Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Biotechnology

Curriculum
For the Academic Year 2023-24
Under CBCS
Three Year Degree Programme in Biotechnology
(Six Semester Programme)

UG First Year
Semester III and IV

Syllabus Approved by Board of Studies in Biotechnology

With effect from June, 2023

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of Biotechnology
Course Structure of B. Sc. Biotechnology Second Year

B. Sc. II (Biotechnology)Semester III

	Code No.	Title of the course	Hours/ Week	Marks		Credits	Total
				In Sem	End Sem		
AECC3	U-COE-301	Communicative English III	04	20	30	02	50
CCT1	U-APM-398	Applied Microbiology	04	20	30	03	50
CCT2	U-IMV-399	Immunology and Virology	04	20	30	03	50
CCT3	U-MOB-400	Molecular Biology	04	20	30	03	50
CCT4	U-MET-401	Metabolism	04	20	30	03	50
CCP1	U-LAC-402	Lab Course IX	03	20	30	02	50
CCP2	U-LAC-403	Lab Course X	03	20	30	02	50
CCP3	U-LAC-404	Lab Course XI	03	20	30	02	50
CCP4	U-LAC-405	Lab Course XII	03	20	30	02	50
SEC1	U-ADC-334	Good Laboratory Practices/ Human Excellence Development	01+02	20	30	02	50
		Total	**35**			**24**	**500**

B.Sc. II [Biotechnology] Semester IV

	Code No.	Title of the course	Hours/ Week	Marks		Credits	Total
				In Sem	End Sem		
AECC4	U-COE-401	Communicative English IV	04	20	30	02	50
CCT1	U-BDS-497	Biodiversity and Systematics	04	20	30	03	50
CCT2	U-ENZ-498	Enzymology	04	20	30	03	50
CCT3	U-PRB-499	Process Biotechnology	04	20	30	03	50
CCT4	U-ENV-500	Environmental Biotechnology	04	20	30	03	50
CCP1	U-LAC-501	Lab Course XIII	03	20	30	02	50
CCP2	U-LAC-502	Lab Course XIV	03	20	30	02	50
CCP3	U-LAC-503	Lab Course XV	03	20	30	02	50
CCP4	U-LAC-504	Lab Course XVI	03	20	30	02	50
SEC2	U-ADC-434-A	Algal Cultivation Technology/ Mushroom Cultivation	01+02	20	30	02	50
		TOTAL	**35**			**24**	**500**

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology
III Semester

Course Title: Applied Microbiology **Course Code: U-APM-398**
Marks: 50 **Lectures: 45** **Credit:03**

Learning Objectives:

- To create awareness about microorganism which is exploited in industrial process, product development it's beneficial as well as harmful aspect and study of applied areas.
- To provide the information on new approaches in microorganism's exploitation.
- To know the technical knowhow about the soil, water and air microorganism along with the microbe which is disease causing and beneficial and their activities for recycling and sustainability
- To inculcate the new approaches to direct the issues related to research in applied microbiology.

Course Outcomes:

On the successful completion of the course, student will be able to-

- acquaint the knowledge in the different areas of microbiology
- understand the significance of microorganism in biogeochemical cycling of nutrients,
- apply the knowledge of soil microbiology and significant biochemical processes of microbes to improve the agricultural practices.
- define the science of microbiology, its development and importance for human welfare.

Unit I: **(12L)**

Soil, Water and Air microbiology

Soil, water and air microbiology: Biogeochemical cycles: Mineralization in Carbon, Nitrogen, And Sulfur, Phosphorous etc. Bacteriological examinations of water; (Presumptive, confirmative, complete test) MPN, SPC, IMVIC, significance of index organism, Significance of microorganism in Air; methods of enumeration and controls.

Unit II: **(10L)**

Food Microbiology and Preservation

Scope of Food microbiology: role of microorganism in food processes.

Spoilage of food, potential responsible microbes, bacteriological examination of foods.

Preservation of food: Different methods of preservation: High temperatures, chemical, irradiation and physical techniques and pasteurization.

Single cell protein: Process, production and its significance.

Unit III: **(13 L)**

Introduction to Medical Microbiology

Normal flora of the body, Immune system and Immunity, Microbial and viral infections and diseases, use of antibiotics its mechanism of action, broad spectrum, narrow spectrum and its respective mechanism Chemotherapy Water born, air born, food borne diseases and their causative agents from different reservoirs.

Unit-IV: (10L)

Environmental and Agriculture Microbiology

Environmental microbiology: Scope and concern, Agricultural microbiology: Scope and concern, Industrial effluents and Waste water Assessment; Sewage treatment plants: Aerobic & anaerobic treatment processes, Integration of genetic engineering & application of genetically engineered, Microbes in Agriculture, Environmental and waste water treatments.

Recommended Textbooks and References:

1. Soil Microbiology (1977) 2nd ed., Martin Alexander, John Wiley and Sons Ltd.
2. Principles of Microbiology (1995) Ronald M. Atlas by William C. Brown 9780815108894
3. Food Microbiology (1995) 4 th ed.-Martin R. Adams, Moris O Moss., Peter MacClure Royal society of Chemistry.
4. Microbiology (1998). Pelczar Tata McGraw-Hill
5. Brock Biology of Microorganisms (2021).15 th ed. Michael T. Madigan., John M Martinko., Kelly S. Bendar., David A. Stahl Pearson Publications.
6. General Microbiology (1976). Roger Y. Stanier London-MacMillan publication
7. Anantharaman and Panikkar's Textbook of Microbiology (2017) 10 th ed. Dr. Reba Kanungo
8. General Microbiology (2019) Vol. I and Vol. II by Pawar and Daginawala Himalaya Publishing House.

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III Semester

Course Title: Lab Course IX **Course Code: U-LAC-402**
Marks: 50M **Hours: 30** **Credit: 02**

Learning Objectives

- To provide Hands-on Isolation of soil, water and air microbes by different methods
- To Provide Hands-on Isolation and Characterization of microbes used as organic fertilizers.
- To provide Hands-on Qualitative and quantitative analysis of Soil and water samples
- To provide solutions for Environment and Agriculture sustainability.

Course Outcomes

On the successful completion of the course, student will be able to-

- isolate the microbes from different reservoir
- check the notability of water samples.
- isolate nitrogen fixing and phosphate solubilizing organisms.
- perform and analyze the normal flora on skin, hair and throats etc.

Practicals:

1. Isolation and enumeration of microbes from soil, water and food samples.
2. Isolation of cellulose degraders
3. Isolation of Rhizobium from root nodules
4. Isolation and characterization of Azotobacter from Rhizospheric soil.
5. Isolation of Phosphate solubilizing bacteria
6. Isolation of microbes from air and their enumeration
7. MPN (bacteriological examination of water)
8. IMVIC (bacteriological examination of water)
9. Isolation of mycotoxin from infected food and vegetables.
10. Visit to waste water plant (field visit)

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III Semester

Course Title: Immunology and Virology **Course Code: U-IMV-399**

Marks: 50 **Lectures: 45** **Credits: 03**

Learning Objectives:

- The student will be made to understand basic concepts of Immunology and its historical background.
- To make the students understand the basic principles of Antigen-Antibody interactions and its applications in diagnosis.
- To make the students understand the basic concepts of virus structure, Nomenclature and its Classification.
- To make the students understand the life cycle of viruses and use of different antiviral drugs.

Course Outcomes:

On the successful completion of the course, student will be able to:

- understand the role of immune system in defense and the different mechanisms involved in it.
- acquaint the knowledge about antigen, antibody structure, interaction and their use in disease diagnosis.
- gain knowledge about the virus structure, its nomenclature and classification systems.
- understand the life cycle of viruses and study the different anti-viral agents and their mechanism.

UNIT I **(15L)**

Overview of Immunology

Historical perspective Innate and Adaptive Immune response. Hematopoiesis, Cells of Immune system and their biological role. Humoral and cell mediated Immunity. The Primary and secondary lymphoid organs.

UNIT II **(10L)**

Basics of Immunology

Antigen: Antigens- General properties, types, Factors that influence antigenicity, Epitopes, Paratopes, Haptens, adjuvant and its types. **Antibody:** General Structure of antibody molecule, Antibodies- variation in structure of antibody and their biological significance.

Antibody Antigen interactions: Strength of Antigen-Antibody Interactions, Ka and Kd with its importance, Affinity and avidity

Immunological reactions: Precipitation and Agglutination reactions, ELISA.

UNIT III **(10L)**

Introduction to viruses

Viruses and their importance. Discovery of viruses. Structure of virus: viral nucleic acid, nucleocapsid, envelope. Variation in structure of viruses. Viroids and Prions. Nomenclature and Classification of viruses.

UNIT IV **(10L)**

Life cycle of Viruses

Structure of animal virus (HIV) and plant virus (TMV). Life cycle and replication of DNA virus (Adenovirus), RNA virus (Retrovirus), Bacteriophages (lytic and lysogenic) Vaccines, antiviral drugs.

Recommended Textbooks and References:

1. Kuby Immunology (2000)4th Ed., Thomas J. Kindt Richard A. Goldsby,Barbara A. Osborne(W.H.Freeman & Company)
2. Kuby Immunology (2000)6th Ed., Thomas J. Kindt Richard A. Goldsby,Barbara A. Osborne(W.H.Freeman & Company)
3. Roitt's Essential Immunology (2017) 11th ed. Deives, Martin, Burton, Roitt. 11th ed. (Wiley Blackwell publications)
4. Virology Principles and Applications (2013) John B. Carter and Venetia A. Saunders, (John Wiley & Sons Ltd)
5. An introduction to viruses (1992) Amita Biswas (Vikas Publishing House)
6. Ananthanarayan and Paniker's Textbook of Microbiology (2017) 10th Ed.,R. Anantnarayan and J. Panikar (Universities Press Private Limited)

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B.Sc. Biotechnology
III Semester

Course Title: Lab Course X **Course Code: U-LAC-403**

Marks: 50M **Hours: 30** **Credit: 02**

Learning Objectives:

- To study tools and technical skills in the field of Immunology and Virology.
- To provide hands on approach for different immunodiagnostic techniques.
- To provide hands on approach on different basic techniques of virus isolation.
- To study antigen antibody interactions.

Course Outcome:

After the completion of this course, students will be able to:

- perform different immunodiagnostic techniques.
- handle instruments used in immunology.
- perform various methods of virus isolation.
- perform phage titration.

Practicals:

1. Agglutination reaction.
2. Latex agglutination.
3. Immunoprecipitation.
4. Immunodiffusion.
5. Blood film preparation and identification of cells.
6. Differential leucocyte count.
7. Microscopic observation of lymphoid organs.
8. Widal.
9. VDRL.
10. Demonstration of immunodiagnostics.
11. Demonstration of ELISA.
12. Isolation of Bacteriophages from sewage.
13. Titration of phage.
14. Isolation of plant virus.
15. Demonstration of one step growth curve of Bacteriophages.
16. Cultivation of virus in embryonated eggs.

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III Semester

Course Title: Molecular Biology **Course Code: U-MOB-400**
Marks 50 **Lecture: 45** **Credit: 03**

Learning Objectives:
The main objectives of this course:

- To provide comprehensive background of Salient features of Nucleic Acids and DNA model.
- To impart detailed understanding of key events of molecular biology comprising of mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes.
- To provide adequate knowledge about Post Transcriptional Modifications and Processing of Eukaryotic RNA.
- To develop comprehensive understanding regarding DNA Repair Mechanisms and gene expression regulation.

Course Outcomes:
On the successful completion of the course, student will be able to:

- understand the structure, and function of nucleic acids in prokaryotes and eukaryotes.
- get knowledge about the mechanism of dna replication, transcription and translation in prokaryotes and eukaryotes
- understand post transcriptional modifications and processing of eukaryotic rna.
- understand different dna repair mechanisms and transcriptional regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms

UNIT I: **(10 L)**

The beginning of Molecular Biology

Introduction Historical perspective the structure of DNA-Primary structure: the components of nucleic acids, Secondary structure of DNA, Tertiary structure of DNA Genome organization: from nucleotides to chromatin, Introduction, Eukaryotic genome Bacterial genome DNA replication and Telomere maintenance (Introduction, DNA polymerases and other enzymes that catalyze DNA synthesis DNA replication- In prokaryotes and brief introduction to eukaryotes, Telomere maintenance: the role of telomerase in DNA replication, aging, and cancer.

UNIT II: (12 L)

From Gene to Transcriptome

Introduction, the central dogma, the genetic code the versatility of RNA, Introduction Secondary structure of RNA Tertiary structure of RNA Roles -RNA is involved in a wide range of cellular processes Unique function: The discovery of RNA catalysis and Ribozymes catalyze a variety of chemical reactions Prokaryotic Transcription Brief introduction to Eukaryotic Transcription Post Transcriptional Modifications in Eukaryotes

UNIT III: (08L)

Gene Expression and Regulation

Protein structure, Protein function, Prokaryotic Translation Brief introduction to Eukaryotic Translation Post Translational Modifications in Eukaryotes.

Prokaryotic gene expression and regulation, Operon Concept-Lac operon, Tryptophan operon, Eukaryotic gene expression and regulation (in brief)

UNIT IV: (15L)

DNA Mutation and repair

Introduction, Types of mutations and their phenotypic consequences, General classes of DNA damage, Repair of single Base excision repair, Mismatch repair, Nucleotide excision repair, Disease - Hereditary nonpolyposis colorectal cancer: a defect in mismatch repair Base changes and structural distortions by removal of DNA damage, Double-strand break repair by removal of DNA damage Disease –Xeroderma pigmentosum and related disorders: defects in nucleotide excision repair Disease - Hereditary breast cancer syndromes: mutations in BRCA1 and BRCA2, SOS repair. Homologous recombination – non-homologous end-joining

Recommended Textbooks and References:

1. Molecular Biology of the Gene (2013) 7th ed., James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine, Richard Losick (Pearson)
2. Molecular Biology (2004) David Freifelder (Narosa)
3. Molecular Biology (2011)5th ed., Robert F. Weaver (McGraw Hill Education)
4. Concepts Of Genetics (1999) 6th Ed., William S. Klug, Michael R. Cummings, et al. (Prentice Hall)
5. Genetics (1995)3rd Ed., M.W., Strick Berger, Prentice Hall India.
6. Concepts of Genetics (2000)2nd Ed., P.J. Russell (Benjamin Cummings)
7. Principles of Genetics (2006)8th Ed., E.J. Gardner (Wiley)
8. Lab manual in biochemistry, immunology and biotechnology (2007) Arti Nigam, Archana Ayyagari Tata McGraw-Hill Publications.

Rajarshi Shahu Mahavidyalaya, Latur
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III Semester

Course Title: Lab Course XI **Course Code: U-LAC-404**
Marks: 50M **Hours: 30** **Credit: 02**

Learning Objectives:

- To provides hands-on tools and techniques in Molecular Biology.
- To inculcate and augment the hands-on expertise on isolation of nucleic acid from different sources.
- To study qualitative and quantitative analysis of Nucleic Acids.
- To study purity of Nucleic acid

Course Outcomes:

On the successful completion of the course, student will be able to:

- isolates nucleic acids from different sources.
- perform analysis of DNA and RNA qualitatively and quantitatively
- check purity of nucleic acid
- check effect of mutagens on bacterial growth.

Practicals:

1. Isolation of DNA from Bacterial cells.
2. Isolation of DNA from Animal
3. Isolation of DNA from plant cells.
4. Quantification of DNA by using Diphenylamine (DPA) method.
5. To resolve the given DNA sample by using agarose gel electrophoresis.
6. Spectroscopic determination of nucleic acid purity and concentration.
7. Isolation of total RNA from yeast cells.
8. To estimate RNA quantitatively by using orcinol reagent.
9. Study to Tm value of DNA
10. To study mutation and repair using replica plating.
11. Industrial Visit.

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III Semester

Course Title: Metabolism **Course Code: U-MET-401**
Marks: 50 **Lectures: 45** **Credit:03**

Learning Objectives

- To explain the role of catabolic and anabolic pathways in cellular metabolism.
- To understand the role of Biomolecules in providing the energy to the living system by its oxidation
- To understand the biosynthesis of Biomolecules
- To distinguish between exergonic and endergonic reactions in terms of available energy change.
- To impart knowledge of structural and functional aspects of biomolecules in living systems

Course Outcomes

On the successful completion of the course, student will be able to-

- understand the relationship between the structure and function of specific biological molecules.
- compare and contrast anabolism and catabolism.
- understand the function of specific anabolic and catabolic pathways and how these pathways are controlled and interrelated.
- describe how current research has provided us with an understanding of the molecular basis of the control of metabolism.

Unit I **(11 L)**

Introduction to Metabolism and Respiration

Catabolism, anabolism, catabolic, anabolic and amphibolic pathways

Respiration: aerobic respiration, glycolysis and its regulation, Krebs cycles and its regulation, Anaplerotic reaction, Substrate Level Phosphorylation, oxidative phosphorylation: Electron Transport Chain and its inhibitors, Electrochemical proton gradient, chemiosmotic theory, ATP synthase, shuttle systems/O ratio, Pasteur effect, warburg effect, respiratory quotient, Anaerobic Respiration: Alchohol and Lactic acid Fermentation, cori cycle.

UNIT II **(11 L)**

Photosynthesis

Photosynthetic pigments, Absorption and action spectra, Fate of light energy absorbed by Photosynthetic Pigments, concept of photosynthetic unit and pigment system, Stages of Photosynthesis: oxygenic & anoxygenic photosynthesis, Light reaction: Cyclic and Non-Cyclic Photophosphorylation, Dark reaction: carbon reduction and fixation cycle, Photorespiration C4 cycle, CAM Pathway, Starch and sucrose synthesis.

Unit III **(12L)**

Carbohydrate and Lipid Metabolism

Glyoxylate Pathway, Pentose Phosphate Pathway, Entner-Doudoroff Pathway, Carbohydrate metabolism – Gluconeogenesis, Glycogen Metabolism.

Synthesis and storage of triacylglycerols, Biosynthesis of Fatty acid, Elongation of Fatty acid, Unsaturation of fatty acids, Fatty acid oxidation: Mitochondrial β -oxidation, alternative Pathway of fatty acid oxidation, Ketone bodies.

Unit IV **(11 L)**

Amino acid Metabolism: Biodegradation of amino acids – deamination, transamination, decarboxylation, urea cycle including its regulation. Biosynthesis of amino acids, Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, Biologically active amines)

Nucleotide Metabolism – Nucleotide synthesis: De-Novo and Salvage PW, Nucleotide degradation.

Recommended Textbooks and References:

1. Lehninger, Principles of Biochemistry by Nelson, D. L., Lehninger,· A. L., & Cox, M. M. (2008), 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and Company, New York, p: 677-878.
2. Biochemistry by Donald Voet, Judith G. Voet, Publisher: John Wiley & Sons (2011), Fourth Edition, ISBN-10: 0071737073, ISBN-13: 978-0071737074.
3. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain, Nithin· Jain (2008), Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.
4. A Text Book of Biochemistry by E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, Oxford and IBH Publishing Co., New Delhi, 1974.

5. Harper's Biochemistry by Robert K. Murray , Daryl K. Granner, Peter· A. Mayes and Victor W. Rodwell, Publisher: Appleton & Lange; 25th Revised edition (1 July 1999), ISBN-10: 0838536840, ISBN-13: 978-0838536841.
6. J. Zubay. Biochemistry
7. Berg, Jeremy M., John L. Tymoczko, Gregory J. Gatto, and Lubert Stryer. *Biochemistry*. 8th ed. W. H. Freeman & Co., 2015. ISBN: 9781464126109.
8. P.M.Dey- Plant Biochemistry-Academic Press

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III Semester

Course Title: Lab Course XII **Course Code: U-LAC-405**

Marks: 50M **Hours: 30** **Credit: 02**

Learning Objectives

- To provide Hands-on Enzyme Assay
- To Provide Hands-on Quantitative analysis of biomolecules
- To provide Hands-on Qualitative analysis of biomolecules
- To provide solutions of Problems in Biochemistry and Metabolism

Course Outcomes

On the successful completion of the course, student will be able to-

- quantify different metabolites.
- perform enzyme assays
- perform quantitative and qualitative analysis of molecules
- solve problems in biochemistry and metabolism

Practicals:

1. Hydrolysis of Sucrose and Starch
2. Qualitative Test for Amino Acids
3. Qualitative Test for Proteins
4. To Perform Fatty Acid Titration
5. Estimation of Ketone Bodies
6. Determination of Urinary Titrable acidity
7. Estimation of Urinary Creatinine
8. Estimation of Enzyme activity of Acid Phosphatase
9. Estimation of Enzyme activity of β-amylase
10. Estimation of Total Serum Cholesterol by Zak and Henley's method
11. Determination of Serum Bilirubin by Van de Bergh reaction
12. Solution of Problems in Biochemistry and Metabolism

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III Semester
Skill Enhancement Course

Course Title: Good Laboratory Practices **Course Code: U-ADC-334**

Marks: 50M **Lectures: 30** **Credit: 02**

Learning Objectives:

- To teach the students safety handling and regulation laboratory facility.
- To learn how to record, keep and analyze laboratory data with accuracy.
- To practice minimization of Errors related with handling of laboratory accessories and equipment's.
- To learn Standard Operating Procedures (SOPs) Laboratory equipment's.

Course outcomes

On the successful completion of the course, student will be able to-

- understand the basic calibration and handling of instrumentation in laboratory.
- safely practice, basic laboratory procedures and protocols in on job laboratory situations.
- maintain laboratory records, complaints with current industry standards.
- maintain audit record

Unit I: **(08L)**

Introduction to GLP

History, Scope, Fundamental points of GLP (Resources Characterization, Rules, Results, Quality assurance)

Practicals

Standard Operating Procedures

Unit II: **(08L)**

Laboratory rules and Protocols

General Rules/Protocols for Lab Safety measures, Precaution and Safety in handling of chemicals, Laboratory tools, Glassware and instruments. Internal and External Audit,

Practicals

- Preparation of Standard Solution and Buffers

- Demo and Maintenance of Internal and External Audit

Unit III: (08L)

Laboratory hierarchy and SOP

Levels of Laboratories, Log Book Maintenance, Basic SOPs for instrument handling and Maintenance

Practicals

Calibration of Instruments: PH meter, colorimeter, spectrophotometer, water bath, Distillation assembly, Burette, Pipette etc.

Unit IV: (06L)

Record Keeping and Interpretation

Keeping data records, its analysis by using statistical and mathematical tools. Result analysis and its interpretation.

Practicals:

1. Use of Microsoft word, Excel. (for Data entry, calculation and graphical representation)
2. Use of internet and emails

Recommended Textbooks and References:

1. Handbook Good Laboratory Practices (2010) World health organization (WHO)
2. Life science protocol manual (2018)-DBT star college scheme.
3. Guidelines for good laboratory practices (2008).-Indian council of medical research, New Delhi

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III Semester
Skill Enhancement Course

Course Title: HED- Human Excellence Development **Course Code: U-ADC-334**

Marks 50 **Hours 30** **Credit: 02**

Learning Objectives:

- To sharpen the intellect through analytical thinking and discussion
- To teach the students about various interview skills.
- To boost self-confidence among students.
- To make the students to understand etiquette and moral values.

Course outcomes:

On the successful completion of the course, student will be able to-

- Get self-confidence.
- enhance their potential for higher achievement
- develop creativity and interpersonal skills
- acquire life coping skills

Related Audience	-	Students of B.Sc. II Year
01. Spoken English	-	Basics of Grammar
02. Communication Skills	-	Verbal / Non verbal
03. Influencing Skills	-	Attitude Management
04. Managerial Skills	-	Leadership Skills, Managing Aggressiveness
05. Listening Skills	-	Paying attention to opponents, friends, seniors, Teachers & Parents
06. Social Skills	-	Extempore, Group Discussions
07. Presentation Skills	-	Seminars
08. Writing Skills	-	How to write effective Letter, Resume, E-mail Application, etc.
09. Paradigm Shift	-	Understanding challenges and try to accept them
10. Motivation	-	Self Motivation Making friends for Progress

11. Aptitude Skills - Understanding aptitude Role plays Small Test

12. Becoming better Student - Plan to become better student on daily basis

13. Preparing for Interview - Dress Code, Eye Contact, Killing nervousness, Building Confidence, Winning the interviewer

** After all these classroom trainings mock interviews will be conducted of each and every student in an open environment.

Recommended Textbooks and References:

1. Seven hobbit of highly effective people: Powerful lesion in personal change Stephan R . Kovey
2. Who moved my cheese (1999) Kenneth H. Blancered.

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IV Semester

Course Title: Biodiversity and Systematics **Course Code: U-BDS-497**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To educate the students about the existing Biodiversity in the world with special reference to Indian continent, various geographical hotspots and losses and remedial mitigation strategies
- To inculcate the values of Biodiversity and knowledge about classification of flora and fauna and their detail studies with new methods such as identification keys and evolutionary relationship.
- To study the interpretation and analysis of results with the reference material it would be key to identification of new plants and animals.
- To inculcate the moral, legal and ethical values about Biodiversity

Course Outcomes:

On the successful completion of the course, student will be able to-

- acquaint knowledge about current situation of biodiversity and existing conservation strategies and laws.
- understand traditional and recent methods of classification of plant and animals
- acquaint knowledge about endangered species and their conservation
- get the knowledge, ethics and sustainability with special reference to biodiversity conservation, a global perspective.

Unit-I **(13 L)**

Basic concept of Biodiversity

What is Biodiversity, why should we conserve it, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Types of biodiversity (Alpha, Beta) Cataloguing and Discovering Species, Geographical Patterns of Species Richness, what is Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species).

Unit-II **(10 L)**

Biodiversity Loss

Biodiversity & Conservation – Major drivers of biodiversity loss such as Overexploitation, habitat destruction, latitudinal gradient and invasive species etc. threatening living species and IUCN, RED Data Book, Current status of

International illegal trade of animals, Problems in Controlling International Trade (Enforcement, Reservations, Illegal Trade).

Unit III **(12 L)**

Biodiversity Conservation and its value

Endangered Species Conservation – endangered categories (Extinct, threatened, critically endangered etc.) The US Endangered Species Act, State endangered Species Acts Successes and Failures of the Endangered Species Act Problems with the Endangered Species Act, Habitat Conservation Plans or restoration. strategies Conservation strategies by National and International communities, conventions etc. Ethics of Conservation – Values of Biodiversity, Bio piracy, Hybridized plants, GM crops (benefits & criticism), and Economic Value of Biodiversity & Legal, Ethical issues related to uses of biodiversity, Global Conservation Issues.

Unit IV **(10 L)**

Basic concept of Taxonomy and modern approaches

Nomenclature and Species concept. Classification and, systematics Construction of Phylogenetic tree, Cladistics, Cladograms, Phenetics, Molecular Taxonomy in relation to DNA characteristics & Protein sequences, genetic markers for taxonomic purposes, comparing total genome by DNA-DNA hybridization, important bioinformatics based tools and databases for evaluation biological identification through DNA barcodes.

Recommended Text Books and References:

1. The Biology of Biodiversity (2012) M. Koto – Springer-Verlag Tokyo.
2. Principle of Animal taxonomy G. G.–Simpson Oxford IBH Publication company.
3. Biodiversity (2003) E.O. Wilson – Academic Press Washington
4. Principle of Animal taxonomy (1961) G. G.–Simpson Oxford IBH Publication company.
5. Ecology and Environment (2009). P. D. Sharma Rastogi Publications.
6. Fundamentals of Ecology (1953). 5 th ed. Eugene P. Odum and Garry Barret University of Georgia press.
7. An advance textbook on Biodiversity (2004) Kulithalai V. Krishnamurthy Oxford and IBH publishing.

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IV Semester

Course Title: Lab Course XIII **Course Code: U-LAC-501**
Marks: 50 **Credit: 02**

Learning Objectives

- To learn basics of plant systematics
- To learn methods of Plant conservation and Propagation.
- To impart basic knowledge of Plant and Animal diversity.
- To appreciate the beauty inherent in plants.

Course Outcomes:

On the successful completion of the course, student will be able to-

- evaluate the current environmental issues in wider perspectives
- understand the importance of estimation and recording of Biodiversity
- gain Hands-on experience and training on Gardening and Plant propagation techniques
- understand distinguishing features of Plants and Animals

Practical:

1. Morphology of major groups (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms)
2. Study of Leaf Morphology
3. Study of Flower Morphology
4. Study of fruits Morphology
5. Surveys, collection and preservation of different plant groups
6. Visits to Nurseries, herbaria, gardens, culture collections centres
7. Photography and illustration in field8. Study of Insect Morphology
8. Visit to local Fish market for Morphological studies
9. Studies of Animal specimens
10. Field Visit to Zoological Park, Botanical Garden and Sanctuaries

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IV Semester

Course Title: Enzymology **Course Code: U-ENZ-498**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives

- To provide a deeper insight into the fundamentals of enzyme structure and function.
- To outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.
- To develop an understanding of Enzyme Kinetics and Enzyme Inhibition.
- To understand Mechanism of enzyme action and their regulation.

Course Outcomes

On the successful completion of the course, student will be able to-

- describe structure, functions and the mechanisms of action of enzymes.
- get exposure of wide applications of enzymes and their future potential in research .and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.
- learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.
- know the applications of Biosensor in Industry and Research.

Unit I **(14L)**

Enzymes & Enzyme Catalysis:

Unique features of Enzymes, General Features of enzymes , Classification : IUB system, rationale, overview and specific examples, Characteristics of enzymes, enzyme substrate complex, Concept of active center, binding sites, Types of Specificity , Factors affecting reaction rate, Catalytic Strategies, Mechanism of Enzyme catalysis : Nucleophilic , proximity and orientation effects, distortion or strain, acid – base, Electrostatic, Metal ion etc. , Isoenzymes and multiple forms of enzymes, Zymogen, Chemical modification of enzymes Examples: Lysozyme and Chymotrypsin, Ribozyme.

Unit II **(8L)**

Application And Characterization Of Enzymes

Commercial application of enzymes in food, pharmaceutical and other industries; Enzymes for analytical and diagnostic applications, Production and Purification of Crude Enzyme extracts from plant, animal and microbial sources-some case studies; methods of characterization of enzyme; development of enzymatic assays.

Unit III **(12L)**

Enzyme Kinetics

Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics, Significance of Vmax and Km, Bisubstrate reactions, Graphical procedures in enzymology - advantages and disadvantages of alternate plotting, Enzyme inhibition - types of inhibitors - competitive, non-competitive and uncompetitive, their mode of action and experimental determination. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay.

Unit IV

Enzyme Regulation & Immobilized Enzymes **(11L)**

Product inhibition, Feedback control system, Irreversible and Reversible covalent modification, Regulation by Non -Covalent Modification (Allosteric regulation).

Enzyme immobilization: Methods of immobilization – Physical adsorption, ionic bonding, covalent bonding (based on R groups of amino acids), Crosslinking, microencapsulation and gel entrapment etc.

Biosensors: Principle and applications with examples (glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors.)

Recommended Textbooks and References:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York),
2. Biochemistry (2019) 9th ed., Stryer, L., Berg J., Tymoczko J., Gatto G., W.H. Freeman (New York),.
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York),
4. Fundamentals of Enzymology (2000) ed 3rd: Price and Stevens ISBN: 9780198502296
5. Immobilized Biocatalysts :W. Hartneir(2018). Springer-Verlag publication.
6. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (2007)ed.2nd , Philip L. Bonner Trevor Palmer.
7. Enzymes: Dixon and Webb (2014), 2nd Edition, Publisher: Elsevier

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IV Semester

Course Title: Lab Course XIV **Course Code: U-LAC-502**
Marks: 50 **Credit: 02**

Learning Objectives

- To Provide Hands-on Enzyme Assays.
- To Provide Hands-on factors affecting enzyme rate of reaction.
- To Provide Hands on Immobilization Techniques.
- To Provide Hands-on Purification Techniques

Course Outcomes

On the successful completion of the course, student will be able to-

- perform Enzymes Assays
- study effect of different factors on enzyme rate.
- perform immobilization of enzymes.
- perform experiments on purification of enzymes

Practical:

1. To Study Effect of amylase activity on Starch
2. Determination of α-amylase activity
3. Effect of substrate concentration on enzyme activity
4. Effect of Salt concentration on enzyme activity
5. Effect of pH concentration on enzyme activity
6. Effect of Temperature on enzyme activity
7. Effect of Time on enzyme activity
8. Effect of Inhibitors/Activators/Cofactors on enzyme activity,
9. Immobilization of enzyme in sodium alginate matrix
10. Production and Characterization of Enzyme
11. Indirect estimation of lactate dehydrogenase
12. Purification of enzyme
13. Problems based on Enzyme Kinetics

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IV Semester

Course Title: Process Biotechnology **Course Code: U-PRB-499**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives

- To explain the role of fermenter in Industrial Biotechnology
- To improve knowledge of students with designs of various fermenters.
- To study the process kinetics of fermentation.
- To make the student to understand bioreactor design, upstream processing, downstream processing, and operation.

Course Outcome

On the successful completion of the course, student will be able to-

- understand bioprocess engineering and its relation to other disciplines.
- interpret the Bioprocess Engineering and product formulation.
- create awareness of job functions in bioprocess industries, professional issues and entrepreneurship.
- get familiar with computer applications in bioprocess industries.

Unit I **(11L)**

Introduction to Concepts of Bioprocess engineering:

Definition of Bioprocesses engineering. Introduction to Simple engineering calculations, Mass & Energy Balances. Oxygen uptake rate (OUR), KLa, Viscosity & its control. Design of Fermenters: Construction, Design & Operation, Materials of Constructions, Welding, Surface treatment Components of the fermenters & their specifications

Unit II: **(11L)**

Air & Media sterilization:

Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth & Screen Filters, Sizing, Testing & validation of filters for air Sterilization.

Principles of Media Sterilization, Decimal reduction, Design of sterilization Cycle using kinetics of thermal death of microbes, Equipment's used in sterilization; Constituents of media, Media Optimization their estimation & quantification. Design of media. Costing of media

Unit III **(12L)**

Types of Bioprocesses, Screening and Strain Improvement of Microorganism

Types of Bioprocesses: Biotransformation (enzyme, whole cell), Batch, Fed-batch, continuous. Screening: Primary and Secondary Screening, Preservation and Maintenance methods for Microbial culture. Strain Improvement: Feedback

Mechanism, Isolation of mutants which do not produce feedback inhibitors or repressors. Isolation of mutants which do not recognize presence of inhibitors or repressors. Modification of Permeability.

Unit IV **(11L)**

Measurement & Control of Bioprocesses Parameters:

Cell growth. pH, temperature, Substrate consumption, product formation, Measurement of O2/CO2 uptake, evolution. Specific rates of consumption substrate & formation of product. Strategies for fermentation control. Foam & its control. Computer controlled fermentations. Scale up in Bioprocesses fermentations, Factors used in scale up.

Recommended Textbooks and References:

1. Principles of Fermentation Technology(2016) ed 3rd - Whittaker & Stan bury, Pergamon Press ISBN: 9780444634085.
2. Bioprocess Engineering Principles(1995) - Pauline Doran, Academic Press
3. Operational Modes of Bioreactors, BIOTOL series(1992) - Butter worth, Heinemann
4. Bioreactor Design & Product Yield, BIOTOL series(1992) - Butter worth Heinemann
5. Bioprocess Engineering: Systems, Equipment & Facilities(1993) - Ed. B. Lydersen, N.A. Delia & K.M. Nelson, John Wiley & Sons Inc,
6. Bio separation & Bioprocessing(1998) - Ed. G. Subramaniam, Wiley –VCH,
7. Product Recovery in Bioprocess Technology, 'BIOTOL series(1992) Butter worth Heinemann
8. Bio separation: Downstream Processing for Biotechnology(1988) - Paul A. Belter, E.L Cussler, Wei-Shou Hu, Academic Press.
9. Solvent Extraction in Biotechnology(1994) - Larl Schuger, Spinger Verlag,

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IV Semester

Course Title: Lab Course XV **Course Code: U-LAC- 503**
Marks: 50 M **Hours: 30** **Credit: 02**

Learning Objectives

- To get deeper understanding of fermentation technology
- To provide hands-on experience on sterilization techniques
- To Aquent the effect of various factors on growth Kinetics.
- To provide hands-on knowledge on isolation of microorganisms for production of industrially important products

Course Outcomes

On the successful completion of the course, student will be able to-

- describe how effective sterilization techniques control the contamination.
- perform qualitative analysis of fermentative products
- perform quantitative analysis of fermentative products
- solve problems encountered during fermentation process.

Practicals:

1. Strain improvement
2. Sterilization Techniques
3. Maintenance of pure Culture
4. Growth Curve
5. Growth kinetics: Effect of pH & Temp
6. Media Formulation
7. Sterilizer Design- TDP, TDT
8. Cell and Enzyme immobilization
9. Screening of Industrially important Microorganisms for production of Antibiotic, Organic acid, Enzyme
10. Production of Citric Acid by using *Aspergillus niger* .
11. Production of amylase from *Bacillus subtilis*
12. Production of lactic acid from Lactic Acid Bacteria
13. Visit to Fermentation Industry

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Course Title: Environmental Biotechnology **Course Code: U-ENZ-400**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To impart the understanding of global environmental problems.
- To get deeper understanding of environment pollutions.
- To understand waste water treatment technology.
- To acquaint bioremediation techniques.

Course Outcomes

On the successful completion of the course, student will be able to-

- describe various components of environment.
- explain types of pollution and associated pollutants.
- describe waste water treatment process.
- discuss bioremediation technology and its global perspective.

UNIT I: **(10 L)**

Components of Environment and Global Environmental Problems

Hydrosphere, lithosphere, atmosphere and biosphere – definitions with examples;

Environmental Studies as a multidisciplinary subject. Acid rain, Green House Effect,

Global warming, Ozone depletion, Biodiversity loss.

UNIT: II: **(12 L)**

Environmental pollution and Environmental Management

Pollution of air, water and land with reference to their causes, nature of pollutants & impact. Environmental damage by agriculture, Perspectives of pollution in urban, industrial and rural areas. Habitat Pollution with example. Environmental diseases – infectious (Water and air borne) and pollution related, Solid waste management.

UNIT: III- **(13 L)**

Waste water treatment and management

Domestic Waste Water Treatments: Preliminary, Primary, Secondary and Tertiary.

Waste water treatment Reactors: Introduction and types in brief Aerobic Biological Treatments: Activated sludge process, Lagoons Anaerobic Biological Treatments: upflow anaerobic sludge blanket (UASB) reactor, Fluidized bed reactor

UNIT IV **(10 L)**

Biodegradation and Bioremediation

Biodegradation of Hydrocarbon, Xenobiotics biodegradation-pesticide biodegradation Bioremediation: Introduction, Definition and Concept, Methods of Bioremediation (In Situ and Ex Situ Methods) Phytoremediation: Concept and Types

Recommended Textbooks and References:

1. Environmental Biotechnology: Theory and Applications (2003), Evan G. M. and Furlong J.C, John Wiley and Sons Ltd., England.
2. Environment: Problems and Solutions (2001), Asthana D.K. and Asthana M., S. Chand and Company Ltd, New Delhi.
3. Introduction to Environmental Biotechnology (2004) Chatterji A.K. Prentice Hall of India Pvt. Ltd, New Delhi.
4. Environmental Biotechnology (2006),3rd Edi. Jogdand S.N., Himalaya Publishing House, Mumbai.
5. Environmental Science and Biotechnology: Theroy and Techniques (2005). Murugesan A. G. and Rajakumari., C, MJP Publishers, Chennai.
6. Environmental Biotechnology Principles and Applications. (2001) Rittmann B. E. And McCarty P. L, McGraw Hill, USA
7. Waste water engineering and management (1972) Eddy and Metcalf Tata Mac Graw-Hill.

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IV Semester

Course Title: Lab Course XI **Course Code: U-LAC-404**
Marks: 50 **Credit: 02**

Learning Objectives

- To provide hands-on experience on water analysis.
- To provide practical experience on determination of presence of harmful microbes in environment.
- To identify hazardous pollutants and effect on human.

Course Outcomes

On the successful completion of the course, student will be able to-

- study effect of pollutants on environment.
- perform determination of DO, COD & BOD
- perform experiments for isolation of microbes from polluted water, soil & air
- analyze physico-chemical properties of water.

Practicals:

1. Visit and observe any two pollutant sights and write a short report on cause, effects and Remedial measures through biotechnology.
2. Waste water analysis for pollution and compare it with drinking water standards**.**
3. Determination of Dissolved oxygen (D.O.)
4. Determination of Biochemical oxygen demand (BOD).
5. Determination of Chemical Oxygen demand (COD)
6. Determination of Hardness of given water sample.
7. Determination of P^H of given water sample
8. Determination of alkalinity and chlorinity of given water sample.
9. Detection of water through Bacterial Examination of Water by MPN Test:
10. Isolation of bacteria from polluted water.
11. Isolation of fungi from polluted water.
12. Isolation of bacteria from polluted air.
13. Isolation of fungi from polluted air.
14. Isolation of hydrocarbon degrading bacteria and test it for degradation of aromatic hydrocarbons.
15. To observe effects of air pollutants on plants and note the nature of pollution in your surrounding and suggest remedial measures.

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IV Semester
Skill Enhancement Course

Course Title: Algal Cultivation Technology Course Code: U-ADC-434-A

Marks 50 Hours 30 Credit: 02

Learning objectives:

- To learn collection, maintenance and preservation of algal culture.
- To study of basic and applied science behind the production of mass culture.
- To teach students about current applications and future potential of algae.
- To educate students on the commercial production of algae.

Course outcome:

On the successful completion of the course, student will be able to-

- acquire the knowledge of Algal culturing techniques.
- learn laboratory skill, lab organization & nutritional importance of different algae.
- understand about the algal isolation, identification, screening and cultivation, method.
- describe structure, functions and the economic importance of algae.

Unit I (8 L)

Theory: Introduction to Algae, Life cycle of Algae, Role of Algae in Ecosystem.

Practical:

1. Collection & Microscopic observation of algae.

2. Quantification of collected algae.

Unit II (8 L)

Theory: Techniques for cultivation of Algae in laboratory, seed culture & its maintenance. Designing of photo-bioreactor and Raceway Ponds for algal cultivation & its application.

Practical:

1.Isolation, Identification of economic important algae.

2.Inoculam development pilot scale production.

Unit III **(6L)**

Theory:

Algal Biotechnology – potential of microalgae for SCP, carotene, Biofertilizer, Biodiesel; Principles of mass cultivation of microalgae and its Economic Importance.

Practical:

1. Qualitative estimation of protein from algae.

2.Chromatographic separation of essential biomolicules from algae.

Unit IV **(8 L)**

Theory

Business economics for algal cultivation, Indoor cultivation methods and scaling up, Large-scale cultivation and processing of algae, Futuristic approaches in algal biotechnology.

Practical

1.Visit to industry actively engaged in algal technology.

2.Project report on algal technology.

3. Study of Spirulina production and its products.

Recommended Textbooks and References:

1. Handbook of Algal Biofuels (2022). Mostafa El-Sheekh and Abd El-Fatah Abomohra

2. Algal Culturing technique (2004). Editor: Robert A. Andersene .Elsevier publications.

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IV Semester
Skill Enhancement Course

Course Title: Mushroom Cultivation **Course Code: U-ADC-434-A**

Marks 50 **Hours 30** **Credit: 02**

Learning Objectives:

- To teach the student about various cultivation method of mushroom.
- To make the student to understand about commercial & medicinal importance of mushroom.
- To learn seed culture preparation and preservation methods.
- To help the learners to practice a means of self-employment and income generation

Course Objectives:

On the successful completion of the course, student will be able to-

- distinguish the principle of various cultivation methods of mushroom.
- grow various varieties of Mushroom in-house.
- standardize protocol for commercial production of Mushroom.
- Knowledge of harvesting and post harvesting processes of mushroom.

Unit: I **(06 L)**

Cultivation System & Farm design:
Fundamentals of cultivation system-
Small village unit & larger commercial unit.
Principles of mushroom farm layout-location of building plot, design of farm, bulk chamber, composting platform, equipment & facilities, Pasteurization room & growing rooms.

Practical:

1) To study sterilization techniques for culture media

Unit: II **(06 L)**

Compost & Composting:
Principles of composting, machinery required for compost making, materials for compost preparation.
Methods of Composting-Long method of composting (LMC) & Short method of composting (SMC).

Practical:

2) Preparation of raw material for spawning.

Unit: III **(06 L)**

Spawn & Spawning:

Facilities required for spawn preparation, Preparation of spawn substrate, preparation of pure culture, media used in raising pure culture, culture maintenance, and storage of spawn.

Practical:

3) Preparation of culture, mother spawn production, multiplication of spawn

Unit: IV **(06 L)**

Casting materials & Case running:

Importance of casing mixture, Quality parameters of casing soil, different types of casing mixtures, commonly used materials.

Unit: V **(06 L)**

Cultivation of Button, Oyster and Straw Mushrooms:

Collection of raw materials, compost & composting, spawn & spawning, casing & case run, cropping & crop management, picking & packing. Visit to relevant Labs/Field Visits

Practical:

4) Cultivation techniques, harvesting, packing and storage.
5) Problems in cultivation --- diseases, pests and nematodes, weed moulds and their management strategies.
6) Maintenance of mushroom beds of oyster mushroom, and *Agaricus.* Processing and preservation of mushrooms, economics of spawn and mushroom production.

Recommended Textbooks and References:

1. Mushroom Cultivation (2005) Tripathi, D.P Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
2. Mushroom Production and Processing Technology (2010). Pathak Yadav Gour Published by Agrobios (India).
3 A hand book of edible mushroom (1980). S. Kannaiyan & K. Ramasamy (1980). Today & Tomorrows printers & Publishers, New Delhi
4. Handbook on Mushrooms (2000). Nita Bahl, oxford & IBH Publishing Company.

Summary of cross cutting issues:

Biotechnology is a collective term for a group of technologies that use biological matter or processes to generate new and useful products and processes. As such, it ranges in complexity and maturity from ancient brewing and bread-making techniques to genetic modification through hybridization and interbreeding of plants and animals, as well as the manipulation of individual genes in humans, animals, plants and micro-organisms. Biotechnology is a key technology for the new millennium. It has an immense range of applications in agriculture, medicine, food processing, environmental protection, mining, and even nanoelectronics.

It is expected to cover some critical issues in the designed curriculum for the development of Students. In our syllabus we tried to include following cross cutting issues.

Cross-cutting issues relevant to Professional Ethics, Gender, Environment and Sustainability, and Human Values into the curriculum:

Sr. No.	Course Name	Code	Relevant to Professional Ethics	Description
1	Applied Microbiology	U-APM-398	Professional Ethics	Students will enable as an expert in role of microorganism in biogeocycles
2	Immunology and Virology	U-IMV-399	Professional Ethics	Student will be skilled in Immunotechniques
3	Molecular Biology	U-MOB-400	Professional Ethics	Expertise in Molecular Techniques (Lab Technician)
4	Metabolism	U-MET-401	Professional Ethics	Skilled in Metabolomics
5	Good Laboratory Practices	U-ADC-334	Professional Ethics	Expertise in Practical skills/
6	Enzymology	U-ENZ-498	Professional Ethics	Expertise in Enzyme Technology
7	Process Biotechnology	U-PRB-499	Professional Ethics	Expertise in Upstream and Downstream processing of industrial products

8	Algal Cultivation Technology/ Mushroom Cultivation	U-ADC-434	Professional Ethics	Skilled in algal production/mushroom cultivation

Environment and Sustainability

Sr. No.	Course Name	Code	Relevant to Environment and Sustainability	Description
1	Biodiversity and Systematics	U-BDS-497	Environment and Sustainability	It plays a crucial role in the composition and functioning of every ecosystem and their cycles: the water cycle, the food chain, the soil cycle.
2	Environmental Biotechnology	U-ENV-500	Environment and Sustainability	The significant benefits of environmental biotechnology are that it helps us to make our environment safer and cleaner for further use.

Human Values

Sr. No.	Course Name	Code	Relevant to Human values	Description
1	Human Excellence Development	**U-ADC-334**	**Human values**	inculcate Human Values and Ethics

Curricula developed and implemented have relevance to the local, national, regional and global developmental needs

Sr. No.	Course code	Course Name	Linkage with Local/National/Regional/Global development
1.	U-APM-398	Applied Microbiology	Solution to Environmental Problems
2.	U-IMV-399	Immunology and Virology	Basic Immuno techniques
3.	U-FMB-400	Fundamentals of Molecular Biology	Molecular Techniques
4.	U-MET-401	Metabolism	Qualitative and Quantitative Analysis of Metabolites
5.	U-ADC-334	Good Laboratory Practices/Human Excellence Development	GLP (Practices in Industry and Research)
6.	U-BDS-497	Biodiversity and Systematic	Conservation of endangered species
7.	U-ENZ-498	Enzymology	Quantitative Analysis, Production, Purification techniques
8.	U-PRB-499	Process Biotechnology	Quality Control, Upstream and Downstream Processing in Industry
9.	U-ENV-500	Environmental Biotechnology	Global Environmental issues, Solution to Environment Problems
10.	U-ADC-434	Algal Cultivation Technology/ Mushroom Cultivation	SCP Production, Purification, Marketing

Courses having focus on employability/ entrepreneurship/ skill development

Sr. No.	Name of the Course	Course Code	Activities/Content with a direct bearing on Employability/ Entrepreneurship/ Skill development			Year of introduction
			Employability	**Entrepreneurship**	**Skill development**	
1	Applied Microbiology	U-APM-398	Job opportunities as Lab technician/principal investigator		Students will expert be expertise in role of microorganism in biogeocycles/Bioremediation	2018-2019
2	Immunology and Virology	U-IMV-399	Expertise in immunological techniques will create employability in Pathology Labs, Clinical and Research Institutes		Student will be skilled in Immuno techniques	2018-2019
3	Molecular Biology	U-MOB-400	Job opportunities as Lab technician/principal investigator		basics and advance molecular tools and techniques which helps in diagnosis of disease at molecular level	2018-2019
4	Metabolism	U-MET-401			Skilled in Metabolomics	2018-19
5	Good Laboratory Practices/Human Excellence Development	U-ADC-334			Expertise in Practical skills/inculcate Human Values and Ethics	
6	Biodiversity and Systematic	U-BDS-497	Work as a consultant and resources person for conservation		Student will get updated with current problems and strategies to mitigate the loss of	2019-20

			of biodiversity		biodiversity	
7	Enzymology	U-ENZ-498			Student will get exposure of wide applications of enzymes and their future potential	2018-2019
8	Process Biotechnology	U-PRB-499	Students will get job in Fermentation Industries. Wineries		Student will understand the Upstream and Downstream processing of Industrial Products	2018-2019
9	Environmental Biotechnology	U-ENV-500	Job opportunity as Environment officer/Public Health officer	Knowledge of waste management helps the student to become good Entrepreneur	Students will be skilled in water analysis /soil analysis/waste management	2018-2019
10	Algal Cultivation Technology / Mushroom Cultivation	U-ADC-434	Job opportunity in Production Lab	Set Up Algal Production Lab/mushroom Cultivation Plant	Students will be able to understand the collection and processing of algae/mushroom cultivation	2018-19