	15	35	50
SEC		**BTSEC124** Practicals in Plant and Animal Sciences	2	2	15	35	50
VSC	Major Specific Theory	**BTVSC125** Fundamentals of Plant and Animal sciences	2	2	15	35	50
AEC		English	2	2	15	35	50
VEC	---	Environmental Science	2	2	15	35	50
IKS	---	---	---	---	---	---	---
OJT / FP, CEP, CC, RP	CC I	Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts	6	2	15	35	50

CIA- Continuous Internal Assessment
ESE-End Semester Examination

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune (Autonomous)**	
Bachelor of Science (Hons.) in Biotechnology		
SEMESTER –II Major Paper 4 (Theory)		
Year - First year	**Paper No- BTMJ121**	**Credits 2**
Semester- II	**Name of Paper- Cell Biology I**	**Hours 30**

Course Outcomes (COs)

On completion of the course, the students will be able to

1 Describe the structure and basic components of Prokaryote & Eukaryotic Cell.

2..Study of various Cell Organelles ,cell junctions.

3. Acquire the Knowledge of cell biology and understanding various physiological process

Sr No.	COURSE CONTENT / SYLLABUS	Lectures
I	**Introduction To Cell** Cell Theory Types of Cell: • Prokaryote & Eukaryotic Cell • Plant & animal cell Cellular Diversity: Cell structure & related functions	7
II	**Cell Membrane** • Chemical components of biological membranes • Organization and Fluid Mosaic Model, membrane as a dynamic entity • Functions of cell membrane • Transport – Active Transport (Primary active transport ,secondary active transport)Passive transport (Simple and facilitated diffusion difference) with oneexample Bulk transport: Exocytosis, endocytosis.	8
III	**Cell Organelle** • Structure, components and function of : • Nucleus, • Mitochondria • Chloroplast • Lysosomes and Vacuoles • ER & SER • Golgi Bodies • Centrioles	7

IV	**Cell Junctions**- Gap Junctions, Tight junctions ,Adherens Junctions Cell to Extracellular matrix interaction- Hemidesmosomes • Extracellular Matrix Components i)Glycosaminoglycan ii)Adhesion proteins- Fibronectine,Lamiline iii)Structural proteins- Collagen, Elastin Cell to cell adhesion-Desmosomes • Cytoskeleton Microtubules and Microfilaments-Structure and functions	8
References	1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., KReiger 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, JulianLewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science 3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA 4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments.6th Edition. John Wiley & Sons. Inc. 5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006.Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia. 6. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E.Hausman, Sinauer Associates, Inc. USA. 7. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition.ASMPress& Sunderland, Washington, D.C.; Sinauer Associates, MA. 8. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7 th edition.Pearson Benjamin Cummings Publishing, San Francisco.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune (Autonomous)** **NEP**	
Bachelor of Science (Hons.) in Biotechnology		
SEMESTER –II Major Paper 5 (Theory)		
Year - First year	**Paper No- BTMJ122**	**Credits 2**
Semester- II	**Name of Paper- Microbial Biotechnology**	**Hours 30**

Course Outcomes (COs)

On completion of the course, the students will be able to:

1: Learn role of microorganisms in food and dairy industry.

2: Understand importance of Microbes in Waste treatment Processes.

3: Learn Applications of Microbial Biotechnology.

Sr No.	COURSE CONTENT / SYLLABUS	Lectures
I	**History and Scope of Microbial Biotechnology.** **Food and Dairy Microbiology** **A) Food Microbiology** • Role of microorganisms in food spoilage, Factors affecting growth of microbes in food (intrinsic and extrinsic factors), Spoilage of meat and poultry, Fruits and vegetables, and Canned food. • Principles of Food Preservation. • Methods of preservation • Chemical and Physical methods. **B) Dairy Microbiology** • Milk: Definition, Composition of milk, Normal and abnormal microflora of milk, Sources of contamination of milk, International standards of Milk. • Milk Spoilage- Flavour and color defects, Stormy fermentation, Sweet curdling, Ropiness. • Grading of milk- Direct and Indirect Tests • Preservation of Milk- Pasteurization and efficiency of pasteurization. • Microbial processing of milk- Curd, Yogurt, Butter, Kefir, Cheese. Foodborne diseases- Food infection and intoxication	7 8

II	**Microbes in Waste treatment Processes:** • Water borne diseases: indicators of faecal pollution, Routine bacteriological analysis of water for potability: Presumptive, Confirmed, Completed test, Membrane Filter Technique and Eijkman tests. • Bacteriological standards of drinking water.(WHO, BSI) • Sewage and Industrial waste water: Types of wastes, relevance of COD and BOD determination in analysis of waste water, Methods and principles of treatment of sewage primary, secondary and tertiary treatment methods	8
III	**Applications of Microbial Biotechnology:** • Geomicrobiology-Ore leaching (methods and examples), MEOR, Microbial plastics and bio deterioration of plastics. • Bioweapons • Bio fertilizers and Bio pesticides and Microbial plant growth Promoters (gibberellins and IAA) • GMOs-Norms and applications • Microbial Sweeteners (Thaumatin, Monelin) • Microbial toxins and their applications • Microbial Polysaccharide production: any 2 examples • Concept of Synthetic Biology and Bio metabolite Production	7

References:

1. Food Microbiology, Frazier & Westhoff, 4th edition, Tata McGraw Hill Publications
2. Modern Food Microbiology, James Jay, 7th edition, Springer Publications
3. Milk & Milk Products, C. Eckles, 4th edition, Tata McGraw Hill Publications
4. Prescott, S.C. and Dunn, C.G., (1983) Industrial Microbiology, Reed G. AVI tech books
5. General Microbiology - Stanier R.Y., 5th edition, (1987) Macmillan Publication, UK.
6. Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction 5th Edition, Benjamin Pub. Co. NY
7. Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Text book of microbiology, 5th edition, Orient Longman. .Park and Park, Preventive and Social medicine. 2013, Publisher: Banarsidas Bhanot, Jabalpur
8. Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3nd Edition. Thomson Brooks / Cole.
9. Standard Methods for the Examination of Water and Wastewater (2005) 21st edition, Publication of the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton, Mary Ann H. Franson.Satyanarayan, U. Biotechnology(2008), Books and Allied Ltd.Kolkata
10. Sing, B. D. Biotechnology,(2010), Kalyani Publishers, New Delhi

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Bachelor of Science (Hons.) in Biotechnology		
SEMESTER- I Major Practical 6		
Year - First year	**Paper No- BTMJ123**	**Credits 2**
Semester-II	**Name of Paper- Practicals in Cell Biology I & Microbial Biotechnology**	**Hours 60**

Course Outcomes (COs)
On completion of the course, the students will be able to:
1: How to handle and prevent hazards
2: How to calibrate pipettes and sterilization and wrapping of glassware
3. Concept of normality, molecular weight reagent storage
4: Cultivate food microorganisms in the lab by using various media and techniques.
5: To detect the Portability of a water sample.
6: How to preserve industrially important microbial cultures.

15 Practicals	**COURSE CONTENT / SYLLABUS**	7 Practicals
	Practicals in Cell Biology I	
1.	Study of Prokaryotic and Eukaryotic cell structure. Study of ElectronMicrographs of all important cell organelles.	1
2.	Micrometry- Measurement of cell size by taking different types of cells.	1
3.	Staining and Observation of human cheek epithelial cells.	1
4.	.Isolation and characterization of the following subcellular components,using appropriate samples, by differential centrifugation: i. Nuclei: staining and counting ii. Mitochondria: Succinate Dehydrogenase Assay iii. Lysosomes: Acid Phosphatase Assay	3
5.	.Methods of cell lysis and confirmation	1

	Practicals in Microbial Biotechnology	8 Practicals
1.	Isolation and identification (Genus level) of spoilage-causing microorganisms from: a. Spoiled foods. b. Fermented foods (Curd\ Idli batter).	2
2.	Grading of raw milk- a. Dye reduction test. b. Determination of efficiency of Pasteurization - phosphatase test.	1
3.	Assessment of potability of water: a. MPN test. b. IMViC tests.	3
4.	Preservation and maintenance of microbial cultures for industrial use.	1
5.	Visit to Dairy/ Effluent treatment plant / Sewage Treatment /Bio-fertilizer plant/ any other relevant industry and report writing.	1

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	
Bachelor of Science (Hons.) in Biotechnology		
SEMESTER- I Major Practical		
Year - First year	**Paper No- BTSEC124**	**Credits 2**
Semester-II	**Name of Paper - Practicals in Plant & Animal Science**	**Hours 60**

Course Outcomes (COs)
On completion of the course, the students will be able to:
1 : Understand the morphological features of Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, Angiosperm
2: Concept of water plant relationship
3: Understand different types of cells in animals
4: Mounting techniques for microscope

15 Practicals	**COURSE CONTENT / SYLLABUS**	**Hours 60**
	Practicals in Plant Science	
1.	Study of Algae, Fungi, Bryophyte with one example each	1
2.	Study of Pteridophytes, Gymnosperms, Angiosperm with one example each	1
3.	Study of Morphological parameters of Angiosperm	1
4.	Study of Anatomy of root, stem, leaf of Dicot	1
5.	Study of Anatomy of root, stem, leaf of Monocot	1
6.	Study of process of Osmosis, Turgor pressure and determination of Diffusion Pressure Deficit	1
7.	Separation of photosynthetic pigments by paper chromatography	1
8.	.Effect of GA3 on seed germination	1

	Practicals in Animal Science	
1	Study of invertebrate model systems: *Paramecium*: Morphology, Reproduction-Binary fission & Conjugation,Culturing	1
2	Hydra: Permanent slides- Morphology, Reproduction Study of different types of tissues using permanent histological slides: Epithelial tissue, epithelial tissue, connective tissue, muscular tissue and nervous tissue	1
3	Study of vertebrate model systems: a.Frog: fertilized embryo, pre-feeding stage, feedingstages, metamorphosis stage	1
	b.Chick: Any two stages	1
	c.Temporary mounting of striated muscle fiber from frog/rat	1
	d.Study of *Drosophila*: Characters, Life cycle, sexual dimorphism, eye & wing mutations(*bar eye, sepia eye , white eye, vestigial wings, curly wings*)	1
4	Culturing of *Drosophila* using standard methods	1

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune (Autonomous)**	
Bachelor of Science (Hons.) in Biotechnology		
SEMESTER –II		
Year - First year	**Paper No- BTVSC125**	**Credits 2**
Semester- II	**Name of Paper- Fundamentals of Plant and Animal sciences**	**Hours 30**

Course Outcomes (COs)

On completion of the course, the students will be able to

1. Get the knowledge of diversity among Algae, fungi, Bryophytes, Pteridophytes,Gymnosperms, Angiosperms
2. Different types of cells and their function
3. Metabolic activities in Plant system
4. Mechanism of growth in plant system
5. Basic classification system in Animals
6. Anatomy of vertebrates and invertebrates Tissue system in Animals

Sr No.	COURSE CONTENT / SYLLABUS	Lectures
I	**Plant Diversity:** • Unique features of plants • Cryptogams: General characters, Anatomy, and economic importance of Algae, Fungi, Lichens, Bryophytes, and Pteridophytes with suitable examples • Phanerogams: General characters, Anatomy, and economic importance of Gymnosperms and Angiosperms with suitable examples **Anatomy** • The shoot and root apical meristem and its histological organization • simple & complex permanent tissues • primary structure of shoot & root, secondary growth, growth ring • leaf anatomy (dorsiventral and isobilateral leaf)	8

II	• **Plant water relations** Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanismof opening & closing. • **Carbon metabolism** Photosynthesis- Photosynthesis pigments, concept oftwo photosystems, photophosphorylation, Calvin cycle, CAM plants, photorespiration, compensation point • **Growth and development** Growth and development: Definitions, phases ofgrowth, growth curve, growth hormones (auxins,gibberellins, cytokinin's, abscisic acid, ethylene)	7
III	**Introduction to the Five Kingdom Classification System** General characters and features **Introduction to taxonomy** **Rules and regulations for Nomenclature of systems**	7
IV	**Introduction to Invertebrates and Vertebrates** • (Protochordates, Agnatha, Pisces, Amphibia, Reptiles, Aves, Mammals) • Introduction to Invertebrates (Kingdom Protista, Phylum-Porifera, Cnidaria, Platyhelminthes, Nemathelminths , Annelid, Arthropoda, Mollusca, Echinodermata, Hemichordata)	8
References:	• Dutta A.C. (2000) A Class book of Botany (Oxford University Book Agency, Kolkata) • Esau K. (1977) Anatomy of seed plants (Wiley, USA) • Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK. • Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, WadsworthPublishing Co. Ltd. • Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4Th edition, SinauerAssociates Inc .MA, USA • Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of theVertebrates. IX Edition. The McGraw-Hill Companies. • Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the useof Students. Asia Publishing Home	