



Maharashtra Education Society's  
Abasaheb Garware College (Autonomous)

Four Year Bachelor's Degree Program in Biotechnology  
(Faculty of Science and Technology)

Syllabi under NEP 2020  
**S.Y.B.Sc. (Biotechnology) (Level 5.0)**

To be implemented from Academic Year 2024-2025

S.Y.B. Sc. Biotechnology (NEP 2020)

Level	Year	Semester	Course Type	Course Code	Course Title	Credit	No. of Hrs
5.0	2	III	Major	BT-201-MJ	Molecular Biology	2T	30
			Major	BT-202-MJ	Genetics	2T	30
			Major	BT-203-MJ	Bioanalytical Techniques	2T	30
			Major	BT-204-MJP	Practicals in Molecular Biology and Bioanalytical Techniques (2P)	2P	15
			VSC	BT-221-VSC	Chromatographic and Electrophoretic Techniques	1T+1P	30
			Minor II	BT-241-MN	Microbial Physiology and Genetics	2T	30
				BT-242-MNP	Practicals in Microbial Physiology and Genetics	2P	15
			GE/OE*	OE-201-BT	Flavours and Fragrance	2T	30
		FP / Internship / CEP	BT-231-FP	FP	2		
		IV	Major	BT-251-MJ	Genome Organization and Functions	2T	30
			Major	BT-252-MJ	Enzyme Technology	2T	30
			Major	BT-253-MJ	Industrial Microbiology	2T	30
			Major	BT-254-MJP	Practicals in Enzyme Technology and Industrial Microbiology	2P	15
			Minor III	BT-291-MN	Environmental and Applied Microbiology	2T	15
				BT-292-	Practicals in Environmental and	2P	15

				MNP	Applied Microbiology		
			SEC	SEC-251-BT	Proximate Analysis	1T+1P	30
			GEOE	OE-251-BT	Biotechnology in Human Welfare		
			FP / Internship / CEP	BT-281-CEP	CEP	2	

**Course Code and title: BT-201-MJ Molecular Biology****Credits: 2****Total Lectures: 30****Course outcome: On completion of course, students will be able to,**

1. Understand the types of nucleic acids and their structures.
2. Understand and compare different processes of DNA replication in various life forms
3. Gain knowledge about types of DNA damage and repair mechanisms.
4. Get acquainted with the concept of genetic code and its importance in molecular biology

<b>Units</b>	<b>Topics</b>	<b>Number of Lectures</b>
1	Historical and conceptual Background- <ul style="list-style-type: none"><li>• Molecular basis of heredity &amp; Central dogma of Molecular Biology,</li><li>• Discovery of DNA as genetic material: Griffith's experiment, Hershey and Chase Waring Blender experiment, Avery, MacCleod, McCarty's Experiment</li><li>• Miescher to Watson and Crick- historic perspective.</li><li>• Nucleic acids- structure, properties and function, Nucleoside and nucleotide,</li><li>• Structure of DNA: DNA forms; A, B &amp; Z.</li><li>• Salient features of double helix, Chargaff's rule.</li><li>• Types and structure of RNA : tRNA, rRNA , mRNA and noncoding RNA (miRNA, SiRNA)</li></ul>	8
2	Replication of DNA <ul style="list-style-type: none"><li>• DNA synthesis: general principles, bidirectional replication, Semiconservative nature of DNA replication,</li><li>• Meselson and Stahl Experiment,</li><li>• Rolling circle Replication.</li><li>• The replication complex: Enzymes involved in DNA replication, Unique aspects of eukaryotic &amp; prokaryotic DNA replication, Fidelity of replication.</li></ul>	12
3	DNA damage and repair <ul style="list-style-type: none"><li>• Causes and types of DNA damage.</li><li>• Mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, SOS repair, recombination repair</li></ul>	7
4	<ul style="list-style-type: none"><li>•</li></ul>	3

**References:**

1. Benjamin Lewin, Genes X, 10th edition (2009), Publisher - Jones and Barlett Publishers Inc. USA

2. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Molecular Biology of the Gene, 6th Edition (2008), Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
4. Weaver R., Molecular Biology, 5th Edition (2011), Publisher-McGraw Hill Science. USA
5. Pal J.K. and Saroj Ghaskadbi, Fundamentals of Molecular Biology, (2009), Oxford University Press. India
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
7. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
8. T A Brown. Genomes. 6<sup>th</sup> edition (2020) John Wiley & Sons Publications.

**Course Code and title: BT-202-MJ Genetics****Credits: 2****Total Lectures: 30****Learning Outcomes:****On completion of course students will be able to,**

1. Reiterate the fundamentals of genetics.
2. Understand linkage, recombination and sex determination.
3. Generate awareness about the consequences of mutations, genetic disorders and subsequent genetic counselling.

<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	<b>Genetics: Definitions, History and Scope</b> <ul style="list-style-type: none"><li>• Genetic basis of Inheritance, Variations, Heredity, Pre- Mendelian Concept, Importance of Genetics</li></ul> <b>Mendelian Genetics</b> <ul style="list-style-type: none"><li>• Mendel's Experiments</li></ul> <b>Mendel's Laws</b> <ul style="list-style-type: none"><li>• <b>Law of Segregation:</b> Mono Hybrid cross.</li><li>• <b>Law Of Independent Assortment:</b> Di Hybrid and Tri Hybrid crosses</li><li>• <b>Deviation From Mendel's Law:</b> Partial or Incomplete Dominance, Co-Dominance, Multiple Allele, polygenic inheritance</li><li>• <b>Lethality and interaction of genes:</b> Modifiers, Suppressors, Selfish and Pleiotropic genes, Modified Di Hybrid Ratio, Epistasis</li><li>• <b>Penetrance and expressivity</b></li><li>• <b>Genetics of quantitative traits</b></li><li>• <b>Cytoplasmic inheritance (Maternal effects)</b></li></ul>	10
2	<b>Chromosomal aberrations and Mutations</b> <ul style="list-style-type: none"><li>• Variation in chromosome number</li><li>• Variation in chromosome structure</li><li>• Mutations Classification and types, molecular basis of mutations</li><li>• Mutagens – types and their action, hot spot mutations</li></ul>	7
3	<b>Recombination and Sex Determination</b> <ul style="list-style-type: none"><li>• <b>Linkage and Recombination-</b> Discovery of Linkage, Complete and incomplete linkage, crossing over, Cytological Proof Of Crossing Over, three point test cross, Recombination Frequency and Linkage mapping, Coincidence and interference</li></ul> <b>Mechanism of Sex Determination</b> <ul style="list-style-type: none"><li>• Homo and Heterogametic Theory</li><li>• Dosage compensation and Barr bodies (Human)</li><li>• Sex determination in invertebrates, Vertebrates, Plants</li><li>• Environmental Sex determination</li><li>• Lack of dosage compensation</li></ul>	9

4	<p><b>Genetic Disorders</b></p> <ul style="list-style-type: none"> <li>• Pedigree Analysis</li> <li>• Autosomal dominant</li> <li>• Autosomal recessive</li> <li>• Sex linked, sex influenced and sex-limited</li> </ul> <p><b>Genetic Counselling</b></p> <ul style="list-style-type: none"> <li>• Reasons for genetic counselling</li> <li>• Clinical diagnostic tests</li> <li>• Karyotype analysis, amniocentesis and CVS</li> </ul>	4
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**References:**

1. Strickberger M W (2006) Genetics, Prentice Hall, India
2. B.D Singh (2022) Fundamentals of Genetics, MedTech Science Press
3. P.K. Gupta (2018) Genetics, Rastogi Publications
4. Benjamin Lewin (2007) GENES IX, Jones and Barlett Publishers, Inc
5. Peter J. Russell (2005) IGenetics: A Mendelian Approach, Pearson

**Course Code and Title: BT-203-MJ Bioanalytical Techniques****Credits: 2****Total Lectures: 30****Course Outcome:****On completion of course students will be able to**

1. Understand Basic principles of Bio-analytical techniques
2. Develop the analytical skills in handling the instruments
3. Learn spectroscopic methods to study biomolecules

<b>Units</b>	<b>Topics</b>	<b>Number of Lectures</b>
1	Viscometry: Factors affecting viscosity, Measurement of viscosity, Applications of viscometry, significance of viscosity in biological systems. Density Meter, Types of density meter and applications	6
2	Centrifugation: Basic principle of centrifugation, RCF, Factors affecting sedimentation velocity, Types of centrifuge, High-speed, Analytical and Ultracentrifuge. Types of rotors- Fixed- angle, Vertical-tube rotors, swinging bucket rotors. Preparative centrifugation-Differential centrifugation, Density gradient centrifugation, Isopycnic centrifugation. Applications.	8
3	Spectroscopy: Basic principle- The laws of absorption, Absorption spectrum, Concept & Measurement of transmittance and absorbance. The Chromospheres Concept. Auxochromes. Beers Lamberts law, molar extinction coefficient, limitations of Beers Lamberts law.	8
4	Types of spectrometers – UV & visible, Instrumentation of Single beam and double beam spectrophotometer, Applications of UV-Visible in quantitative analysis, enzyme assay and other physicochemical studies, Mass spectrometry-instrumentation and applications Introduction to spectrofluorimetry. Fluorescence, Principle, Instrumentation and applications.	8

**References:**

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 8<sup>th</sup> edition, 2018
2. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house, 4<sup>th</sup> edition, January 2020
3. Willard and Merrit, Instrumental Methods and Analysis, 7<sup>th</sup> edition 2004



4. Ewing Galen W, Instrumental Methods of Chemical analysis, 3<sup>rd</sup> edition, 1969
5. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.

**Course Code and title: BT-204 MJP - Practical in Molecular Biology and Bioanalytical Techniques**

**Credits: 2**

**Total Lectures: 30**

**On completion of course students will be able to:**

1. Isolate nucleic acids and analyse them by various qualitative and quantitative methods
2. To analyse proteins by following different procedures.
3. To analyse biomolecules by spectrophotometer.
4. To study physicochemical parameter of biological samples.

<b>Sr. NO</b>	<b>Title of Experiments</b>	<b>Number of practical</b>
	<b>Molecular Biology</b>	
1	Reagent Preparation for Molecular Biology experiments	1
2	Estimation of given DNA sample by YV-spectrophotometry	1
	DNA isolation from eukaryotic system-plant and animal cells and purity check by using A 260/280.	1
3	DNA isolation from Bacterial source and its analysis agarose gel electrophoresis	2
4	Isolation of RNA from Yeast/cauliflower	1
5	Qualitative analysis of RNA by agarose gel electrophoresis	1
6	Quantitative analysis of DNA by DPA method	1
	<b>Bioanalytical techniques</b>	
1	Determine the $\lambda$ max of protein, DNA and bromophenol blue	1
2	To study the absorption spectrum of protein (hemoglobin)	1
3	Estimation of protein by E280/E260 method	1
4	Density gradient/Differential centrifugation	1
5	Effect of temperature on viscosity of Suitable biological sample using Ostwald's viscometer	1
6	Soxhlet Extraction: Principle, working and applications.	2

**Reference Books:**

1. Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J. G. Seidman, John A. Smith, Kevin Struhl, Short Protocols in Molecular Biology, Wiley, 2002
2. Molecular cloning – A laboratory manual – (Vol. 1-3), 4th edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA
3. An Introduction to Practical Biochemistry. 3rd Edition, (2017), David Plummer, Tata McGraw Hill Edu. Pvt. Ltd. New Delhi, India.
4. Biochemical Methods. 4<sup>th</sup> edition, (2022), S. Sadashivam, A. Manickam, New Age International Publishers, Indi

**Course Code and Title: BT-221-VSC Chromatographic and Electrophoretic Techniques (1T + 1P)**

**Credits: 1**

**Total Lectures: 15**

**Course Outcome:**

1. To Understand Basic principles of separation techniques
2. To learn and understand chromatographic techniques
3. To learn electrophoretic methods to study biomolecules

<b>Units</b>	<b>Topics</b>	<b>Number of Lectures</b>
<b>1</b>	<b>Introduction to Chromatography</b> Introduction to chromatography, general principle, planar chromatography. Partition chromatography, Thin layer chromatography, paper chromatography.	<b>5</b>
<b>2</b>	<b>Column Chromatography</b> -columns, stationary phases, packing of column, application of sample, column development, fraction collection and analysis. Adsorption chromatography, Ion exchange chromatography, size exclusion chromatography. Introduction to HPLC and HPTLC	<b>5</b>
<b>3</b>	<b>Electrophoresis:</b> General Principle, Factors affecting electrophoresis voltage, current resistance, buffer, composition, concentration, pH Agarose gel electrophoresis SDS Page, Native Page, denaturing gels Applications	<b>5</b>

**References:**

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 8<sup>th</sup> edition, 2018
2. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house, 4<sup>th</sup> edition, January 2020
3. Willard and Merrit, Instrumental Methods and Analysis, 7<sup>th</sup> edition 2004
4. Ewing Galen W, Instrumental Methods of Chemical analysis, 3<sup>rd</sup> edition, 1969
5. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.
6. Raymond P. W. Scott, Techniques and Practice of Chromatography, 1<sup>st</sup> edition –e Book March 2020
7. B.D. Hames, Gel Electrophoresis of Proteins- A Practical Approach, 3<sup>rd</sup> edition, 1998

**Course Code and Title: BT-221P-VSC Chromatographic and Electrophoretic Techniques (1T + 1P)**

**Credits: 1**

**Total Practical: 7**

<b>Sr. NO</b>	<b>Title of Experiments</b>	<b>Number practical</b>
1	Separation of lipids/amino acids by Thin Layer Chromatography	1
2	Separation of proteins/ amino acids by Ion exchange chromatography	1
3	Separation of proteins by Gel filtration Chromatography	1
4	Study of proteins by Native PAGE	2
5	Separation of proteins by SDS PAGE	2

**References:**

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 8<sup>th</sup> edition, 2018
2. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house, 4<sup>th</sup> edition, January 2020.
3. An Introduction to Practical Biochemistry.3rd Edition, (2017), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India.
4. Biochemical Methods.4<sup>th</sup>edition, (2022), S.Sadashivam, A.Manickam, New Age International Publishers, India.

**Course Code and Title: BT-241-MN Microbial Physiology and Genetics****Credits: 2****Total Lectures: 30****Course Outcome: After the completion of the course student will be able to**

1. Understand the growth patterns of microbes
2. Relate different biochemical capacities in microbial world
3. Understand basic genetics that governs these capacities

<b>Sr. No</b>	<b>Topic</b>	<b>No. of Lecture</b>
1	<ul style="list-style-type: none"><li>● <b>Microbial Growth</b> Growth - concept, methods of estimation  Synchronous growth, diauxic growth  Growth kinetics - batch, fed-batch and continuous culture</li></ul>	06
2	<ul style="list-style-type: none"><li>● <b>Microbial Physiology</b> Concepts- Metabolism, catabolism, anabolism, respiration, fermentation, oxidation-reduction reactions  Energy production by anaerobic processes (Glycolysis, Pentose Phosphate pathway, Entner-Doudoroff pathway, fermentation )  Energy production by aerobic processes ( TCA cycle, catabolism of proteins, lipids, glyoxylate cycle  Energy production by photosynthesis (cyclic and noncyclic photophosphorylation)</li></ul>	12
3	<ul style="list-style-type: none"><li>● <b>Microbial Genetics</b> Extrachromosomal elements in prokaryotes  1. Plasmids (types, properties, replication) 2. Transposable elements (IS elements , transposons, Phage Mu)  Gene transfer mechanisms 1. Transformation 2. Conjugation Transduction (generalised and specialised)</li></ul>	12

**References:**

1. Prescott L. M., Harley J.P.and Klein D.A.(2022).Microbiology. 12th Edition. MacGraw Hill Companies Inc.(UnitII)

2. Michale J. Pelczar Jr., E.C.S Chan, Noel R. Krieg, (2023) Microbiology, 5th Edition, McGraw Hill Education
3. Stanier R.Y. (1999), General Microbiology, 5th Edition, Palgrave Macmillan Publisher
4. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). Principles of Genetics.8th edition.John Wiley and Sons Publication. ISBN-13: 9788126510436
5. Russel P. J. (2016). Fundamentals of Genetics. 11<sup>th</sup> edition Publisher: Benjamin/ Cummings.

**Course Code and Title: BT-242-MNP Practicals in Microbial Physiology and Genetics**

**Credits: 2**

**Total Practicals: 15**

**Course Outcomes-** At the end of course the students will be able to:

1. Isolate specific bacterium and estimate its growth
2. Prepare competent cells for transformation
3. Isolate bacterial mutants
4. Perform biochemical tests that help in identification

<b>Sr. No.</b>	<b>Topic</b>	<b>No. of Practicals</b>
1	Growth curve of <i>E. coli</i>	1
2	Estimation of bacterial growth by Direct Microscopic count (DMC)	2
3	Pure culture Isolation techniques- spread / pour / streak plate	2
5	Preparation of competent cells and their transformation	3
6	Isolation of mutants by UV exposure.	2
7	Isolation of mutants by replica plate technique.	2
8	Biochemical tests for bacterial identification (Sugar fermentation tests, catalase and oxidase tests)	3

**References**

1. Dubey R. C. and Maheshwari D. K. (2002). Practical Microbiology. S. Chand and Company Limited, New Delhi, India
2. Molecular cloning – A laboratory manual – (Vol. 1-3), 4th edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA
3. Michale J. Pelczar Jr., E.C.S Chan, Noel R. Krieg, (2023) Microbiology, 5th Edition, McGraw Hill Education



**Course Code and title: OE-201-BT Flavours and Fragrance****Credits: 2****Total Lectures: 30****Learning Outcomes:****On completion of course students will be able to,**

1. Get introduced to Biochemical and Biological aspects of aromatic compounds.
2. Obtain knowledge of *in vivo* and *in vitro* extraction and analytical methods of flavour compounds from plant materials.
3. Gain awareness about the future opportunities in this field.

<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	<b>Introduction</b> <ul style="list-style-type: none"><li>• History of flavours and fragrances</li><li>• Use of these substances for various purposes viz., Aesthetic, religious, preservative and Culinary</li><li>• <i>Invivo</i> functions of aromatic compounds</li></ul>	2
2	<b>Flavours and Fragrances</b> <ul style="list-style-type: none"><li>• Spices and Condiments, Flowers, Fruits, Wood / Bark, Rhizomes / Seeds</li></ul> <b>Chemistry of Aromatic compounds</b> <ul style="list-style-type: none"><li>• Classes, Structure, Biosynthesis</li></ul>	10
3	<b>Methods of extraction :</b> <ul style="list-style-type: none"><li>• Distillation, Solvent extraction, Expression, Enfleurage, Maceration</li></ul> <b>Types of extracts</b> <ul style="list-style-type: none"><li>• Essential oils, Concretes, Pomades, Resinoids, Absolutes</li></ul>	8
4	<b>Optimisation of yield and quality</b> <b><i>In vivo</i> approaches</b> <ul style="list-style-type: none"><li>• Quality and quantity of plant material, Moisture content, Degree of processing, Particle size, Choice of Solvents, Extraction methods</li></ul> <b><i>In vitro</i> approaches</b> <ul style="list-style-type: none"><li>• Suspension culture – Cell Immobilization, Elicitation, Precursor feeding</li><li>• Hairy root culture</li></ul> <b>Methods of analysis of aromatic compounds</b> <ul style="list-style-type: none"><li>• TLC, GC, HPLC, Mass spectrometry</li></ul>	6
5	<b>Applications of Aromatic compounds</b> <ul style="list-style-type: none"><li>• Consumer goods : Soaps and Detergents, Perfumes, Cosmetics, Confectionary food products, Beverages</li><li>• Agricultural products – Insecticides, Pesticides</li><li>• Medicines – Massage oils, Aroma therapy, Pharmaceuticals</li></ul>	2
6	<b>Future Prospective</b> <ul style="list-style-type: none"><li>• National and Global market of flavours and Fragrance</li><li>• Research institutes and Private sector industries in India</li><li>• Job opportunities</li></ul>	2

## References:

1. Satyanarayana U., (2021) Biochemistry, 6<sup>th</sup> edition, Elsevier
2. Essential Oils Guide Book: The Complete Reference Guide to Essential Oil Remedies, Recipes, History, Uses, Safety, and How to Choose the Best Essential Oils, (2018), Olivia Banks, Cac Publishing LLC
3. Ernest Guenther, (2014) The Essential Oils - Vol 1: History - Origin in Plants - Production – Analysis, Jepson Press
4. P.K. Tripathi, (2022) Handbook on Perfume, Deodorant, Air Freshener, Body Spray, Fragrances, Flavours and Essential Oil Industry with Manufacturing Formulations, Process, Machinery Equipment Details & Factory Layout, Niir Project Consultancy Services
5. The Papyrus Scholar (2023) The History of Spices
6. Constance L. Kirker, Mary Newman, (2016) Edible Flowers: A Global History, Reaktion Books

## S.Y. BSc Biotechnology Semester IV

**Course Code and title: BT-251-MJ Genome Organization and Functions**

**Credits: 2**

**Total Lectures: 30**

### Course outcome:

1. Understand the Chromosomal organization in all life forms.
2. Learn the processes of Transcription and Translation.
2. Understand the concept of genetic code
3. Acquire and apply the knowledge of Gene regulation.

Units	Topics	Number of Lectures
1	<p>Concept and Organization of Genome</p> <ul style="list-style-type: none"><li>• Organization of DNA in Eukaryotes, Prokaryotes, Viruses: Supercoiling, Linking number</li><li>• Chromosomal organization and structure</li><li>• Chromatin structure: Euchromatin, heterochromatin, nucleosomes- histone, non-histone proteins.</li><li>• Organelle DNA – mitochondria and chloroplast DNA.</li><li>• Definition of gene – introns/exons, Regulatory sequences, promoters, enhancers and suppressors, gene families, Repetitive DNA sequences- LINES, SINES, VNTRs, satellite DNA, Transposable DNA elements</li></ul>	5
2	<p>Synthesis of RNA: Transcription:</p> <ul style="list-style-type: none"><li>• Transcription in Prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination.</li><li>• Transcription in Eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation.</li><li>• Post-transcriptional modifications: processing of pre-mRNA: 5' cap formation, polyadenylation, introduction to splicing.</li></ul>	8
3	<p>Genetic code and Synthesis of Protein: Translation</p> <ul style="list-style-type: none"><li>• Concept of codon, reading frame, Wobble hypothesis,</li><li>• Major scientific contributions to decipher genetic code.</li></ul> <p>Properties of genetic code</p> <ul style="list-style-type: none"><li>• Structure of ribosome and assembly,</li><li>• Protein Synthesis in Prokaryotes: properties of the prokaryotic Initiator tRNA-fMet, Charging of tRNA, amino acyl tRNA synthetases.</li></ul>	10

	<ul style="list-style-type: none"> <li>• Protein Synthesis in Eukaryotes: Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation.</li> <li>• Posttranslational modifications of proteins</li> </ul>	
4	<ul style="list-style-type: none"> <li>• Regulation of activity of Genes and Gene products in Prokaryotes:</li> <li>• General aspects of gene Regulation: inducible and repressible system <ul style="list-style-type: none"> <li>a. The lactose operon : Catabolite repression</li> <li>b. The Arabinose operon: Positive , negative regulation</li> <li>c. The Tryptophan operon: Regulation by attenuation.</li> </ul> </li> </ul>	7

### References:

1. Benjamin Lewin, Genes XII, 12<sup>th</sup> edition (2017), Publisher - Jones and Barlett Publishers Inc. USA
2. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Molecular Biology of the Gene, 6th Edition (2008), Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
3. Weaver R., Molecular Biology, 5th Edition (2011), Publisher-McGraw Hill Science.USA
4. Pal J.K. and Saroj Ghaskadbi, Fundamentals of Molecular Biology, (2009), Oxford University Press. India
5. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
6. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

**Course Code and title: BT-252- MJ Enzyme Technology****Credits: 2C****Total Lectures: 30****Course outcome:**

- To understand mechanism of bio-catalysis.
- To develop relationship between enzyme and it's kinetic.
- To understand various factor affect the kinetic of enzymes.
- To know about various commercial applications of enzyme.

<b>Units</b>	<b>Topic</b>	<b>Lectures</b>
1	Introduction to Enzymes: <ul style="list-style-type: none"><li>• Classification of enzyme</li><li>• Properties of enzymes; definition of active sites, enzyme units, specific activity; purity of enzyme.</li><li>• Protein nature of enzymes and Non-protein enzymes- Ribozymes and DNAzymes.</li><li>• Metalloenzymes and metal activated enzymes, Isoenzymes</li></ul>	6
2	Enzyme Catalysis: <ul style="list-style-type: none"><li>• Mechanism of enzyme catalysis: Acid base catalysis, Covalent Catalysis, Metal ion catalysis, Proximity and orientation effect</li><li>• Activation and mechanism of Serine proteases: Chymotrypsin</li></ul>	6
3	Enzyme Kinetics: <ul style="list-style-type: none"><li>• Factors affecting the enzyme activity- Enzyme &amp; Substrate Concentration, pH and Temperature.</li><li>• Kinetics of Single substrate enzyme catalysed reaction.</li><li>• Michealis- Menten equation, Km, Vmax, Lineweaver-Burk plot, Turnover number, Kcat.</li></ul>	6
4	Enzyme Regulation: <ul style="list-style-type: none"><li>• Regulation on the basis of Activity:</li><li>• Feedback Regulation, Allosteric Regulation, Covalent modification and Proteolytic activation of Zymogens</li><li>• Multienzyme complexes eg. Pyruvate dehydrogenase complex system</li><li>• Mechanism of enzyme Degradation: Lysosomal and non- lysosomal pathways.</li></ul>	6
5	Application of enzyme <ul style="list-style-type: none"><li>• Immobilization of Enzymes: methods and application</li><li>• Industrial Enzymes: Amylases, Lipases, Proteolytic enzymes in Meat and leather industry, cellulose degrading enzymes.</li><li>• Clinical Enzymes: SGPT,SGOT, Anti-inflammatroy agents, LDH, Transaminases (AST), Amylases, Phosphatases.</li><li>• Biosensor: Glucose oxidase.</li></ul>	6

## References

1. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
2. Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet& Judith Voet , John Wiley and Sons, Inc. USA.
3. Biochemistry:7th Edition, (2022), Jeremy Berg, LubertStryer, W.H.Freeman and company,NY.
4. Lehninger , Principles of Biochemistry. 8th Edition (2021), David Nelson & Michael Cox, W.H. Freeman and company, NY.
5. Biocatalysts and enzyme technology. . Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. John Wiley & Sons, 2023.
6. Enzymes: a practical introduction to structure, mechanism, and data analysis. Second edition Copeland, Robert A. John Wiley & Sons, 2008.

**Course Code and Title : BT-253-MJ Industrial Microbiology****Credits: 2****Total lectures: 30**

**Course outcome:** By the end of the industrial microbiology course, students will

1. Demonstrate a comprehensive understanding of microbial diversity, metabolic pathways, and fermentation technologies relevant to industrial applications.
2. Demonstrate a comprehensive understanding Media formulation and optimization
3. Understand sterilization techniques
4. Demonstrate a comprehensive understanding of different aspects of downstream process.

<b>Unit</b>	<b>Topic</b>	<b>No. Of lectures</b>
1	<b>Introduction to Industrial Microbiology:</b> <ul style="list-style-type: none"><li>• Concept of Fermentation Process- definition, historical perspective,</li><li>• Types of fermentations: submerged, surface, solid state, dual, batch, continuous, fed batch</li></ul>	3
2	<b>Strain Improvement Techniques:</b> <ul style="list-style-type: none"><li>• Strain Improvement: Objectives Methods for strain improvement with examples (mutants with altered permeability, auxotrophic mutants, analogue resistant)</li></ul>	4
3	<b>Bioreactor Design:</b> <ul style="list-style-type: none"><li>• Characteristics of an ideal Fermenter,</li><li>• Construction material used, surface treatment of the material</li><li>• Design of a typical batch fermenter, aerator and agitator- types, baffles, seals and valves used, steam traps.</li><li>• Different designs of bioreactors: air lift (internal and external loop), packed bed reactor, fluidized bed reactor</li></ul>	3
4	<b>Large Scale media and sterilization:</b> <b>Media components and optimization</b> <ul style="list-style-type: none"><li>• Carbon sources: cane and beet molasses, malt, corn, starch, oils, hydrocarbons, alcohols.</li><li>• Nitrogen sources: corn steep liquor, Soybean meal, peanutmeal,</li><li>• Buffering agents, chelators, water, precursors, inhibitors, inducers antifoams.</li><li>• Classical method of media optimization</li></ul> <b>ii. Sterilization:</b> Principles of media sterilization and equipments used in sterilization: batch and continuous, <b>iii. Air sterilization:</b> <ul style="list-style-type: none"><li>• Principles, mechanism of capture of particles in air</li></ul>	7
5	<b>Measurement and Control of different Bioprocess parameters:</b> temperature, pH, foam, dissolved oxygen, microbial biomass concept of scale up and scale down	4

6	<p><b>Downstream Processing of fermentation product- Methods and equipment's</b></p> <p>Definition: Unit operations and downstream processing, General strategy of product recovery</p> <ol style="list-style-type: none"> <li>a. Cell Disruption (Physico-mechanical and chemical methods).</li> <li>b. Precipitation (agents used: salts, organic solvents, polyelectrolytes, acids and bases)</li> <li>c. Filtration (plate frame. rotary vacuum, filter aids, flocculating agents)</li> <li>d. Centrifugation (types used in Industry: basket, tubular bowl, disc bowl)</li> <li>e. Solvent extraction- liquid liquid extraction</li> <li>f. drying : drum and spray</li> </ol>	5
7	<p><b>Large Scale Manufacturing Process-</b></p> <p>Baker's yeast (single cell protein), Organic acid (Citric Acid), Vit B12, lysine, alcohol, Enzyme- amylase</p>	4



## Reference books:

1. Wulf C., and Anneliese C., Biotechnology: A Textbook of Industrial Microbiology, 2<sup>nd</sup> edition, Panima Publishing Corporation, 2004.
2. Stanbury P., Whitaker A., Stephen H. Principles of Fermentation Technology 3rd Edition Butterworth-Heinemann 2017
3. Casida E., Industrial Microbiology, 1st edition, New Age International (P) Ltd, 2007.
4. Prescott, D. Industrial Microbiology, 1st edition, Agrobios (India), CBS Publication, 2004.
5. Patel A., Industrial Microbiology, 1st edition, MacMillan Publication, 2008.
6. Mathuriya S Abhilasha Industrial Biotechnology books, 2009
7. Prescott C., and Dunn G. Industrial Microbiology Jodhpur Agrobios. 2011  
<http://rims.ruforum.org/B5C1BA5D7194/industrial-microbiology-prescott-dunn.pdf>
8. James E. Bailey and David F. Ollis Biochemical Engineering Fundamentals 2nd edition, McGraw Hill, 1986 [http://str-tn.org/biochemical\\_engineering\\_fundamentals\\_bailey.pdf](http://str-tn.org/biochemical_engineering_fundamentals_bailey.pdf)
9. Doran P Bioprocess Engineering Principles Academic Press Ltd 2<sup>nd</sup> edition 2013  
[http://site.iugaza.edu.ps/mwhindi/files/ebooksclub.orgBioprocess\\_Engineering\\_Principles.pdf](http://site.iugaza.edu.ps/mwhindi/files/ebooksclub.orgBioprocess_Engineering_Principles.pdf)

**Course code and Title BT-254-MJP Practicals in Enzyme Technology and Industrial Microbiology**

**Credits: 2**

**Total practicals – 15**

**Course outcome: By the end of the industrial microbiology course, students will**

1. They will acquire practical skills in microbial cultivation, bioprocess engineering, and data analysis, enabling them to effectively contribute to various industries such as biotechnology, pharmaceuticals, and food production.
2. Able to isolate enzyme from plant source
3. Perform its catalytic activity along with various factors such as pH, temperature and time

<b>Sr.no</b>	<b>Title of Experiment</b>	<b>No. of practical</b>
	<b>Enzyme Technology</b>	
1.	Isolation of Alpha / Beta Amylase from suitable sources	1
2.	Preparation of Standard graph of Maltose	1
3	Assay of $\alpha$ -amylase and calculation of enzyme activity	1
4	Effect of various parameters on Enzyme activity- Temperature/ pH/ Time	2
5	Immobilization of enzyme	2
	<b>Industrial Microbiology</b>	
1	Isolation of antibiotic resistant mutants by Gradient plate technique	1
2	Lab scale Production, Recovery of baker's Yeast for single cell protein	2
3	Lab scale Production, Recovery (Filtration, Precipitation, distillation, solvent extraction) and estimation (Titrimetric, colorimetric, bioassay) of: Primary metabolite: Organic acid/Secondary metabolite: Antibiotic	2
4	Preparation of wine and estimation total titrable acidity and volatile acidity of wine	2
5	Visit to a Fermentation based Unit	1

**References:**

1. Practical Manual on Fermentation Technology, edsKulandaivel& S. Janarthanani K, International Publishing House Pvt. Ltd,2012
2. Experiments in Microbiology, Plant Pathology and Biotechnology ,K.R. Aneja, New age International, 2017
3. An Introduction to Practical Biochemistry.3rd Edition, (2017), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India.
4. Biochemical Methods.4<sup>th</sup>edition, (2022), S.Sadashivam, A.Manickam, New Age International Publishers, India.
5. Hans Bisswanger. Practical enzymology. John Wiley & Sons, 3 rd edition 2019.
6. Introductory practical biochemistry. Alpha Science Int'l Ltd., 2000.

**Subject code and Title: BT-291-MN Environmental and Applied Microbiology****Credits: 2****Total Lectures: 30****Course outcome:** By the end of this course students will be able.

1. To understand the fundamental concepts of microbiology and their application in environmental contexts.
2. To explore the diversity and ecological roles of microorganisms in different environmental habitats.
3. To examine the microbial processes involved in biogeochemical cycles and environmental transformations.

<b>Unit</b>	<b>Topics</b>	<b>No of lectures</b>
1	<b>Introduction to Environmental and Applied Microbiology</b> Overview of microbiology and environmental science Importance of microorganisms in environmental processes	1
2	<b>Microbial Diversity and Ecology</b> Bacterial, archaeal, fungal, and viral diversity Microbial habitats and ecological niches Microbial interactions and community dynamics	4
3	<b>Microbial Biogeochemical Cycles</b> Carbon, nitrogen, phosphorus, and sulfur cycles Microbial contributions to nutrient cycling and ecosystem functioning Environmental factors influencing microbial activities in biogeochemical processes	5
4	<b>Bioremediation and Environmental Cleanup</b> Principles and applications of bioremediation Microbial degradation of pollutants: hydrocarbons, pesticides, heavy metals Bioremediation strategies and case studies Wastewater treatment and microbial engineering	5
5	<b>Wastewater Treatment and Microbial Engineering</b> Microbial processes in wastewater treatment Anaerobic digestion and aerobic treatment methods Emerging technologies and microbial engineering for sustainable wastewater management	5
6	<b>Microbial Applications in Agriculture and Soil Health</b> Plant-microbe interactions: symbiotic nitrogen fixation, mycorrhizae Microbial inoculants and biofertilizers Soil microbial communities and soil health assessment	5
7	<b>Bioenergy Production and Microbial Technologies</b> Microbial fuel cells and bioelectrochemical systems Anaerobic digestion for bioenergy generation Microbial production of biofuels and bioproducts	5

## References

1. Environmental Microbiology by Raina M. Maier, Ian L. Pepper, Charles P. Gerba
2. Microbial Ecology: Fundamentals and Applications by Ronald M. Atlas
3. Bioremediation: Principles and Applications by Ronald L. Crawford, Don L. Crawford
4. Applied Microbiology by P. C. Trivedi, S. K. Jain
5. Principles of Environmental Microbiology by Ronald L. Crawford, Don L. Crawford
6. Aithal S. C. and Kulkarni N. S. (2015). Water microbiology ~ an Indian perspective.
7. Published by Himalaya Publishing House, IstEdition. ISBN: No.: 978-93-5202-129-1.
8. Dube H. C. and Bilgrami K. S. (1976). Textbook of modern pathology. Vikas publishing house. New Delhi.
9. Dubey R. C. and Maheswari D.K. Textbook of Microbiology. S. Chand Publishing. ISBN:9788121926201
10. Frobisher M. (1974). Fundamentals of Microbiology. 9th Edition. Saunders, Michigan University Press. ISBN: 9780721639222
11. Ingraham C. A. and Ingraham J. L. (2000). Introduction to Microbiology. United Kingdom: Brooks/Cole.
12. Lim D. V. (1989). Microbiology. 2nd Edition. West Publishing Company. ISBN: 9780314262066
13. Madigan M. T., Thomas Brock T., Martinko J., Clark D. P. and Paul D. P. (2009). Brock

## BT-292-MNP Practical in Environmental and Applied Microbiology

**Credits: 2**

**Total Practicals: 15**

Course Outcomes:

1. To investigate the application of microbial technologies in environmental remediation and pollution control.
2. To analyse the role of microorganisms in sustainable agriculture, bioenergy production, and bioremediation.

Experiment no	Title	No of practicals
1	Isolation and identification of microorganisms from environmental samples (soil/water/ air)	4
2	Assessment of microbial degradation of pollutants: hydrocarbons/pesticides/ heavy metals	4
3	Screening and isolation of pollutant-degrading microorganisms from contaminated sites	2
4	Microbial assays for wastewater quality assessment (BOD/COD/microbial diversity)	2
5	Isolation and characterization of beneficial soil microorganisms (nitrogen-fixing bacteria/mycorrhizal fungi)	2
6	Field trip or virtual tour for environmental sampling/wastewater treatment plant visit	1

### References:

1. Biology of Microorganisms. Pearson/Benjamin Cummings. ISBN: 9780132324601
2. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
3. Martin A. Introduction to Soil Microbiology. (1961). John Wiley & Sons, New York and London publication
4. MPCB, CPCB, BIS and WHO websites guidelines for drinking water quality
5. Pawar C. B. and Daginawala H.F. (1982). General Microbiology. Vol. I and II. 1st Edition.
6. Himalaya Publishing House, Mumbai. ISBN: 9789350240892 and ISBN9789350240908
7. Pelzar M. J., Chan E. C. S. and Krieg N. R. (1986). Microbiology. 5th Edition. McGraw-Hill Publication
8. Prescott L. M., Harley J. P. and Klein D. A. (2006). Microbiology. 6th Edition. McGraw Hill Higher Education. ISBN-13: 978-0-07-295175-2
9. Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi.
- 10.15. Salle A. J. (1971). Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Publishing Co.

**Course Code and title: SEC-251-BT Proximate Analysis (1T+1P)**

**Credits: 1**

**Total Lectures: 15**

**Course Outcome:**

1. To Understand Basic principle methods of analysis
2. To learn and understand basic composition of biomass
3. To learn methods of proximate analysis

<b>Units</b>	<b>Topics</b>	<b>Number of Lectures</b>
1	<b>Introduction</b> Introduction to Proximate composition of Biomass/Food/Feed/waste general theory, Biomass characteristics, Understanding compositions, Different analytical methods.	5
2	<b>Methods of Proximate analysis</b> Sample preparation, Understanding different methodology, Direct and indirect methods. AOAC methods, Crude fiber contents Crude protein content, crude fat content, ash and moisture content methods.	5
3	<b>Applications:</b> Factors affecting Proximate composition Legitimate comparisons of feed on the basis of specific nutrients Evaluation of contaminants, Industrial applications.	5

**References:**

1. John M. deMan Principles of Food Chemistry by 2018
2. Suzanne Nielsen Food Analysis by S.. 22 April 2010
3. S. Suzanne Nielsen Food Analysis Laboratory Manual by 2017.
4. Fennema Food Chemistry by 5th Edition 2017

**Course Code and title: SEC-251-BT Proximate Analysis (1T+1P)**

**Credits: 1**

**Total Practicals: 07**

**Course Outcome:**

1. To Understand Basic principles of Proximate analysis methods
2. To develop the analytical skills in laboratory
3. To learn and apply proximate analysis methods to study biomolecules

<b>Sr. No.</b>	<b>Title of Experiment</b>	<b>Number of Practicals</b>
1	To determine moisture content of a given sample	1
2	To determine crude protein content of a given sample	1
3	To determine crude fat content of a given sample	1
4	To determine carbohydrate content of a given sample (By Difference)	1
5	To determine any two secondary metabolites in a given sample	2

**References:**

5. Principles of Food Chemistry by John M. deMan 2018
6. Food Analysis by S. Suzanne Nielsen. 22 April 2010
7. Food Analysis Laboratory Manual by S. Suzanne Nielsen 2017.
8. Food Chemistry by Fennema 5th Edition 2017



**Course Code and title: OE-251-BT Biotechnology and Human welfare**

**Credits: 2**

**Total Lectures: 30**

**Learning Outcomes:**

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

1. Create link between past present and future of Biotechnology as well as get introduced to living organisms and needs of improvement of varieties from human perspective.
2. Be familiar with problem of waste generation and get knowledge of current methods used for waste disposal
3. Know various food industries, food products and ensure it for human consumption.
4. Understand different human diseases, their preventive measures and Treatments.
5. Get introduced to modern methods of crop improvement through tissue culture and transgenic approaches.

<b>Unit</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	<b>Introduction</b> <ul style="list-style-type: none"><li>• Use of biotechnological methods since ancient times in human history</li><li>• Introduction to living cells viz., Plant, animal and microbial</li><li>• Important biomolecules viz., DNA, RNA, Protein, Enzymes, Carbohydrates, Lipids and secondary metabolites</li><li>• Needs for improvement of varieties</li><li>• Achievements till date e.g., Edible vaccines, Phytainsuline, Animal cloning, Golden rice, Flavr- savr tomato etc</li></ul>	6
2	<b>Biotechnology and Environment</b> <ul style="list-style-type: none"><li>• Introduction to waste and waste disposal</li><li>• Types of waste materials</li><li>• Methods of waste disposal</li><li>• Biocomposting, Biofuel, Biofertilizers,</li><li>• Sanitary landfills, Incineration, Biological remediation</li></ul>	6
3	<b>Biotechnology and Food</b> <ul style="list-style-type: none"><li>• Introduction to food industry,</li><li>• Dairy products- Milk, Curd, Cheese,</li><li>• Bakery products: Enhancing the taste, yield, shelf life and nutritive values</li><li>• Alcoholic beverages – fermentation, wine and beer production.</li></ul>	6
4	<b>Biotechnology and Medicine</b> <ul style="list-style-type: none"><li>• Introduction to human health and diseases,</li><li>• Types of diseases- Viral diseases, Malaria, Diabetes, Sickle cell anaemia, Cancer</li><li>• Molecular diagnosis, Prevention of diseases</li><li>• Genetically engineered insulin, Gene therapy, Vaccines.</li></ul>	6

5	<b>Biotechnology and Agriculture</b> <ul style="list-style-type: none"> <li>• Introduction to Plant tissue culture</li> <li>• Micropropagation, Artificial seeds, haploids</li> <li>• Transgenic plants for quality and quantity improvement</li> <li>• Transgenic plants for disease resistance</li> </ul>	6
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**References:**

1. U Satyanarayana, (2020) Biotechnology (Books & Allied Ltd)
2. Razdan M.K. (2009) Introduction to Plant Tissue culture - (Oxford & IBH Publ, New Delhi)
3. R.C. Dubey (2022) A Textbook of Biotechnology – (S Chand And Company Ltd)
4. C. S. K. Mishra, Pascale Champagne, (2013) Biotechnology Applications (I K International Publishing House Pvt. Ltd)
5. B.D. Singh (2015) Biotechnology (Kalyani Publishers)